

**17<sup>th</sup> annual Congress of the  
EUROPEAN COLLEGE OF SPORT SCIENCE**

**4-7<sup>th</sup> July ECSS Bruges 2012 – Belgium**

**BOOK OF ABSTRACTS**

**Edited by:**

Meeusen, R., Duchateau, J., Roelands, B., Klass, M., De Geus, B., Baudry, S., Tsolakidis, E.

Hosted by:

Vrije Universiteit Brussel & Université Libre de Bruxelles

ISBN 978-90902686-8-2

**European College of Sport Science:**

Book of Abstracts of the 17<sup>th</sup> Annual Congress of the

European College of Sport Science – 4-7<sup>th</sup> July ECSS Bruges 2012 – Belgium.

Edited by Meeusen, R., Duchateau, J., Roelands, B., Klass, M., De Geus, B., Baudry, S., Tsolakidis, E.

ISBN 978-90902686-8-2

Copyright by European College of Sport Science

Conception & DTP: SporTools GmbH – Data management in sports

Cover: Stéphane Baudry

Corrections: Patera, N., Chassapis D., Tsolakidis, K.

Printed by: BlosoVlaamseoverheid

supported by

**SPORTTOOLS**

Data management in sports

Paul-Niessen-Str. 12, 50969 Cologne, Germany

[www.SporTools.de](http://www.SporTools.de)

# Organization

---

## Congress President

Romain Meeusen (BEL)  
Jacques Duchateau (BEL)

## ECSS Executive Board

President: Sigmund Loland (NOR)  
Past President: Hans Hoppeler (SUI)  
President Elect: Marco Narici (GBR)  
Exchanges and Affiliations: Romain Meeusen (BEL)  
Journal and Media Relations: Gisela Sjøgaard (DNK)  
Finances and Partners: Tim Cable (GBR)

## ECSS Scientific Board

Anton Wagenmarkers, Chair (GBR)  
Flemming Dela, Co-Chair (DEN)  
Jan Cabri, Secretary (NOR)  
Peter Bärtsch (GER)  
Joan Duda (GBR)  
Paul Greenhaff (GBR)  
Martin Halle (GER)  
Jose Antonio Lopez Calbet (ESP)  
Erich Müller (AUT)  
Gertrud Pfister (DEN)

## ECSS Scientific Committee

Natalia Balague (ESP)  
Wilhelm Bloch (GER)  
Annalisa Cogo (ITA)  
Nenad Dikic (SRB)  
Taija Finni (FIN)  
Daniel Green (GBR)  
Michael Grey (GBR)  
Markus Gruber (GER)  
Jørn Wulff Helge (DEN)  
Ylva Hellsten (DEN)  
Luc van Loon (NED)  
Mike McNamee (GBR)  
Maria Francesca Piacentini (ITA)  
Janice L. Thompson (GBR)  
Nicole Wenderoth (BEL)

## Local Scientific Committee

Jean-Pierre Baeyens (BEL)  
Stéphane Baudry (BEL)  
Luk Buyse (BEL)  
Alain Carpentier (BEL)  
Erik Cattrysse (BEL)  
Peter Clarys (BEL)  
Veerle De Bosscher (BEL)  
Bas de Geus (BEL)  
Kristine De Martelaer (BEL)  
Benedicte Deforche (BEL)  
Jacques Duchateau (BEL)

Véronique Feipel (BEL)  
Malgorzata Klass (BEL)  
Romain Meeusen (BEL)  
Nathalie Pattyn (BEL)  
Jacques Poortmans (BEL)  
Steven Provyn (BEL)  
Bart Roelands (BEL)  
Mark Theeboom (BEL)  
Peter Vaes (BEL)  
Luc Van Loon (NLD)  
Evert Verhagen (NLD)  
Paul Wylleman (BEL)  
Evert Zinzen (BEL)

#### **Additional reviewers**

Dirk Aerenhouts  
Constantino Balestra  
Peter Bartsch  
Nathalie Boisseau  
Jan Cabri  
Ariane Caplin  
Laura Capranica  
Marc Cloes  
Wouter Cools  
Cristina Cortis  
Gael Deboeck  
Benedicte Deforche  
Roger Enoka  
Vitalie Faoro  
Veronique Feipel  
Jean-Francois Grosset  
Leen Haerens  
Dominique Hansen  
Floor Hettinga  
Jo Van Hoecke  
Kristel Knaepen  
Jos De Koning  
Michel Lamotte  
Vesa Linnamo  
Sigmund Loland  
Mira Meeus  
Erich Muller  
Caroline Nicole  
Jo Nijs  
Jessica Van Oosterwijk  
Frank Pauwels  
Gertrud Pfister  
Maria Francesca Piacentini  
Steven Provyn  
Jan Seghers  
Filip Struyf  
Heiko Strueder  
Antonio Tessitore  
Jo Verschueren  
Philip Watson  
Paul Wylleman

## **Organizing Committee**

Stéphane Baudry (BEL)  
Bas de Geus (BEL)  
Kevin De Pauw (BEL)  
Jacques Duchateau (BEL)  
Malgorzata Klass (BEL)  
Romain Meeusen (BEL)  
Nathalie Pattyn (BEL)  
Bart Roelands (BEL)  
Werner Van Cleemputte (BEL)  
Laurens Wets (BEL)

## **ECSS Office**

Thomas Delaveaux (DE)  
Sarah Köster (DE)  
Juliane Melber (DE)  
Steffen Neubert (DE)  
Elias Tsolakidis (DE)  
Tobias Vogt (DE)



# Welcome

---

On behalf of the European College of Sport Science (ECSS) and the Free Universities of Brussels, we welcome you to Bruges for the 17th annual congress of the ECSS.

The two universities hosting ECSS 2012, Université Libre de Bruxelles and Vrije Universiteit Brussel, have for many years contributed to the development of sport science in Europe. This sustained commitment to sport-related research from Brussels, the site of the European Institutions, led us to choose **"Sport Science in the Heart of Europe"** as the theme of the 17th congress of the ECSS.

The Bruges congress comprises an outstanding scientific programme that emphasizes contemporary knowledge in sport science. The congress will feature 4 plenary sessions and 36 invited symposia on topical issues in the field, the vitality of which is underscored by the submission of close to 2000 abstracts from approximately 60 countries. After a thorough review and the withdrawal of some abstracts, ~85% of the submitted abstracts have been selected for the final programme. These free communications are distributed among 74 thematic oral and 115 e-poster sessions. A new feature this year is that all posters (1132 abstracts) will be presented in electronic format, which we anticipate will increase interactions among meeting participants.

Bruges was chosen as the host city for the congress due to its beauty and its historical role in the development of Europe. In these ancient times, Bruges was one of the European cities in which intellectual, artistic, and trading activities converged and then expanded into Europe and well beyond. This history captures the objective of the College to establish a strong foundation for sport science in Europe and into the world.

By combining the cultural heritage and beauty of Bruges with a high-quality scientific programme, we anticipate that the 17th annual congress of the ECSS will be an exceptional professional experience. On behalf of the ECSS and the local organisers, we wish you a productive and enjoyable stay in **Bruges**.

Prof. R. Meeusen (VUB)

Prof. J. Duchateau (ULB)





# Table of Contents

---

|                                                                                                                 |           |
|-----------------------------------------------------------------------------------------------------------------|-----------|
| <b>ORGANIZATION.....</b>                                                                                        | <b>3</b>  |
| <b>WELCOME.....</b>                                                                                             | <b>7</b>  |
| <b>TABLE OF CONTENTS .....</b>                                                                                  | <b>9</b>  |
| <b>WEDNESDAY, JULY 4TH, 2012 .....</b>                                                                          | <b>18</b> |
| <b>15:00 - 16:30.....</b>                                                                                       | <b>18</b> |
| IS-PM05 Exercise in Extreme Environments: From Space to Antarctica .....                                        | 18        |
| OP-SH01 Sport Management .....                                                                                  | 19        |
| OP-BN01 Sports Biomechanics 1 .....                                                                             | 21        |
| OP-PM01 Muscle signaling and adaptation.....                                                                    | 23        |
| OP-PM02 Health and Lifestyle Interventions.....                                                                 | 25        |
| IS-SH10 A Cost-Benefit Analysis of Exercise for Health (*) .....                                                | 27        |
| IS-BN01 Importance of Feedback in Motor Control and Learning .....                                              | 29        |
| IS-PM01 JSPFSM Exchange Symposium: Physiological and environmental factors influencing sports performance ..... | 30        |
| OP-PM03 Neuromuscular Physiology 1 .....                                                                        | 31        |
| OP-PM04 Brain and Exercise Performance .....                                                                    | 34        |
| <b>17:00 - 18:30.....</b>                                                                                       | <b>36</b> |
| PS-PL01 Cycling Economy: From Performance to Business .....                                                     | 36        |
| <b>THURSDAY, JULY 5TH, 2012.....</b>                                                                            | <b>38</b> |
| <b>08:00 - 09:30 .....</b>                                                                                      | <b>38</b> |
| IS-PM11 Skeletal Muscle Stem Cells .....                                                                        | 38        |
| OP-SH02 Sport and Exercise Psychology .....                                                                     | 39        |
| OP-BN02 Gait and running patterns .....                                                                         | 41        |
| OP-PM05 Training and Testing 1.....                                                                             | 43        |
| OP-PM06 Skeletal Muscle Physiology .....                                                                        | 45        |
| IS-SH03 Winning the Gold Medal War: The Production of Elite Sporting Success .....                              | 48        |
| IS-BN02 The Motor Control of Human Locomotion: the Role of Stretch Reflex in Natural Human Movement.....        | 49        |
| IS-PM04 Exercise and Testing in Patient Populations (*) sponsored by Xlab.dk .....                              | 50        |
| OP-PM07 Exercise and Cardiac Physiology.....                                                                    | 51        |
| OP-PM08 High Intensity Training .....                                                                           | 53        |
| <b>09:50 - 11:20.....</b>                                                                                       | <b>55</b> |
| IS-PM06 Nutritional Supplementation and Sports: Hopes and Disappointments .....                                 | 55        |
| OP-BN03 Motor Learning .....                                                                                    | 56        |
| OP-PM09 Measurement and analysis techniques .....                                                               | 58        |
| OP-PM10 Sports Medicine/Exercise Therapy .....                                                                  | 61        |
| OP-PM11 Nutrition 1.....                                                                                        | 63        |
| IS-SH04 Martial Arts from a Multidisciplinary Perspective: Historical, Sociological and Psychological .....     | 65        |
| IS-BN03 Neuroplasticity: From Basic Sciences to Sport Performance.....                                          | 66        |

|                                                                   |            |
|-------------------------------------------------------------------|------------|
| OP-BN04 Muscle/Tendon/Bone .....                                  | 68         |
| OP-PM12 Training & Tapering .....                                 | 70         |
| OP-PM13 Pacing and Perception .....                               | 73         |
| <b>11:30 - 12:45 .....</b>                                        | <b>75</b>  |
| PS-PL02 Performance in the Heat: What Happens in your Head? ..... | 75         |
| <b>13:45 - 14:45 .....</b>                                        | <b>76</b>  |
| PP-BN01 Sport Biomechanics 1 .....                                | 76         |
| PP-BN02 Motor Learning and Coaching 1 .....                       | 80         |
| PP-PM01 Sports Medicine 1 .....                                   | 84         |
| PP-PM02 Nutrition 1 .....                                         | 88         |
| PP-PM03 Physical Activity .....                                   | 92         |
| PP-PM04 Physiology and Biochemistry .....                         | 97         |
| PP-PM05 Neuromuscular Physiology 1 .....                          | 100        |
| PP-PM06 Rehabilitation, Physiotherapy, Health and Fitness .....   | 105        |
| PP-PM07 Training & Testing 1 .....                                | 109        |
| PP-SH01 Psychology 1 .....                                        | 114        |
| PP-PM08 Sports Medicine 2 .....                                   | 118        |
| PP-BN05 Coaching 1 .....                                          | 122        |
| PP-SH03 Sport Management .....                                    | 125        |
| PP-SH04 Sport Statistics and Analysis 1 .....                     | 129        |
| PP-PM16 Rehabilitation 1 .....                                    | 132        |
| PP-PM17 Physiotherapy .....                                       | 134        |
| PP-PM18 Nutrition 2 .....                                         | 137        |
| PP-PM19 Adapted Physical Activity 1 .....                         | 140        |
| PP-PM20 Health & Fitness 1 .....                                  | 144        |
| PP-PM21 Training & Testing 3 .....                                | 148        |
| <b>14:45 - 15:45 .....</b>                                        | <b>151</b> |
| PP-BN03 Sport Biomechanics 2 .....                                | 151        |
| PP-BN04 Sport Biomechanics 3 .....                                | 156        |
| PP-PM09 Physiology 1 .....                                        | 160        |
| PP-PM10 Physiology 2 .....                                        | 165        |
| PP-PM11 Physiology 3 .....                                        | 169        |
| PP-PM12 Physiology 4 .....                                        | 174        |
| PP-PM13 Physiology 5 .....                                        | 177        |
| PP-PM14 Training & Testing 2 .....                                | 181        |
| PP-PM15 Physiology 6 .....                                        | 185        |
| PP-SH02 Social Sciences and Humanities 1 .....                    | 189        |
| PP-BN06 Sport Biomechanics 4 : Neuromuscular Aspects .....        | 193        |
| PP-BN07 Coaching 2 .....                                          | 196        |
| PP-SH05 Management & Ethics .....                                 | 200        |
| PP-SH06 Physical Education and Pedagogics 1 .....                 | 203        |
| PP-SH07 Sport Psychology .....                                    | 207        |
| PP-PM22 Sports Medicine 3 .....                                   | 210        |
| PP-PM23 Training & Testing 4 .....                                | 214        |

|                                                                                                              |            |
|--------------------------------------------------------------------------------------------------------------|------------|
| PP-PM24 Training & Testing 5 .....                                                                           | 218        |
| PP-PM25 Health & Fitness: Elderly .....                                                                      | 222        |
| PP-PM26 Physiology 7 .....                                                                                   | 225        |
| <b>16:05 - 17:35 .....</b>                                                                                   | <b>230</b> |
| IS-PM02 ACSM Exchange Symposium/Pacing : Who Got the Turtle's Running Shoes? .....                           | 230        |
| OP-SH03 Management and economics in sports .....                                                             | 230        |
| OP-PM14 Sports Medicine 2 .....                                                                              | 232        |
| OP-PM15 Health and Fitness 2 .....                                                                           | 234        |
| OP-PM16 Nutrition 2 .....                                                                                    | 236        |
| IS-SH02 It's Natural to Play: Promoting Psychomotor Development in Challenging Environments .....            | 239        |
| IS-BN05 Musculoskeletal Modelling for Problem Solving in Rehabilitation (*) .....                            | 240        |
| OP-BN05 Sports Biomechanics 2 .....                                                                          | 241        |
| OP-PM17 Training and Testing 2 .....                                                                         | 243        |
| OP-PM18 The Elite Athlete .....                                                                              | 245        |
| <b>17:45 - 19:15 .....</b>                                                                                   | <b>246</b> |
| IS-PM08 Towards an Integrative Approach of Exercise-Induced Fatigue .....                                    | 246        |
| OP-SH04 Sport Psychology 2 .....                                                                             | 247        |
| OP-PM19 Training and Testing 3 .....                                                                         | 250        |
| OP-PM20 Health and Fitness: Elderly population .....                                                         | 251        |
| OP-PM21 Molecular Biology 2 .....                                                                            | 254        |
| IS-SH01 Intervention Development Using Social, Environmental and Psychological Approaches .....              | 256        |
| OP-PM22 Training and Testing: Youth population .....                                                         | 257        |
| IS-PM07 Exercise to Reduce Musculoskeletal Pain (*) .....                                                    | 259        |
| OP-PM23 Cardiovascular Physiology .....                                                                      | 260        |
| OP-PM24 Exercise Physiology 2 .....                                                                          | 263        |
| <b>FRIDAY, JULY 6TH, 2012 .....</b>                                                                          | <b>266</b> |
| <b>08:00 - 09:30 .....</b>                                                                                   | <b>266</b> |
| IS-PM13 Evidence Based Physiotherapy (Cardiac Rehabilitation) (*) .....                                      | 266        |
| OP-SH05 Experimental Psychology .....                                                                        | 267        |
| OP-PM25 Sport Science .....                                                                                  | 269        |
| OP-PM26 Sport Medicine: Experimental Interventions .....                                                     | 271        |
| OP-PM27 Physiotherapy and Sports Medicine .....                                                              | 273        |
| IS-SH06 Psychological and Sociological Perspectives on Prevention and Rehabilitation of Sport Injuries ..... | 275        |
| IS-BN10 Tendon Plasticity: Neuromechanics and Motor Output .....                                             | 276        |
| OP-BN06 Biomechanics .....                                                                                   | 277        |
| OP-PM28 Training and Testing: Elite Athletes .....                                                           | 279        |
| OP-PM29 Molecular Physiology .....                                                                           | 281        |
| <b>09:50 - 11:20 .....</b>                                                                                   | <b>283</b> |
| IS-PM03 Sports Nutrition Symposium: Sports Nutrition offered by Mother Earth sponsored by GSSI .....         | 283        |
| OP-SH06 Sociology .....                                                                                      | 284        |
| OP-PM30 Health and Fitness: Female population .....                                                          | 286        |
| OP-PM31 Training and Testing 4 .....                                                                         | 288        |

|                                                                    |            |
|--------------------------------------------------------------------|------------|
| OP-PM32 Neuromuscular Physiology: Fatigue .....                    | 290        |
| IS-SH05 Social-Psychological Issues in Team Sports .....           | 292        |
| IS-BN04 Balance Control in Elderly: Fall Risk and Prevention ..... | 293        |
| OP-BN07 Coaching .....                                             | 295        |
| OP-PM33 Training and Testing: Pacing Strategies .....              | 297        |
| OP-PM34 Metabolic Physiology.....                                  | 299        |
| <b>11:30 - 12:45 .....</b>                                         | <b>301</b> |
| PS-PL03 Olympism & Sport (*).....                                  | 301        |
| <b>13:45 - 14:45 .....</b>                                         | <b>301</b> |
| PP-PM27 Training & Testing 6: Swimming.....                        | 301        |
| PP-PM28 Physiology 8 .....                                         | 306        |
| PP-PM29 Physiology 9 .....                                         | 310        |
| PP-PM30 Health & Fitness: Children .....                           | 314        |
| PP-PM31 Health & Fitness: Disease.....                             | 317        |
| PP-PM32 Molecular Biology 1 .....                                  | 320        |
| PP-PM33 Neuromuscular Physiology 2 .....                           | 323        |
| PP-PM34 Training & Testing 7.....                                  | 326        |
| PP-PM35 Physiology 10.....                                         | 330        |
| PP-PM36 Biochemistry.....                                          | 334        |
| PP-BN08 Sport Biomechanics 5 .....                                 | 338        |
| PP-BN09 Motor Learning and Coaching 2.....                         | 342        |
| PP-SH08 Physical Education and Pedagogics 2 .....                  | 345        |
| PP-SH09 Sociology .....                                            | 349        |
| PP-SH10 Psychology 2 .....                                         | 352        |
| PP-PM37 Sports Medicine 4 .....                                    | 356        |
| PP-PM38 Nutrition 3 .....                                          | 359        |
| PP-PM39 Adapted Physical Activity 2.....                           | 362        |
| PP-PM40 Nutrition 4 .....                                          | 366        |
| PP-PM41 Health & Fitness: Sport and supplements.....               | 370        |
| <b>14:45 - 15:45 .....</b>                                         | <b>374</b> |
| PP-PM42 Training & Testing 8.....                                  | 374        |
| PP-PM43 Physiology 11 .....                                        | 377        |
| PP-PM44 Biochemistry, Training & Testing .....                     | 381        |
| PP-PM45 Health & Fitness: Physical Activity 1 .....                | 385        |
| PP-PM46 Health & Fitness: Exercise .....                           | 389        |
| PP-PM47 Molecular Biology 2 .....                                  | 392        |
| PP-PM48 Neuromuscular Physiology 3 .....                           | 395        |
| PP-PM49 Training & Testing 9.....                                  | 399        |
| PP-PM50 Physiology 12.....                                         | 404        |
| PP-PM51 Physiology 13 .....                                        | 408        |
| PP-BN10 Sport Biomechanics 6 .....                                 | 412        |
| PP-BN11 Motor Learning 1 .....                                     | 415        |
| PP-SH11 Psychology 3.....                                          | 420        |
| PP-SH12 Sport Statistics and Analysis 2 .....                      | 424        |

|                                                                                                           |            |
|-----------------------------------------------------------------------------------------------------------|------------|
| PP-PM52 Rehabilitation and Sports Medicine.....                                                           | 428        |
| PP-PM53 Sports Medicine 5.....                                                                            | 432        |
| PP-PM54 Training & Testing 10.....                                                                        | 434        |
| PP-PM55 Health & Fitness: Physical Activity 2.....                                                        | 438        |
| PP-PM56 Training & Testing 11.....                                                                        | 441        |
| PP-PM57 Training & Testing 12.....                                                                        | 445        |
| <b>16:05 - 17:35.....</b>                                                                                 | <b>449</b> |
| IS-PM12 Benefits of High Intensity Intermittent Training (HIIT) in Untrained and Diseased People (*)..... | 449        |
| OP-SH07 Sport Psychology 3.....                                                                           | 450        |
| OP-PM35 Rehabilitation 1.....                                                                             | 452        |
| OP-PM36 Reliability and Validity of testing procedures.....                                               | 455        |
| OP-PM37 Muscle Physiology.....                                                                            | 457        |
| IS-SH07 Role and Competences of PE Teacher and Coaches.....                                               | 459        |
| IS-BN08 Biomechanics and Optimizing Performance in Elite Sports.....                                      | 460        |
| OP-BN08 Sports Biomechanics 3.....                                                                        | 461        |
| OP-PM38 Health and Fitness: Obese population.....                                                         | 464        |
| OP-PM39 Neuromuscular Physiology 2.....                                                                   | 466        |
| <b>17:45 - 19:15.....</b>                                                                                 | <b>468</b> |
| IS-PM09 Mechanism in Sarcopenia.....                                                                      | 468        |
| OP-SH08 Sport Statistics & Analysis.....                                                                  | 469        |
| OP-PM40 Rehabilitation 2.....                                                                             | 471        |
| OP-PM41 Biochemistry.....                                                                                 | 473        |
| OP-PM42 Training and Testing 5.....                                                                       | 475        |
| IS-SH08 Life-Style Sports and Youth Development.....                                                      | 478        |
| IS-BN06 Biomechanics and Injury Prevention in Elite Sports (*).....                                       | 479        |
| OP-SH09 Psychology.....                                                                                   | 480        |
| OP-PM43 Health and Fitness: Youth population.....                                                         | 481        |
| OP-PM44 Exercise Physiology 3.....                                                                        | 483        |
| <b>SATURDAY, JULY 7TH, 2012.....</b>                                                                      | <b>486</b> |
| <b>08:00 - 09:30.....</b>                                                                                 | <b>486</b> |
| IS-PM10 Protein Turnover and Inactivity.....                                                              | 486        |
| OP-SH10 Physical Education and pedagogics 1.....                                                          | 487        |
| OP-PM45 Sports Medicine: Game Injuries.....                                                               | 489        |
| OP-PM46 Neuromuscular Physiology 3.....                                                                   | 491        |
| OP-PM47 Neuroscience.....                                                                                 | 493        |
| IS-SH09 The Integrative Role of Sport in Multicultural Societies: From Research to Practice.....          | 496        |
| IS-BN07 Core Stability and Injury in Sports (*).....                                                      | 497        |
| OP-BN09 Sports Biomechanics 4.....                                                                        | 497        |
| OP-PM48 Health and Fitness 3.....                                                                         | 500        |
| OP-PM49 VO2max and O2 Kinetics.....                                                                       | 502        |
| <b>09:50 - 11:20.....</b>                                                                                 | <b>504</b> |
| IS-PM14 The Athletes Paradox Revisited: Athletic Lessons for Diabetic People (*).....                     | 504        |

|                                                                                |            |
|--------------------------------------------------------------------------------|------------|
| OP-SH11 Physical Education and pedagogics 2 .....                              | 505        |
| OP-PM50 Sports Medicine 3 .....                                                | 507        |
| OP-PM51 Training, testing and health .....                                     | 509        |
| OP-PM52 Cardiovascular physiology 2 .....                                      | 512        |
| IS-SH11 European Sports Tradition: Towards Unified Concepts and Policies.....  | 514        |
| IS-BN09 Neuromechanics of Stretch Shortening Cycle: Application to Sports..... | 515        |
| IS-PM15 Exercise in cancer patients (*) .....                                  | 516        |
| OP-PM53 Training and Testing: Fatigue .....                                    | 517        |
| OP-PM54 Physiology: Performance / Hypoxia.....                                 | 520        |
| <b>11:30 - 12:45 .....</b>                                                     | <b>522</b> |
| PS-PL04 Sport Science in the Heart of Europe (*) .....                         | 522        |
| <b>13:45 - 14:45 .....</b>                                                     | <b>522</b> |
| PP-PM58 Physiology 14.....                                                     | 522        |
| PP-PM59 Physiology 15.....                                                     | 526        |
| PP-PM60 Training & Testing 13 .....                                            | 531        |
| PP-PM61 Health & Fitness: BMI 1.....                                           | 534        |
| PP-PM62 Health & Fitness: BMI 2 .....                                          | 538        |
| PP-PM63 Neuromuscular physiology 4 .....                                       | 540        |
| PP-PM64 Training & Testing 14 .....                                            | 544        |
| PP-PM65 Physiology 16.....                                                     | 548        |
| PP-PM66 Physiology 17 .....                                                    | 551        |
| PP-PM67 Physiology 18 .....                                                    | 555        |
| PP-BN12 Sport Biomechanics 7 : Gait & Balance .....                            | 558        |
| PP-BN13 Motor Learning 2.....                                                  | 562        |
| PP-SH13 Psychology 4.....                                                      | 565        |
| PP-SH14 Physical Education and Pedagogics 3 .....                              | 569        |
| PP-SH15 Social Sciences and Humanities 2.....                                  | 572        |
| PP-PM68 Sports Medicine 6 .....                                                | 575        |
| PP-PM69 Sports Medicine 7 .....                                                | 578        |
| PP-PM70 Nutrition 5 .....                                                      | 582        |
| PP-PM71 Training & Testing 15 .....                                            | 586        |
| PP-PM72 Training & Testing 16 .....                                            | 589        |
| <b>14:45 - 15:45 .....</b>                                                     | <b>593</b> |
| PP-PM73 Physiology 19 .....                                                    | 593        |
| PP-PM74 Physiology 20 .....                                                    | 597        |
| PP-PM75 Training & Testing 17.....                                             | 601        |
| PP-PM76 Health & Fitness 2 .....                                               | 605        |
| PP-PM77 Health & Fitness 3 .....                                               | 608        |
| PP-PM78 Training & Testing 18 .....                                            | 612        |
| PP-PM79 Training & Testing 19 .....                                            | 616        |
| PP-PM80 Physiology 21.....                                                     | 620        |
| PP-PM81 Physiology 22.....                                                     | 623        |
| PP-PM82 Physiology 23 .....                                                    | 627        |
| PP-BN14 Sport Biomechanics 8.....                                              | 631        |

|                                             |            |
|---------------------------------------------|------------|
| PP-PM83 Nutrition 5 .....                   | 636        |
| PP-SH16 Sport Psychology: Team sports ..... | 638        |
| PP-PM84 Physiology 24 .....                 | 642        |
| PP-PM85 Sports Medicine 8 .....             | 646        |
| <b>AUTHORS INDEX .....</b>                  | <b>651</b> |







# Wednesday, July 4th, 2012

15:00 - 16:30

## Invited symposia

### IS-PM05 Exercise in Extreme Environments: From Space to Antarctica

#### 1. NEUROCOGNITIVE ENHANCEMENT THROUGH EXERCISE. CURRENT APPROACHES AND APPLICATIONS

Schneider, S.

*German Sport University Cologne*

The definition for health raised by the World Health Organization (WHO) includes physical and mental health. Today exercise science holds extensive knowledge about the adaptation of peripheral physiological systems to exercise (e.g. the hormonal, cardiovascular and musculoskeletal system). Although the impact of exercise on mental fitness, cognitive performance and overall well-being has been extensively described in the recent decade, comparatively little is known about the underlying neurophysiological processes. This is mainly due to missing imaging possibilities as standardized imaging procedures, as positron emission tomography (PET) or functional magnetic resonance imaging (fMRI) are hardly applicable to health-orientated exercise settings. Nevertheless a deeper insight in the underlying neurophysiological parameters of exercise and their implications for neurocognition and emotional well-being are of utter importance to a holistic understanding on how exercise promotes health. The aim of this lecture is three folded: (1) to give an overview of current theories concerning the relationship between exercise and neuro-cognitive function, (2) to display methodological approaches in the area of exercise neuroscience and (3) to verify this theoretical background with two current studies from extreme environments: Space and school.

#### MOVE TO SLEEP: HOW PHYSICAL ACTIVITY ENHANCES SLEEP EFFICIENCY DURING ANTARCTIC EXPEDITIONS

Pattyn, N.

*Royal Military Academy/Vrije Universiteit Brussel*

Introduction Sleep complaints are consistently cited as the most prominent problem in Arctic and Antarctic expeditions. Continuous bright light exposure in the summer, and continuous darkness in the winter suggest a fundamental disturbance of circadian sleep-wake regulation in this environment. The present investigation was conducted during two Antarctic summer expeditions, the BELARE (Belgian Antarctic Research Expedition) campaigns 2007-2008 and 2008-2009. We hypothesized that participants with a more intense physical activity would increase their homeostatic sleep pressure, and therefore suffer less from the possible circadian disruption due to the constant daylight conditions. Method 8 subjects were investigated in the first expedition. Actigraphy data were collected for 72 hrs every ten days. Sleep efficiency (sleep time/lying down time) as well as a sleep fragmentation were computed, and related to the magnitude of active energy expenditure. 21 subjects participated during the second campaign. Data were collected every 2 weeks for each subject. These included 48 hrs actigraphy, one night polysomnography, morning and evening Profile of Mood States and Karolinska Sleepiness Scale, morning Psychomotor Vigilance Test. Circadian rhythms profiles were determined with a 24 hrs cortisol and melatonin sampling. Results First year data showed poor sleep efficiency and high sleep fragmentation, in concordance with participants' subjective evaluations. Furthermore, there was a strong correlation between sleep efficiency and active energy expenditure (Pearson's  $r = 0,63$ ;  $p = 0,015$ ), as well as a strong relationship between active energy expenditure and sleep fractionation. Second year data results didn't confirm this relationship (Pearson's  $r = 0,21$ ;  $p = ns$ ). Discussion Results from the first campaign confirmed our hypotheses, namely the lower sleep quality (lower efficiency and higher fragmentation) during the expedition and the relationship between sleep quality and active energy expenditure. Data from the second campaign, despite what was expected to be a stronger methodological set-up, due to the larger sample size, failed to evidence the relationship between sleep efficiency and the intensity of physical activity. Considering the difference in set-up, and the frequent repeated measures on a small number of participants during the first campaign, this shows that the relationship between sleep efficiency and energy expenditure is valid at an intra-individual level, but fails to show at an interindividual level, especially in a population where a wide range of physical activity intensity is present. These findings are discussed in the framework of the existing literature on sleep and exercise, and the argument is being made for the use of exercise as a potential countermeasure in isolated and confined environments.

#### BRAIN FUNCTION, COGNITIVE PERFORMANCE AND PHYSICAL ACTIVITY: RECENT INSIGHTS INTO MECHANISMS AND COUNTERMEASURES FROM RESEARCH IN EXTREME ENVIRONMENTS.

Stahn, A.

*Center for Space Medicine Berlin, Charité University Medicine Berlin*

'Because running makes you free.' (Edison Pena, December 2010) In October 2010 the world held its breath like rarely before when Chilean miners were successfully rescued after being trapped 700 m underground for 69 days, setting a new world record for the longest time survived underground after a mining accident. When the freed miner Edison Pena was asked how he dealt with the stress of being trapped and the constant fear of death he said that he started exercising in the mine. During the last decade there has been an increasing interest in understanding the relationships between exercise, cognition and its neural correlates. In line with the Chilean example data from various extreme environmental conditions indicate that physical activity might play a dominant role in minimizing cognitive impairments. While meta-analytic findings indicate that exercise seems to be beneficial for brain function and cognition, its underlying mechanisms and potential moderators and mediators remain to be determined though. Some of these aspects could be pinpointed by studies under extreme environmental conditions, where human adaptations are accelerated to an extent that can typically only be seen in long-term observation studies or employing very unique experimental conditions. Accordingly, monitoring human performance in

extreme environments can pave innovative and unique ways in promoting research typically confined to conventional laboratory settings. Recent studies indicate that executive control and decision-making can be affected by long-term bedrest and overwintering in Antarctica, the former providing an excellent control for the impact of physical activity on cognition. Data from real and simulated spaceflight imply that the changes in cognitive function might be related to changes in the autonomic nervous system, and specifically heart rate variability, which might serve as a global indicator of prefrontal cortex excitability. Moreover, it is suggested that stimulation of mechanoreceptors in the feet might be important to reveal the true potential of physical activity on brain function and cognitive performance. Finally, in addition to a lack of physical activity both perceived loneliness as well as sensual deprivation have been shown to be independently related to cognitive function. It is therefore suggested that studying humans exposed to isolation, confinement and environmental conditions can lead to a better insight into some of the potential mechanisms underlying the interaction between physical activity and cognition and promote an integrative model. Such knowledge will help the full range of activity-related cognitive plasticity to be mapped and might be useful in designing future intervention studies for investigating the interaction between physical activity and cognition.

**15:00 - 16:30**

## Oral presentations

### OP-SH01 Sport Management

#### EUROPEAN GOVERNANCE, ANTI-DOPING AND THE RIGHT TO PRIVACY

MacGregor, O.

*Swansea University*

The European Convention on Human Rights is an international human rights document, ratification of which is a prerequisite for nation state membership in the Council of Europe. The Convention includes provisions for, among other things, the creation of an international court - the European Court of Human Rights in Strasbourg - to monitor compliance with the Convention in Council of Europe member states. The Court hears cases brought by individuals claiming a breach of their rights, as enunciated in the Convention, by a member state. (ECHR, sec II) Among the rights of the Convention, article 8.1 establishes a right of individuals to a 'private and family life'. This is understood as a qualified right, which can be defeated by any of a number of legitimately overriding social goods, including, as per article 8.2 of the same convention, the 'protection of public health or morals'. (ECHR, art 8) In elite sports, the whereabouts requirements of the World Anti-Doping Agency (WADA) stipulate that all elite athletes, regardless of their sport, must submit their whereabouts for every day of the year to their relevant anti-doping organization (WADA 2009a, ch 14.3; WADA 2009b, ch 11). Critics have argued, among other things, that the requirements infringe athlete rights to privacy (Møller 2011). WADA, however, views the requirements as a crucial element in the fight against doping in sport, and considers them justified in light of its goal - doping-free sport - and regardless of any further and potentially deleterious effects (Hanstad and Loland, 2009). In this paper, I argue that the contextual differences between various sports indicate that there are stronger justifying reasons to monitor out-of-competition doping rule compliance in certain sports (with higher risk of out-of-competition doping) than in others, and that in some it fails to be sufficiently strong to override athlete privacy rights. In the latter cases, therefore, the whereabouts requirements constitute a breach of an athlete right to privacy, as per the European Convention on Human Rights. This state of affairs recommends a redrafting of WADA's whereabouts requirements, to better reflect the broad heterogeneity of sports. REFERENCES: Convention for the Protection of Human Rights and Fundamental Freedoms (European Convention on Human Rights, as amended) (ECHR). Hanstad D V, Loland S (2009). *Eur J Sport Sci*, 9(1), 3-10. Møller V (2011). *Int J Sport Pol*, 3(2), 177-190. World Anti-Doping Agency (WADA) (2009a). World Anti-Doping Code. WADA, Montreal. World Anti-Doping Agency (WADA) (2009b). World Anti-Doping Code: International Standard for Testing. WADA, Montreal.

#### A RESOURCE BASED EVALUATION OF COMPETITIVENESS IN ELITE ATHLETICS

TRUYENS, J.1, DE BOSSCHER, V.1, HEYNDELS, B.2

*Vrije Universiteit Brussel*

INTRODUCTION The increase in medal-winning capability of countries in international competition is explained by an increasing number of nations taking a more strategic approach to the development of medal-winning elites (De Bosscher, 2007; Green & Oakley, 2001; Houlihan & Green, 2008). Despite the extensive scientific focus on elite development systems, there is a lack of studies on elite sport development at sport specific level (Sotiriadou & Shillbury, 2009) that describe and measure specific practices at organisational level. Within economic research, the resource-based theory conceptualises competitiveness starting from the relationship between internal resources and dynamic capabilities of an industry and its performances (Barney, 2001). These internal resources and more especially, the policy dimensions in elite athletics are the focal point of attention. METHODS Based on a resource-based perspective, this paper measures and evaluates policy resources and capabilities leading to a competitive advantage in elite athletics of four different countries (BEL (Flanders and Wallonia), CAN, FIN and NED), based on an athletics policy inventory. This instrument is based on a model referring to 11 different policy areas/pillars in elite athletics development. The model is developed through an inductive-deductive analysis (Patton, 2002) of international literature, surveys (N=13) and in-depth interviews (N=21) with national high performance directors in athletics. Later on, 57 international coaches and high performance directors participated in a written survey to validate the model. RESULTS AND DISCUSSION A major contribution of this sport specific inventory of policy factors is its organisational scope: specific practices for national governing bodies in the elite development process are measured and evaluated in a functionalistic model for elite development. Although the NGBs lived through the same tendencies like the professionalization and formalisation of development programs, specific dimensions in the policy process strongly differ. While the development process of potential athletes (pillar 4A&B) is stronger developed in Flanders, coach education, career support and training facilities are more profound for elite development in the Finland, Canada and the Netherlands. REFERENCES Barney JB (2001). *Acad Manag Rev*, 6(1), 41-56. De Bosscher V (2007). *Sports Policy Factors Leading to International Sporting Success*. Published doctoral thesis. Brussel: VUBPRESS. Green M, Oakley B (2001). *Leisure Stud*, 20, 247-267. Houlihan, B, Green M (2008). *Comparative elite sport development. Systems structures and public policy*. London: Elsevier. Patton MQ (2002). *Qualitative research and Evaluation Methods*. Thousand Oaks: Sage Publications. Sotiriadou K, Shillbury D (2009). *Sport Manag Rev*, 12(3), 137-148.

## PERCEIVED DIFFICULTY TO COMBINE THE SPORT AND ACADEMIC CAREER IN ELITE ATHLETES

López de Subijana, C.I, Conde, E.I, Barriopedro, M.I.I, Gallardo, L.2

1 Sport Sciences Faculty- Technical University of Madrid- Madrid-Spain; 2-Sport Sciences Faculty- Castilla-LaMancha University- Toledo-Spain

**Introduction** As the athletes improve in sport they expend the less time for other fields of life (Heinemann, 1998). The sport career development model showed how many areas of life are influenced when the athlete is playing the role of competing in high performance sport (Wylleman, Alferman & Lavalley, 2004). Spain, in a UE Policies comparison, follows the State Centric Regulation in the education services for elite athletes (Aquilina & Henry, 2010). The aim of this study was to measure the perceived difficulty to combine the sport and academic career in elite athletes. **Methods** A survey questionnaire was sent to the entire population of 2697 elite athletes in Spain. A Pearson's chi-square test was done to analyze the relation between variables. The significant level was set at  $p=0.05$ . The response rate was 27,8% in Olympic men, 37,3% in Olympic women, 9,3% in non-Olympic men and 11,9% in non-Olympic women. **Results and Discussion** 840 athletes (23.1  $\pm$  7.4 years-old), 513 men y 327 women answered the questionnaire. Most of the athletes were studying Higher Education (26,9 %), followed by Secondary School (19,3 %) and 18 % did not study any course. Most of the courses taken (74,6%) the athlete had to attend to class. Only some of them (46,5%) ask for help in combining the academic and the sport career. The athletes felt combining these two fields was difficult (41,7%) or moderate (44,8%). Out of all the athletes, 21,1% of them worked, being 48,3% full time and 41,1% part time. The perceived difficulty of studying and training was related with the number of days per week training ( $X^2(18) = 39,8, P=0.001$ ) and also with the type of studies (on-line, mandatory to attend...) ( $X^2(28) = 55,1, P=0.002$ ). The most frequent reasons for not studying were: "I don't have time, the academic timetables are not flexible, the price of the studies is high, I lose the rhythm of the courses, and my actual job situation does not allow me to do so". **Conclusions** In conclusion, more efforts should be done by National Government, Regional Governments, Sports Federations and Educational Institutions to guide the elite athletes the in their academic, social and economic affairs. **Acknowledge** This study was funded by the Spanish Sport Council (022/UPB10/11). **References** Aquilina, D., & Henry, I. (2010). Elite athletes and university education in Europe: a review of policy and practice in higher education in the European Union Member States. *International Journal of Sport Policy*, Vol. 2(1), 25-47. Heinemann, K. (1998). Einführung in die Soziologie des Sports. Hofmann, 4<sup>o</sup> Ed. Wylleman, P., Alfermann, D., & Lavalley, D. (2004). Career transitions in sport: European perspectives. *Psychology of Sport & Exercise*, 5(1), 7.

## ELITE SPORT CLIMATE, MEASUREMENT TWO

De Croock, S., De Bosscher, V.

*Vrije Universiteit Brussel*

**Introduction** Talent, ambition and commitment are the core to success but further investment in elite sports is a must in order to compete in the 'Global Sporting Arms Race'. Without a structured policy at different levels there is a risk to vanish between the Elite sport countries. Therefore, it's important to evaluate and compare the Elite sport policies. In 2003 the 0-measurement started with the aim to investigate how the elite sport policy in Flanders could be improved in an efficient and effective way. This year the two measurement started. **Methods** Just as in 2003 and 2007 elite athletes, coaches and federations were surveyed to assess the elite sport climate. Hereby, the climate is charted objectively in nine performance determining factors (De Bosscher et al., 2008). By interviewing various stakeholders, it is possible to obtain more insight in the developments and expectations of the stakeholders. **Results** 43% of coaches consider the elite sport climate in Flanders to be insufficient. Yet the policy efforts of recent years had its effect because only 7,9% of coaches considers that the elite sport climate has deteriorated compared to 2007. The stakeholders, that were surveyed, have the opinion that the financial input, the coach facilities/developments and the elite sport infrastructure are factors which have the biggest influence on international elite sports success. Also, these are the three factors that, according to the stakeholders, have most need for improvement in Flanders. The Flemish government resources increased continuously and even virtually tripled in the last five years. However, financial resources are no longer a guarantee for success. The elite sport policy has to invest in the various performance determinants. In terms of infrastructure, Flanders has a need for more top sports infrastructure with absolute priority rule for elite athletes. Half of the trainers consider that there are insufficient recognised trainers courses available for elite sport trainers. Also noteworthy is that only some federations have a system to transfer knowledge between coaches. The establishment of a centre of expertise can address this problem. The individual living circumstances of the coaches there is slightly improved compared to 2003 and 2007. **Conclusion** Despite the necessary adjustments of the elite policy, a lacuna still exist in the elite sport climate in Flanders. Certain deficiencies which were already identified in 2003 and 2007 are still a weakness. The efforts of the Flemish elite policy were mainly done to "catch-up" with things, but there's still need for extra efforts. **References** De Bosscher, V., De Knop P. & Van Bottenburg, M. (2008). Vlaanderen sport ook aan de top.

## THAT'S THE SPIRIT: THE DIFFERENCE BETWEEN ELITE AND NON-ELITE SPORT

Huybers, T., Mazanov, J., Connor, J.

*University of New South Wales - Canberra*

**Introduction** The moral basis for protecting the integrity of sport is defined by the 11 attributes in the World Anti-Doping Code's Spirit of Sport statement (Mazanov & Connor, 2010). There is no guidance on how the attributes are to be interpreted or whether the list reflects an intentional order. It is also unclear whether the attributes contained in the Spirit of Sport statement reflect the values of elite sport or non-elite sport. The aim of the study reported in this paper was to determine whether what is considered important to the Spirit of Sport varies by elite and non-elite contexts. **Methods** We used a Best-Worst Scaling (BWS) experiment (Marley and Louviere, 2005) to obtain ratio scores that provide estimates of the relative importance of the 11 attributes listed in the Spirit of Sport statement. Half of the responses of a sample of 154 Australians had been framed in the 'elite' context while the other half had received the 'non-elite' condition. **Results** The BWS scores for the aggregate data showed that "Ethics, fair play and honesty" and "Respect for self and other participants" were the most important attributes across contexts. The disaggregated data, divided into non-elite and elite contexts, revealed a low correlation between non-elite and elite scores ( $R^2=0.372$ ). In the non-elite context, the main differences in comparison with the aggregate model were the higher scores and relative ranking of "Fun and joy" and "Respect for self and other participants", while the main departure in the elite framing was the higher prioritisation of "Dedication and commitment" and "Excellence in performance" and the decline in relative importance of "Fun and joy". **Discussion** While "Ethics, fair play and honesty" was perceived to be a key characteristic of elite and non-elite sports, members of the Australian general population perceived other attributes differently in the two contexts. The non-elite sport importance of the role of "Fun and joy" may be due to non-elite sport participation being seen as an end in itself; i.e. being more a "game"

than "sport" (Suits, 1988). In the elite sport context, the process underlying elite sports production, characterised by attributes such as "Dedication and commitment" and "Respect for rules and laws", was deemed to be particularly important. The implication is that social research designed to inform sport policy or practice at one level of sport does not necessarily translate to other levels. This has implications for "pyramid" approaches to sports policy, where policy is focused at the top of the pyramid (elite sport) in the expectation of beneficial trickle effects (non-elite sport) (Hogan & Norton, 2000). References Hogan, K, Norton, K (2000). *J Sc Med Sp*, 3, 203-218. Marley A, Louviere J (2005). *J Math Psych*, 49, 464-480. Mazanov, J, Connor, J (2010). *Int J Sp Pol*, 2, 49-63. Suits, B (1988). *J Phil Sp*, 15, 1-9.

## 15:00 - 16:30

### Oral presentations

#### OP-BN01 Sports Biomechanics 1

##### EFFECT OF KAYAK ERGOMETER LOADING ON UPPER LIMB RECRUITMENT AND KINEMATICS.

Fleming, N., Donne, B., Fletcher, D.

*Trinity College Dublin*

**Introduction** Altered upper limb muscle recruitment patterns were recently reported comparing on-ergometer and on-water kayaking (Fleming et al., 2010, 2012); however, precise mechanisms underlying EMG changes remain to be elucidated. This study assessed the effect of altered ergometer recoil force on upper limb recruitment patterns and kinematics during the kayak stroke via EMG and 3D kinematic analysis. **Methods** Male flat-water kayakers (n=10, mean  $\pm$  SD; age  $21\pm 3$ yr, height  $1.80\pm 0.06$ m, body mass  $74.6\pm 5.8$ kg) performed 4 by 1 min on-ergometer exercise bouts at a load equivalent to 85%VO<sub>2</sub>max at varying elastic recoil tensions ranging from 0% shortened (T1) up to 30% shortened (T4). Trials were randomised to eliminate possible effect of tension order on kinematics or EMG activity. During exercise, surface EMG data (Mega ME6000) were recorded from Anterior Deltoid (AD), Triceps Brachii (TB) and Latissimus Dorsi (LD). In addition, stroke force (instrumented paddle) and 3D kinematic (CODA) data were recorded. EMG data from 10 consecutive stroke cycles in the latter stages of each trial were amplitude processed via root mean squaring and normalised relative to pre-trial isometric MVC. Stroke force and 3D kinematic data recorded from wrist, elbow, shoulder and scapular markers were assessed over the same time frame. Data were analysed using repeated measures ANOVA and detected differences quantified using post-hoc Tukey tests (P<0.05). **Results** While stationary recoil forces significantly increased across investigated tensions ( $20\pm 4$  to  $45\pm 8$  N, P<0.001), no significant differences were detected in assessed stroke force variables. Increasing tension induced significantly higher normalised AD rmsEMG activity in the 70 to 90% stages of the stroke cycle (T4 vs. T1;  $18.1\pm 12.0$  vs.  $10.6\pm 5.3$  %, P<0.05;  $37.6\pm 16.2$  vs.  $22.7\pm 11.0$  %, P<0.001 and  $26.3\pm 10.1$  vs.  $15.6\pm 8.9$  %, P<0.001 at 70, 80 and 90 %, respectively). No significant differences were observed across tension in TB or LD. A detailed 3D kinematic analysis revealed that overhead arm movements accounted for  $58\pm 10\%$  of the cycle. At stroke cycle onset mean elbow angle was  $144\pm 10^\circ$  and maximal angle ( $151\pm 7^\circ$ ) occurred at  $78\pm 10$  % of stroke cycle. Overall upper arm kinematic markers moved horizontally forward as recoil tension increased. No significant change in wrist marker elevation was observed. Elbow and shoulder marker elevations significantly increased during the 70 and 80% intervals of the cycle (P<0.05). **Discussion** Data suggested that kayakers maintained normal hand position during the cycle via additional AD recruitment despite ergometer induced recoil forces being applied to the upper arm. **References** Fleming N, Donne B, Fletcher D (2010) 15th ECSS Congress, pp. 31 Fleming N, Donne B, Fletcher D, Mahony N (2012) *J Sports Sci Med* 11, in press

##### ARM COORDINATION IN SEMI-TETHERED SWIMMING

Dominguez, R., Morales, E., Arellano, R.

*University of Granada*

**ARM COORDINATION IN SEMI-TETHERED SWIMMING** Dominguez-Castells, R.1, Morales, E.1, Arellano, R.1 UGR (Granada, Spain) **Introduction** In swimming, stroke is composed of different phases: entry-catch, pull, push and recovery. Arm coordination is important and related with freestyle performance. Index of Coordination (IdC) allows precise quantification of lag time between start of propulsion by one arm and end of propulsion by the other. Recent studies have emphasized the close relationship between arm coordination and velocity, but only one has included resistance (Telles et al., 2011). Therefore, the aim of this study was to analyze the relationship between IdC and technical parameters, using semi-resisted swimming with different loads. **Methods** The test consisted on eleven 12.5m trials on semi-tethered swimming. Eighteen swimmers pulled a different load each trial, from 1.59 to 7.84kg. Swimmer's feet were tied together, keeping a pull-buoy between legs and isolating the upper limb action. No breathing was allowed. The test was recorded from a frontal and two lateral underwater cameras (50 Hz). IdC was assessed for each trial. Pearson's correlation coefficients were calculated between IdC and mean speed (v), stroke rate (SR), stroke length (SL) and stroke index (SI) (level of significance: p<0.05). **Results** Coordination mode used in free and semi-tethered swimming was superposition (IdC>0%). IdC was 6.6% when swimming free and it increased significantly with loads (p<0.05). It was, on average, 7.1% with 1.59kg and 14.8% with 7.84kg. Significant correlations (p<0.01) were found between IdC and load (r=0.91), v (r=-0.94), SL (r=-0.93) and SI (r=-0.95), but not between IdC and SR. **Discussion** Concerning arm coordination in swimming, IdC was higher when swimming with parachute (0.1%) than when swimming free (-2.3%) (Telles et al., 2011). Catch-up model was used for long and middle distance (3000 to 200m), while for sprints (100 and 50m) opposition or superposition were used (Chollet et al., 2000; Seifert et al., 2004). In the latter case, the relative duration of non-propulsive phases decreased, while the duration of propulsive phases increased. The same happened in semi-tethered swimming, where swimmers used superposition. IdC increased, v, SL and SI decreased and SR remained constant as loads increased. Some of these results are not in keeping with previous studies which, however, did not include loads (Alberly et al., 2005; Chollet et al., 2000). These differences may be due to the application of loads, which led to fatigue and, therefore, higher IdC (Alberly et al., 2005). Considering that resisted swimming is a widely applied training method, results suggest that load should be carefully controlled, as it modifies swimming coordination. **References** Alberly M, Sidney M, Huot-Marchand F, Hespel J, Pelayo P (2005). *Int J Sports Med*, 26, 471-475. Chollet D, Challes S, Chatard J (2000). *Int J Sports Med*, 21, 54-59. Seifert L, Chollet D, Bardy B (2004). *J Sports Sci*, 22, 651-660. Telles T, Barbosa A, Campos M, Junior O (2011). *J Sports Sci*, 29, 431-438.

### 3D AUTOMATIC MOTION TRACKING IN WATER FOR MEASURING INTRA CYCLIC VELOCITY VARIATIONS IN BREAST-STROKE SWIMMING

Olstad, B.H.1, Zinner, C.2, Haakonsen, D.1, Cabri, J.1, Kjendlie, P.L.1,3

1: NSSS (Oslo, Norway), 2: GSU (Cologne, Germany), 3: VUC (Toensberg, Norway)

**Introduction** Until recently, 3D tracking of human swimming motion capture (mo-cap) from an image has been conducted using interactive tracking (IT). New technology within automatic tracking (AT) in water uses computer algorithms to identify and track small reflective markers attached to the swimmer. The purpose of this study was to show that 3D AT can be used for measuring kinematic variables in human swimming such as the intra-cyclic velocity variations (dv) within a stroke cycle in breaststroke. **Methods** Four swimmers (one male, world championship medalist and three females, one olympic medalist, one national medalist and one national finalist) performed one trial of 20m normal breaststroke at the speeds of 60, 70, 80, 90 and 100% of maximal effort. During each trial, the dv of the swimmers body were recorded at the left and right pelvic and left and right trochanter major (glued to the swimmers suit) with ten underwater mo-cap cameras (Oqus Underwater, Qualisys, Gothenburg, Sweden). The cameras recorded spherical markers (diameter of 19 mm) attached to the swimmers using cyan LED light. A 2.5(z)x1.5(y)x10(x) volume was calibrated using a moving wand method. For statistical analysis trochanter major was selected due to a tracking recording of 100%. The second and third stroke cycle was selected to avoid excess speed from the push-off. The stroke cycle started when the heels were fully pulled up, flexed and ready to kick backward. dv was calculated as the difference between the highest and lowest velocity peaks within the stroke cycle, relative to the average velocity. **Results** The highest and lowest velocity was on average recorded at 72.05% and 93.83% into the stroke cycle for the world class swimmers (WC) and at 63.03% and 96.36% for the national elite swimmers (NE). A t-test showed a significant difference among the groups for the highest dv  $p < 0.001$  and no differences for the lowest dv ( $p = 0.07$ ). R values of .959 for the WC and .859 for the NE showed strong correlations between average cycle velocity and the dv fluctuations. **Discussion** We found that the highest velocity during the breaststroke cycle corresponded to approximately the middle of the insweep phase. Subjects had no movement constraints, but had significant added drag from wearing 36 reflective markers (Kjendlie et al., 2012) and also wearing sEMG equipment described by (Olstad et al., 2011). The study successfully showed that 3D analysis can be performed in water using AT. Data analysis with AT is time effective, and open up new possibilities for conducting wide-scale studies investigating different kinematic variables in swimming. **References** Kjendlie, P. L., & Olstad, B. H. (2012). Automatic 3D motion capture of swimming: Marker resistance. Accepted for the American College of Sport Medicine 59th annual meeting. Olstad, B. H., Cabri, J., Zinner, C., Nunes, N., & Kjendlie, P. L. (2011). SEMG measurements on land and in water prior to and after 60-90 minutes of submersion (swimming) are highly reliable. Portuguese Journal of Sport Sciences, 11 (Suppl. 2), 763-765.

### QUANTIFYING BILATERAL ASYMMETRY IN COMPETITIVE FRONT CRAWL SWIMMING

Barden, J.

University of Regina

**Introduction** Studies show that the different phases of the arm stroke cycle in front crawl swimming are bilaterally asymmetric [1,3], and that asymmetry is affected by speed, arm dominance and bilateral differences in body roll [4]. However, little is known about the effect of asymmetry on performance, and given its importance to propulsion mechanics, a simple method to quantify arm asymmetry in competitive front crawl swimming is needed. Therefore, the purpose of this study was to quantify bilateral asymmetry in a group of elite front crawl swimmers at two different speeds using two different stroke-related spatiotemporal parameters. **Methods** Eight swimmers (6 female, 2 male;  $17.9 \pm 0.86$  yrs) performed front crawl for 2 x 200 m repetitions in a 25 m pool at two different speeds: 1) 91% and 2) 110% of critical speed. Stroke frequency (SF) and stroke length (SL) were recorded independently for both arms for each length of each 200 m repetition. An asymmetry index (ASI), previously used to assess gait asymmetry [2], quantified individual asymmetries for SF and SL according to the following equation:  $ASI (\%) = [X_r - X_l] / 0.5(X_r + X_l)] \times 100$  where  $X_r$  and  $X_l$  are the values of the specific stroke variable (SF or SL) measured for the right and left arm, respectively. Group asymmetries were calculated using the absolute value of  $X_r - X_l$ . For the purpose of this study, a stroke (right or left) was defined as consisting of one half of a complete stroke cycle (synonymous with a step in walking). A paired Student's t-test compared mean absolute ASI values for SF and SL between the two 200's. **Results** A range of asymmetries were found (SF: -7.3 to 9.8%; SL: -10.0 to 10.8%), with some participants being more asymmetric than others. The group was divided equally in terms of right (4) vs. left (4) asymmetry. No significant differences in absolute ASI were found for either SF or SL between the two speeds. **Discussion** The findings show that arm asymmetries in front crawl swimming can be easily quantified by adopting existing gait asymmetry indices to the cyclic motion of swimming. Of particular interest was the finding that no ASI differences existed between the two speeds, and that positive SL asymmetries (right arm > left arm) were associated with negative SF asymmetries (right arm < left arm), and vice versa. This indicates that longer stroke times on one side are associated with longer stroke lengths on the same side (and vice versa), demonstrating the important bilateral relationship between stroke phase duration and distance per stroke. It is hoped that future studies will employ the method used here to investigate the effects of breathing, body roll and lateral dominance on bilateral asymmetry in competitive front crawl swimming. **References** 1. Barden JM, Kell RT, Kobsar D (2011). J Sports Sci, 29, 517-526. 2. Carpes FP, Mota CB, Faria IE (2010). Phys Ther Sport, 11, 136-142. 3. Nikodelis T, Kollias I, Hatzitaki V (2005). J Sports Sci, 23, 737-745. 4. Seifert L, Chollet D, Allard P (2005). Hum Mov Sci, 24, 234-256.

15:00 - 16:30

## Oral presentations

### OP-PM01 Muscle signaling and adaptation

#### LOW PHYSICAL ACTIVITY INFLUENCES THE EXPRESSION OF MIRNAS IN HUMAN MUSCLE TISSUE

Kristensen, M.M.1, Bork-Jensen, J.2, Vaag, A.2, Dela, F.1

1: Center for Healthy Aging, University of Copenhagen, Denmark; 2: Rigshospitalet, University of Copenhagen, Denmark

**Introduction** MicroRNAs (miRNAs) are important cellular regulators of gene expression in both health and disease. Studies have found changes in miRNA levels in muscle (1) and blood (2) in response to training. Elucidating the roles of miRNAs in physically inactive humans is important to understand how sedentarism influences gene expression and potentially insulin resistance. We examined the influence of nine days of bed rest on miRNA expression profiles in human skeletal muscle tissue. **Methods** 20 healthy young males were studied before and after bed rest for nine days and after four weeks of retraining. Muscle biopsies (vastus lateralis) were used for RNA extraction and miRNA expression profiling was performed using LNA arrays (Exiqon, Denmark). Linear models for microarray analysis (limma) was used to identify differentially expressed miRNAs using Benjamini and Hochberg's false discovery rate (fdr) adjustment for multiple testing. In silico target predictions (Targetscan) were carried out to understand the biological implications further. **Results** Comparing microarray miRNA expression profiles before and after bed rest, we identified seven differentially expressed miRNAs (P(fdr) less than or equal 0.1) of which three were down-regulated (miR-486-3p, miR-24-2\*, and miR-126) and four were up-regulated (ebv-miR-BART2-5p, miR-1246, miR-21, and miR-1908) after bed rest. Interestingly, none of the miRNAs returned to pre-bed rest levels after the retraining period. Targetscan revealed multiple possible targets for each of the seven differentially expressed miRNAs. Among these were IRS-1 (insulin receptor substrate 1) being a target of miR-126 as well as PIK3R1 (phosphoinositide-3-kinase, regulatory subunit 1) being a target of miR-21. **Discussion** We identified seven miRNAs with altered expression levels in response to short term bed rest, and none of them returned to the pre-bed rest values even after four weeks of retraining. Predicted targets of the miRNAs relevant to understanding insulin resistance included IRS-1 and PIK3R1. Ongoing analyses should reinforce these findings and elucidate the relation between these miRNAs and their respective targets. **In conclusion**, nine days of inactivity induced changes in the expression of miRNAs with relevance to insulin resistance, which in turn were not reversed by four weeks of retraining. **References** 1. S. Nielsen et al., J. Physiol 588, 4029 (2010). 2. A. L. Baggish et al., J. Physiol 589, 3983 (2011).

#### ACUTE HYPOXIA REDUCES MUSCLE PROTEIN TURNOVER IN HUMAN SKELETAL MUSCLE.

D'Hulst, G., Jamart, C., Van Thienen, R., Hespel, P., Francaux, M., Deldicque, L.

KU Leuven, Université catholique de Louvain

**Introduction:** Hypoxia is a state of reduced O<sub>2</sub> tension in tissue, including skeletal muscle. It elicits various responses in the cell leading to preserving O<sub>2</sub>. One of these responses is decreasing protein turnover, as stated by in vitro studies (Pettersen et al., 1986). On the other hand, in vivo studies are not that conclusive due to higher variability (Mizuno et al. 2008). Therefore, this study aims to get more detail on pathways involved in anabolic and catabolic signaling in human skeletal muscle as a response to acute hypoxia. **Methods:** According to a randomized cross-over study, 15 healthy men participated in 2 experimental sessions separated by a 4-week wash-out period. After a standardized breakfast, subjects were randomly assigned to a 4-h lasting seated experimental trial in normoxia (NOR) or hypoxia (11% O<sub>2</sub>, HYP). Three biopsies were taken at the start (T0), after 1-h (T60) and at the end of the trials (T240). Furthermore, arterial blood saturation (SpO<sub>2</sub>) and muscle tissue oxygenation (TOI) were measured by pulseoximetry and Near-infrared spectroscopy (NIRS). Western blot and qPCR were used to determine phosphorylation status or mRNA quantity of several components involved in the regulation of protein synthesis (i.e. protein kinase B and p70 ribosomal S6 kinase, Redd1), breakdown (i.e. 26s Proteasome β5) and hypoxic signaling (i.e. Hypoxia Inducible Factor-1α, VEGF-A). **Results:** Despite a large decrease in SpO<sub>2</sub> (HYP, 75.5 ± 2.02% vs NOR, 99.0 ± 0.18%, p<0.05), TOI was only slightly reduced (HYP, 65.8 ± 1.39% vs NOR, 68.5 ± 1.19%, p<0.05). Hypoxia delayed the return to basal state after feeding for both PKB and P70S6K phosphorylation (p<0.05), furthermore significant differences were found between NOR and HYP at T240 (p-PKB: NOR, 0.44±0.06 vs. HYP, 0.75±0.06 and p-P70S6K: NOR, 0.32±0.09 vs. HYP, 0.48±0.10, p<0.05). Redd1, increased ~2-fold at T240 in HYP compared to NOR at the same time (p<0.05). Activity of 26s proteasome β5 increased by 19 % in NOR at T240 compared to T0 (p<0.05). Conversely, no effect in time was present in HYP (p>0.05). HIF-1α mRNA was not changed throughout the experiment, whereas VEGF-A significantly increased in HYP compared to NOR at T240 (-1.5 fold, p<0.05). **Conclusion:** Our results provide evidence that acute hypoxia slows down the return to basal state of several components of protein synthesis and protein breakdown after feeding. This impairment in the regulation of protein turnover could participate to the decrease in muscle mass observed after long-term exposure to hypoxia.

#### A ROLE FOR FOCAL ADHESION KINASE IN CONTRACTION AND IGF-1 INDUCED SKELETAL MUSCLE CELL GROWTH

Crossland, H., Kazi, A., Smith, K., Szewczyk, N.J., Atherton, P.J.

University of Nottingham

Increasing evidence links the costamere-associated protein focal adhesion kinase (FAK) to the hypertrophic response to mechanical stress and growth factor stimulation in skeletal muscle, and its expression is reciprocal to loading patterns (i.e. downregulated in atrophy/upregulated in hypertrophy (1)). On this basis, we reasoned that reducing FAK expression by short hairpin (sh)RNA interference would restrict cell growth associated with insulin-like growth factor-1 (IGF-1) and contraction (mechanotransduction). Lentiviral transfection techniques were used to produce stably transfected C2C12 cells harbouring FAK targeted (pLKO.1-mFAK) or scrambled shRNA. Myotubes were contracted for 24 h (0.2 Hz, 5 V, 2 ms) using a C-pace system, before assay of total protein. In separate experiments, myotubes were incubated for 72 h with IGF-1 (10 ng.ml<sup>-1</sup>) for measurement of total protein. Immunoblotting was used to determine phosphorylation of 'hypertrophy' signalling targets (i.e. Akt-mammalian target of rapamycin (mTOR)) following 2 h contraction or IGF-1 incubation. Results were analysed by one-way ANOVA and Tukey's post-hoc testing with the level of significance set at P<0.05. Data are presented as mean percentage differences ± standard error. FAK depletion was confirmed at the protein level (-90%: FAK vs. scrambled shRNA; P<0.00001). Increases in total protein in scrambled shRNA cells following 24 h contraction (+57±9%; P<0.01) were absent in FAK shRNA cells (+7±11%

$P=0.65$ ). After 2 h contraction, levels of FAK phosphorylation were increased in scramble shRNA cells (Tyr397:  $+44\pm 6.6\%$ ;  $P<0.01$ ), and contraction-induced increases in phosphorylated Akt (Ser473;  $+87\pm 11\%$ ;  $P<0.01$ ) and p70 S6 kinase (Thr389;  $+170\pm 16\%$ ;  $P<0.001$ ) in scramble cells were significantly attenuated in FAK shRNA cells (both  $P<0.05$ ). IGF-1 treatment for 72 h elicited marked increases in total protein in scramble shRNA cells ( $+77\pm 10\%$ ;  $P<0.001$ ), and this was significantly blunted in FAK shRNA cells ( $+34\pm 14\%$ ;  $P=0.14$ ). Increases in p-Akt ( $+390\pm 49\%$ ;  $P<0.001$ ) and p-mTOR (Ser2448;  $+190\pm 31\%$ ;  $P<0.001$ ) following 2 h IGF-1 treatment in scramble shRNA cells were significantly attenuated in FAK shRNA cells (all  $P<0.05$  vs. IGF-1-treated scramble shRNA cells). The present findings indicate that FAK is required for growth factor (IGF-1) and contraction-induced muscle cell growth, and may act through an Akt/mTOR-dependent pathway. 1. Fluck M, Carson JA, Gordon SE, Ziemiecki A and Booth FW. Focal adhesion proteins FAK and paxillin increase in hypertrophied skeletal muscle. *Am J Physiol* 277:C152-C162, 1999.

### IDENTIFICATION AND CHARACTERISATION OF A NOVEL, MULTI-POTENT SKELETAL MUSCLE-DERIVED STEM CELL WITH BROAD DEVELOPMENTAL PLASTICITY

Henning, B.J.1, Lewis, F.C.1, Sassoon, D.2, Marazzi, G.2, Nadal-Ginard, B.1, Ellison, G.M.1

1:Liverpool JMU, UK, 2:INSERM, Paris, France

**Introduction:** PW1+/Pax7- skeletal muscle-derived interstitial progenitor cells (PICs) are myogenic in vitro and efficiently contribute to skeletal muscle regeneration in vivo (Mitchell et al. 2010). Some stem cells are multipotent and exhibit broad developmental plasticity giving rise to cells and tissues from the 3 germ layers; endoderm, ectoderm and mesoderm. Here we have isolated and characterised a multi-potent PIC population from both mouse and porcine skeletal muscle, which could be used for a variety of regenerative medicine therapies. **Methods:** Satellite cells (PW1+/Pax7+) and PICs (PW1+/Pax7-) were identified and characterised on mouse and porcine skeletal muscle cross sections. Hindlimb skeletal muscle of mouse and porcine was minced and digested in a solution containing collagenase A (100mg/ml), Dispase II (3mg/ml) and DNase I (10mg/ml) for 2 hours at 37°C. The PICs were then purified from the population of small cells using MACS technology (Miltenyi) according to expression of the cell surface markers, Sca-1 and CD34. PICs were characterised for stem cell surface marker expression, clonogenicity, multipotency genes, and myogenic differentiation potential using flow cytometry, cell culture, immunocytochemistry and qRT-PCR. The developmental plasticity of the multi-potent PICs was determined through differentiation into endothelial, epithelial, skeletal muscle, cardiac, adipogenic, hepatic and neurogenic lineages. **Results:** We identified interstitial PW1+/Pax7- PICs as well as PW1+/Pax7+ satellite cells, located underneath the basal lamina of the muscle fibre, in mouse ( $53\pm 5\%$  of PW1+ cells were PICs) and porcine ( $45\pm 4\%$ ) skeletal muscle cross sections. Isolated Sca-1+/CD34+/PW1+/Pax7- PICs showed stem cell properties of clonogenicity (mouse  $48\pm 5\%$ , porcine  $50\pm 10\%$ ), expressed multipotency markers and myogenic differentiation potential in vitro. We purified a subset of PICs that expressed multi-potency markers Oct-4 (99%), Nanog (93%), and Sox-2 (92%). These multi-potent PICs showed a broad developmental plasticity, giving rise to all 3 germ layers. **Conclusion:** We have identified a novel, multi-potent skeletal muscle-derived stem cell which has broad developmental plasticity, and can be propagated and maintained in a primitive state in culture. These findings open new avenues for a variety of solid tissue engineering and regeneration utilising a single multi-potent stem cell type isolated from an easily accessible source such as skeletal muscle. **References** Mitchell KJ et al. Identification and characterisation of a non-satellite cell muscle resident progenitor during postnatal development. *Nature Cell Biology*, 2010;12:257-66.

### DEFECTIVE ADAPTATIONS TO ACUTE EXERCISE IN AGED HUMAN MUSCLE ARE PREVENTED BY LIFE-LONG EXERCISE TRAINING

Cobley, J.N., Waldron, S., Gregson, W., Cable, T., Burniston, J.G., Morton, J.P., Glose, G.L.

Liverpool John Moores University

Defective adaptations to acute exercise in aged human muscle are prevented by life-long exercise training. Cobley, J.N., Waldron, S., Gregson, W., Cable, N.T., Burniston, J.G., Morton, J.P., & Close, G.L. Liverpool John Moores University (Liverpool, UK) **Introduction** Animal models suggest that attenuated heat shock protein (HSP) expression and diminished signalling towards mitochondrial biogenesis following exercise in aged muscle may underlie age-related muscle frailty (Jackson & McArdle, 2011; Ljubicic et al., 2010) however this hypothesis has not been tested in humans. **Methods** Twenty-four subjects were recruited, 12 aged ( $+55$  yrs) and 12 young (18-25 yrs). These groups were further segregated into trained ( $n = 6$ ) and untrained ( $n = 6$ ) groups. Subjects completed a 20 minute high-intensity interval training session on a bicycle ergometer. Muscle biopsies were obtained pre, post and 3 days following exercise. Samples were analysed for HSP72, HSP27, Lon protease and cytochrome c oxidase IV (COXIV) protein content at baseline and 3 days post-exercise. Peroxisome proliferator activated receptor gamma co-activator one alpha (PGC-1 $\alpha$ ) protein content was determined at baseline. **Results** There was significantly greater PGC-1 $\alpha$  protein content at baseline in old trained subjects compared with old untrained ( $P=0.001$ ) and young untrained ( $P=0.002$ ) subjects. COXIV content was not different at baseline between groups ( $P=0.138$ ). COXIV protein content increased at 3 days ( $P=0.002$ ) but this increase was significantly attenuated in old untrained compared to young trained ( $P=0.008$ ) subjects. Irrespective of age, only trained subjects were able to significantly increase HSP72 protein content at 3 days post-exercise ( $P=0.028$ ). No group or time effects were observed for HSP27 and Lon at baseline or 3 days ( $P>0.05$ ). **Discussion** These data represent the first attempt to characterise both the adaptive cytoprotective and mitochondrial responses to exercise in aged trained and untrained human muscle. Life-long training up-regulates PGC-1 $\alpha$  protein content in aged muscle compared with untrained subjects and training is associated with a preserved ability to induct COXIV and HSP72 expression post-exercise. Conversely, untrained aged muscle exhibits decreased basal PGC-1 $\alpha$  expression and defective up-regulation of COXIV post-exercise. PGC-1 $\alpha$  over-expression attenuates age-related muscle wastage in animal models (Wenz et al., 2009) hence elevated expression in humans may help maintain muscle mass in old trained individuals. **In conclusion**, certain exercise adaptations fail in untrained aged individuals which may underlie muscle frailty. **References** Jackson, M.J. & McArdle, A. (2011). *J Physiol*. 589:2139-45 Ljubicic V, Joseph AM, Saleem A, Uguccioni G, Collu-Marchese M, Lai RY, Nguyen LM, Hood DA. (2010) *Biochim Biophys Acta*. 2010 1800(3):223-34 Wenz T, Rossi SG, Rotundo RL, Spiegelman BM, Moraes CT. (2009) *Proc Natl Acad Sci U S A* 1;106:20405-10



## INSULATIVE TROUSERS INCORPORATING ACTIVE HEATING REDUCE MUSCLE TEMPERATURE DECLINE FOLLOWING WARM UP AND IMPROVE SPRINT CYCLING PERFORMANCE

Faulkner, S.1, Ferguson, R.A.2, Gerrett, N.1, Hodder, S.G.1, Hupperets, M.3, Havenith, G.1

*Loughborough University*

**INTRODUCTION:** Elevations in muscle temperature ( $T_m$ ) have been shown to be important for enhancing maximal muscle power output during short duration, sprint based activities, hence the completion of a warm up prior to many exercise types. In many sporting competitions it is not uncommon for there to be delays between warm up completion and performance execution, during which time activity levels may be insufficient to maintain elevations in  $T_m$ . Excessive decline in  $T_m$  may lead to sub-optimal contractile conditions and impaired exercise performance. Therefore, the aim of the present study was to determine to what extent a delay between warm up and competition might influence  $T_m$  and performance and whether this may be attenuated using an insulated athletic trouser with optional heating. **METHODS:** On three separate occasions, 11 male cyclists ( $24 \pm 5$  yrs;  $182.4 \pm 7.6$  cm;  $77.4 \pm 10.0$  kg) completed a standardized 15 min intermittent sprint-based warm up on a cycle ergometer, followed by a 30 min passive recovery period before completing a 30 sec maximal sprint test.  $T_m$  of the vastus lateralis was measured at depths of 1, 2 and 3 cm prior to and following the warm up and immediately before the sprint test. Measures of absolute and relative peak power output were taken. During the recovery period subjects wore a tracksuit top and (in a balanced order) either i) a standard tracksuit ensemble (CONT), ii) a pair of insulated athletic trousers (INS) or iii) insulated athletic trouser with inbuilt electric heating elements around the thighs (HEAT). **RESULTS:** The warm up increased  $T_m$  at all depths by  $\sim 2.5^\circ\text{C}$ , with no differences between conditions. Following the recovery period  $T_m$  declined in both CONT (1cm  $36.3 \pm 0.4^\circ\text{C}$ ; 2cm  $36.6 \pm 0.3^\circ\text{C}$ ; 3cm  $36.9 \pm 0.2^\circ\text{C}$ ) and INS (1cm  $36.5 \pm 0.6^\circ\text{C}$ ; 2cm  $36.8 \pm 0.4^\circ\text{C}$ ; 3cm  $37.0 \pm 0.3^\circ\text{C}$ ), whereas  $T_m$  for HEAT remained elevated at all depths compared to both INS and CONT (1cm  $37.4 \pm 0.3^\circ\text{C}$ ; 2cm  $37.3 \pm 0.2^\circ\text{C}$ ; 3cm  $37.3 \pm 0.2^\circ\text{C}$ ;  $p < 0.01$ ). Peak power output was higher in HEAT ( $20.9 \pm 1.6$  W/kg) than both CONT ( $19.2 \pm 1.7$  W/kg; 9%,  $p < 0.05$ ) and INS ( $20.3 \pm 2.3$  W/kg; 3%,  $p < 0.05$ ). **DISCUSSION:** Though insulated trousers alone were not effective, the use of an insulated athletic trouser with the addition of electric heating elements around the thighs was able to reduce the decline in  $T_m$  that is associated with forced periods of inactivity between warm up completion and competition. Furthermore, the prevention of the decline in  $T_m$  improved subsequent sprint performance compared to when passive heating is not used.

15:00 - 16:30

## Oral presentations

### OP-PM02 Health and Lifestyle Interventions

#### DETERMINING THE OPTIMAL WEEKLY DOSAGE OF INTERMITTENT HYPOXIC EXPOSURE FOR HEALTH BENEFIT

Lizamore, C.1, Kathiravel, Y.2, Elliott, J.3, Hellemans, J.4, Hamlin, M.1

*1: Lincoln University (Christchurch), 2: Active Health (Christchurch), 3: University of Otago Christchurch (Christchurch), 4: National Triathlon Coach (Netherlands)*

**Introduction** Intermittent hypoxic exposure (IHE) is a technique used by athletes to simulate training at altitude. IHE has also been applied to improve cardiovascular health in a compromised population; however, optimal weekly dosages for health benefit are unknown. **Methods** Thirty untrained participants (13 male, 17 female; aged:  $55.9 \pm 5.0$ ; BMI:  $28.0 \pm 4.9$ , mean  $\pm$  SD) were randomly allocated into groups receiving IHE treatments 2-3 times per week (IHE3); IHE treatments 5 times per week (IHE5) or a control group receiving normoxic placebo 2-3 times per week (C). Pre- and post-intervention assessments included: supine heart rate variability (HRV), resting systolic blood pressure (SBP), and maximal oxygen consumption ( $\text{VO}_{2\text{max}}$ ). Highly sensitive C-Reactive Protein (hs-CRP) and Haemoglobin concentration (Hb) were also measured. Participants completed 5 weeks of treatment whereby IHE participants breathed hypoxic air to yield peripheral blood oxygen saturation levels ( $\text{SpO}_2$ ) as follows: week 1:  $\text{SpO}_2 > 95\%$ ; week 2:  $\text{SpO}_2 = 90\%$ ; week 3:  $\text{SpO}_2 = 85\%$ ; week 4-5:  $\text{SpO}_2 = 80\%$ . C participants breathed a normoxic placebo, week 1-5:  $\text{SpO}_2 > 95\%$ . Each session consisted of 5 min hypoxia/placebo:5 min ambient air intervals for 1 hour. Magnitude based inference was used to analyse the data for practical significance, using the mean change  $\pm$  90% confidence interval, and the % chances for harmful/trivial/beneficial outcomes based on Cohen's standardised units for smallest worthwhile change. Hopkins (2007)'s qualitative analysis of the outcome has also been included. **Results** After 5 weeks of treatment, compared to C, SBP (mmHg) decreased in IHE3 ( $10.1 \pm 7.7\%$ ; 0/5/95%; very likely beneficial); and IHE5 ( $6.5 \pm 7.9\%$ ; 1/25/74%; possibly beneficial); HRV (rMSSD) increased substantially in IHE5 ( $50.9 \pm 24.2\%$ ; 0/1/99%; very likely beneficial) but less so in IHE3 ( $15.1 \pm 59.4\%$ ; 18/24/57%; unclear); similarly, Hb (g/L) increased more in IHE5 ( $2.6 \pm 2.5\%$ ; 0/34/66%; possibly beneficial) than IHE3 ( $1.0 \pm 2.9\%$ ; 7/58/35%; unclear). There were no beneficial changes in hs-CRP or  $\text{VO}_{2\text{max}}$  in the IHE groups compared to C. **Discussion** Both IHE groups showed improvement in HRV (especially IHE5), and BP (especially IHE3), with a possible Hb increase in IHE5 only. These results suggest IHE 3-5 times per week is optimal for BP and HRV improvement in untrained subjects. As HRV (Kleiger et al., 2005) and BP (Wilson et al., 1998) are risk factors for heart disease, IHE warrants further investigation as a preventative therapy. **References** Hopkins W (2007). *SportSci*, 11, 16-20 Kleiger R, Stein P, Bigger T (2005). *A.N.E.* 10, 88-101 Wilson P, D'Agostino R, Levy D, Belanger A, Silbershatz H, Kannel W (1998). *Circ*, 97, 1837-1847

#### EFFECTS OF A SIX-MONTH ACTIVE PLAY PROGRAMME ON PRESCHOOL CHILDREN'S HABITUAL PHYSICAL ACTIVITY LEVELS.

O'Dwyer, M.V., Knowles, Z., Fairclough, S.J., Fowweather, L., Stratton, G.

*Liverpool John Moores University*

**BACKGROUND** Despite being the most active segment of the population, monitoring studies suggest that a high proportion of young children may not be sufficiently active for adequate development and health. Intervention during early childhood might be required to ensure health promoting behaviours are established. **AIM** To investigate the 6-month effect of an Active Play intervention on preschool children's moderate-to-vigorous physical activity (MVPA) levels. **METHOD** Participants ( $n=240$ ; 52% male,  $\text{Mage} = 4.4 \pm 0.6$  years) from 12

schools participated in the study. Intervention schools (n=6) received one Active Play session (~30 min) per week for 6-weeks from a trained deliverer. Six schools served as socioeconomic matched comparisons. Details of intervention are described elsewhere (O'Dwyer et al. 2011). Physical activity was quantified using accelerometry at baseline, post-intervention and 6 months. A three-level (time, pupil and school) multilevel analysis was used to determine the effects of the intervention across time on MVPA. RESULTS At six-months non-significant intervention effects were found for MVPA when confounding variables were added to the model. However, it was found that sex and the amount of hours children spent at school were significant predictors of MVPA. Boys engaged in more MVPA than girls ( $2.6 \pm 1.4$  mins). Children who spent a half-day at school engaged in more MVPA than their full-day counterparts ( $6.2 \pm 1.6$  mins). The child's BMI, ethnicity and maternal education were not significant predictors of MVPA. DISCUSSION The intervention did not significantly increase MVPA possibly because there may not have been an ample dose of activity. Additionally, socio-ecological theories propose that the active involvement of a parent during interventions may contribute to a more meaningful behaviour change. Future interventions should aim to incorporate the home environment and run over a longer period of time.

### PREPUBERTAL CHILDREN WITH SUITABLE FITNESS AND PHYSICAL ACTIVITY PRESENT REDUCED RISK OF OXIDATIVE STRESS

Llorente-Cantarero, F.J., Gil-Campos, M., Munoz-Villanueva, M.C., Pérez-Navero, J.L.

*University Hospital Reina Sofia*

**Introduction** Overproduction of oxygen free radicals can damage essential molecules in a process called oxidative stress (OS). Thus, OS is an important pathogenic ageing factor that has been associated with various disorders such as cardiovascular, metabolic and neurodegenerative diseases. To assess the impact of fitness status and physical activity on OS in prepubertal children, we measured selected biomarkers such as protein carbonyls (PC), lipid peroxidation products (LPO) and total nitrites, as well as on the antioxidant system: total glutathione (TG), oxidized glutathione (GSSG), reduced glutathione (GSH), superoxide dismutase activity, and glutathione peroxidase (GPx). **Methods** A total of 132 healthy children aged 7-12, at prepubertal stage were classified into two groups according to their fitness level: low fitness (LF) and high fitness (HF). This level was evaluated by a group of test took of Eurofit Battery and classified with the Olds et al. (2006) score. They were observed while engaged in an after-school exercise program, and a questionnaire was realized to obtain information on their physical activity or sedentary habits. Plasma and red blood cells were obtained to analyze biomarkers. **Results** Regarding oxidative stress markers, the LF group and the sedentary group showed higher levels of TG and GSSG and a lower GSH/GSSG ratio than the HF group and the children engaged in physical activity. A negative association was found between PC and GSSG and TG, and between TG and the GSH/GSSG ratio. Moreover, a negative correlation was found between GSSG and fitness, with a positive correlation with the GSH/GSSG ratio. **Discussion** In this study, the biomarkers TG, GSSG and GSH/GSSG ratio seem to be precocious and sensitive parameters for measuring changes in OS in prepubertal children, in relation to their CRF and PA. These results are in agreement with other associations described between CRF and OS. Antioxidant activity have been assessed in trained and untrained adults, suggesting lower OS in trained subjects [1,2]. This research contributes to recognize that an adequate level of fitness and recreational physical activity in childhood leads to better health and oxidative status. **References** Olds, T.; Tomkinson, G.; Léger, L.; Cazorla, G. *Sports Sci.* 24:1025-38;2006. 1. Urso, M.L.; Clarkson, P.M. Oxidative stress, exercise, and antioxidant supplementation. *Toxicology.* 189:41-54;2003. 2. Falone, S.; Mirabilio, A.; Pennelli, A.; Cacchio, M.; Di Baldassarre, A.; Gallina, S.; Passerini, A.; Amicarelli, F. Differential impact of acute bout of exercise on redox- and oxidative damage-related profiles between untrained subjects and amateur runners. *Physiol. Res.* 59:953-61;2010.

### THE HYPOTENSIVE EFFECT OF HIGH AND LOW INTENSITY RESISTANCE EXERCISE IN YOUNG WOMEN

Terblanche, E.

*Stellenbosch University*

**Introduction** Post-exercise hypotension (PEH) following an acute bout of exercise is considered a possible mechanism for the reduction in cardiovascular disease and mortality associated with regular physical exercise. The effect of aerobic exercise on PEH is well-documented and evidence suggests that this mode of exercise lead to clinically significant reductions in blood pressure (BP) in both normotensive and hypertensive individuals. However, the evidence for resistance training is both limited and conflicting and the majority of studies only involves men. Thus the aims of this study were to determine (1) if resistance training causes PEH in normotensive young women and (2) whether the intensity of the exercise bout affects the magnitude of the BP response. **Methods** Eight healthy young women (age: 18 to 22 years), with previous experience in weight training, were evaluated during three randomized sessions. One repetition maximum (1RM) was determined for the bench press, leg press, biceps curl and overhead triceps extension. Participants then completed a high and low intensity session which consisted of three sets of ten repetitions of each exercise at 70% (HIT) and 30% (LIT) of 1RM, respectively. Subjects also completed a control session of passive rest. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were determined before and up to 60 minutes post-exercise using an ambulatory blood pressure monitor (Ergoline Ergoscan 2008, Germany). **Results** SBP was slightly more elevated directly after HIT compared to LIT ( $126 \pm 8$  vs  $114 \pm 12$  mmHg). Both the 60 minute post-exercise SBP and DBP was significantly more reduced after HIT compared to LIT and control [SBP:  $-5.7 \pm 2.0$  vs  $-0.5 \pm 3.5$  vs  $-2.5 \pm 1.5$  mmHg;  $p < 0.05$  and DBP:  $-7.4 \pm 2.5$  vs  $+3.0 \pm 1.5$  vs  $-0.5 \pm 1.5$  mmHg;  $p < 0.05$ ]. **Discussion** A single episode of high intensity resistance exercise caused small, but clinically significant reductions in BP that lasted for at least 60 minutes following exercise in young, normotensive women. This is in contrast to previous studies (Bermudes et al, 2004; Melo et al, 2006) which suggested that low intensity resistance exercise have a stronger hypotensive effect than high intensity exercise. However, these conflicting results could be explained by the differences in subject characteristics and exercise protocols. Importantly, this study confirms the hypotensive effects of resistance exercise and emphasizes the need to elucidate the optimal training load that is associated with the greatest PEH response in terms of magnitude and duration. **Bermudes AM, Vassallo DV, Vasquez EC, Lima EG. (2004). Arq Bras Cardiol, 82,65-71. Melo CM, Alencar AC, Tinucci T, Mion D, Forjaz CL. (2006). Blood Press Monit, 11,183-189.**

### STRENGTH, BODY COMPOSITION AND CARDIOVASCULAR EFFECTS OF HIGH-RESISTANCE CIRCUIT VS. TRADITIONAL STRENGTH TRAINING IN AN ELDERLY POPULATION

Romero-Arenas, S.1, Martínez-Pascual, M.2, Marín-Pagán, C.1, Blazevich, A.J.3, Luque, A.J.1, López-Román, F.J.1, Pérez-Gómez, J.4, Alcaraz, P.E.1

1: UCAM (Murcia, Spain), 2: HGUSL (Cartagena, Spain), 3: ECU (Perth, Australia), 4: UEX (Cáceres, Spain).

**INTRODUCTION** Circuit training is a time-efficient training modality that can elicit demonstrable improvements in health and physical fitness (Gettman et al., 2002). A significant drawback of standard circuit training programs, however, is that the loads lifted are typically low, so the stimulus for strength and muscle, and bone mass adaptations is minimal. Therefore, the aim of this study was determine the efficacy of a program of high-resistance circuit (HRC) training, and to compare the effects of high-resistance traditional (ST) and circuit strength training on muscle size and strength, body composition and cardiovascular fitness in healthy elderly. **METHODS** Thirty elderly (age  $62.3 \pm 5.9$  years, height  $1.55 \pm 0.07$  m and weight  $71.9 \pm 11.2$  kg) were randomly assigned to the TS group ( $n = 14$ , 6RM, 1-3 sets) or to the HRC group ( $n = 16$ , 6RM, 1-3 sets). Training consisted of weight lifting 2 times a week during 12 weeks. Prior to and at the end of the training program, maximum isokinetic torque ( $90^\circ \cdot s^{-1}$ ), body composition (DXA) and aerobic capacity were determined. Main and interaction effects resulting from the intervention were analyzed using single or multivariate analyses of variance (ANOVA) with repeated measures ( $p \leq 0.05$ ). **RESULTS** After training, total fat free mass (3.4% and 2.2%, HRC and TS, respectively) and bone mineral density (BMD) (1.2% and 1.1%, HRC and TS, respectively) was increased in both experimental groups. Only in the HRC group, the aerobic capacity was improved (10%) and the percentage of body fat was decreased (-4.4%), being established statistically significant differences between HRC and TS. A significant increase of isokinetic strength was observed in both experimental groups for the angular speed of  $90^\circ \cdot s^{-1}$  upper and lower limbs. **DISCUSSION** In this study, we observe the HRC training was as effective as TS for improving isokinetic torque, the lean mass and BMD. Only HRC training promoted decrease the fat mass and improvement the aerobic capacity. Modifications in lean-to-fat mass ratios and improved cardiovascular function have been closely linked with reductions in disease risk and all cause mortality (Sui et al., 2007). Thus, HRC training shows enormous promise as a health modification intervention. **REFERENCES** Gettman LR, Ward P, Hagan RD. (1982). *Med Sci Sports Exerc*, 14(3), 229-34. Sui X, LaMonte MJ, Laditka JN, Hardin JW, Chase N, Hooker SP, et al. (2007). *JAMA*, 298(21), 2507-16.

### JUMPING PERFORMANCE DIFFERENCES AMONG COMPETING ELITE MALE HANDBALL

Setuain, I.

*Research, Studies and Sport Medicine Center, Government of Navarre, Spain*

Handball, is one of the most challenging sports for the knee joint. Although female handball players are one of the most exposed athletes to the ACL injury, the incidence of this injury on their male counterparts is not infrequent. Persisting strength and neuromuscular control deficits may be observed among the athletes who had suffered ACL injury, despite having complete the rehabilitation process due to inadequate or incomplete rehabilitation. This factor could be one of the explaining reasons for the ACL reinjury rates among this population. Measuring jumping performance variables such as stance phase contact time, flight time and mechanical power output during the rehabilitation process would help to minimize high-cost reinjury rate among handball elite athletes. **PURPOSE:** To describe jumping performance among a group of 13 male handball elite athletes using a previously validated jump test battery. Secondly, to identify possible differences between injured and uninjured extremities, in vertical and horizontal jump flight times, stance phase contact time, mechanical power, and reached distance obtained. We hypothesized that previously injured extremities would show deficits in jumping performance despite the injured athletes have completed their rehabilitation process and being competing at the maximum level. **METHODS:** 13 male elite athletes (6 previously injured and reconstructed and 7 uninjured control subjects) were evaluated performing a previously validated jump test battery that includes bilateral drop jump, unilateral drop jump, unilateral countermovement jump, unilateral triple jump for distance and the cross over hop for distance. Height (m), flight time (s), stance phase contact time (s), mechanical power ( $W \cdot kg^{-1}$ ) and distance (m) were obtained in each jump test performed. For the unilateral jump tests, comparison was made between reconstructed legs and the dominant ones of the uninjured subjects. For the bilateral drop jump test, comparison was made between reconstructed and uninjured subjects. **RESULTS:** Previously ACL reconstructed athletes demonstrated significantly lower mechanical power values during the unilateral drop jump ( $11,06$  vs.  $17,43$   $W \cdot kg^{-1}$ ;  $P < 0.05$ ) on their reconstructed leg compared with the healthy legs of the uninjured subjects. No significant differences were observed in the other variables recorded. **CONCLUSION:** Previously ACL reconstructed athletes may cope with some functional deficits once returning to competition, such as in lower mechanical power output ability in the injury limb, potentially increasing their reinjury risk. Restoration of these deficits would help to decrease the reinjury rates among this population. **REFERENCES:** 1. Salmon L, Russell V, Musgrove T, Pinczewski L, Refshauge K, Incidence and Risk Factors for Graft Rupture and Contralateral Rupture After Anterior Cruciate Ligament Reconstruction. *J of arthros relat res* 2005;21(8):948-957. 2. Blackburn JT, Padua DA. Sagittal-plane trunk position, landing forces, and quadriceps electromyographic activity. *J Athl Train* 2009; 44(2):174-179.

15:00 - 16:30

### Invited symposia

#### IS-SH10 A Cost-Benefit Analysis of Exercise for Health (\*)

#### COSTS OF PHYSICAL ACTIVITY AND SPORTS RELATED INJURIES: A DIFFERENT VIEW ON INJURY BURDEN

Verhagen, E.

*EMGO-Institute/VU University medical center*

Regular participation in physical activity and sports is beneficial for health. Thereby, safety in sports and PA is an important prerequisite for continuing participation in sports, as well as maintenance of a healthy physically active lifestyle. A variety of preventive, diagnostic, and therapeutic interventions are commonly used in sports medicine. In addition, an increasing number of randomised trials has evaluated the effectiveness of these interventions. Up till now the financial part of sports and physical related injuries and their prevention has

been mostly neglected in scientific literature. Nevertheless, sports injuries have a huge financial impact on society, because of the costs of the interventions and the costs associated with production loss due to work absenteeism and disablement as a result of sports injuries. In the Netherlands alone, in a population of about 7 million active sports participants, the annual estimated sports injury related costs are just over 3 billion euro's. Reliable descriptive cost data can aid policy makers and governmental agencies in determining 'problem' injuries and sports that require further investigation. In addition, it is important to obtain insight into the efficiency or cost-effectiveness of sports medicine interventions. Economic evaluations may help policy makers in their decision to include an intervention in the public health insurance system and they may help health professionals and patients to make decisions in clinical practice. A more efficient use of limited financial resources results in optimal care for more individuals. In short, financial analyses are a strong tool for agenda setting and implementation.

## **COSTS OF MAJOR BICYCLE ACCIDENTS IN FLANDERS**

de Geus, B.

*Vrije Universiteit Brussel*

**INTRODUCTION** Utilitarian cycling is recognized as an excellent way of being physically active on a regular basis and maintaining good health (Oja et al., 2011). Obesity prevention, reducing the physical inactivity burden, sickness absence reductions, increased productivity and the reduction of disease could result in cost savings. Unfortunately, some cyclists will be involved in accidents, will need medical care and may incur temporal or permanent physical injuries, which will induce costs to the cyclist and the society. In the Belgian SHAPES project, Aertsens et al. (2010) estimated the average total cost of minor bicycle accidents at 841 euro (95% CI: 579-1205) per accident or 0.125 euro per kilometre cycled. Overall, productivity loss is the most important component accounting for 48% of the total cost. The aim of this abstract is to provide more insight into the resulting costs of major bicycle accidents in Flanders. Major bicycle accidents are defined as accidents for which the cyclist had to be hospitalised for more than 24 hours. **MATERIALS AND METHODS** The data for this study were collected in a retrospective study design, using national statistics. In 2008, 2364 bicycle accidents that occurred in Flanders were registered by the National Trust for Accidents (FAO). From those 2364 invited participants, 289 returned the questionnaire and 28 were classified as a major accidents and used for the data analysis. Direct costs, including material damage as well as medical costs and productivity loss are calculated. For calculating the medical costs and productivity loss, a differentiation was made between a recovery phase and a permanent disability phase. **RESULTS** The average costs for the 28 accidents are composed by: a one time cost of 350 euro for material damage and a yearly cost of 1443 euro due to permanent disability resulting in productivity loss. The average medical costs during the recovery phase were composed by 1861 euro for doctor costs, 2680 euro for surgical interventions and 104 euro for medication. As a consequence of the accident, 17 (61%) participants did not fully recover. In the "permanent disability" phase, the average medical costs are 242 euro per year. **DISCUSSION** The calculations in this study does not take into account the indirect costs (productivity loss and leisure time loss) nor intangible costs of pain and psychological suffering. Based on Norwegian data, annual economic costs of bicycle injuries were estimated to approximately 300 million euro or 5804 euro per minor accident, compared to 7617 euro per major accident in Flanders. **CONCLUSION** Total annual bicycle injury costs are huge, but these costs must be balanced against the benefits of bicycling, related to health and environment. **REFERENCES** Aertsens et al, 2010, *Acc Anal Prev*, 42, 2149-2157 Oja et al, 2011, *Scan J Med Sci Sports*, 21, 496-509 Veisten et al, 2007, *Acc Anal Prev*, 39, 1162-1169

## **THE COST-BENEFIT AND COST-EFFECTIVENESS OF PHYSICAL ACTIVITY AND EXERCISE**

van Mechelen, W.

*VU University Medical Center*

**Speaker 1: Willem van Mechelen (NED)** The cost-effectiveness of workplace physical activity and exercise interventions **Running title: Workplace PA programmes** Physical inactivity is now according to WHO worldwide the 4th leading cause of mortality due to non-communicable chronic (i.e. lifestyle-related) disease. In addition, we are faced with demographic changes by which by 2025 in North-West Europe 1 out of 3 adults older than 18, will be older than 65 years. As a consequence of these epidemiologic and demographic trends there is a push for workplace-related physical activity and exercise programmes to counteract both trends of relevance for the vitality of the workforce. Purpose of this presentation is to provide evidence on the cost-benefit and cost-effectiveness of workplace physical activity and exercise interventions. For this purpose the results of a number of recent systematic reviews will be presented, as well as a number of recently conducted randomised controlled trials. From this evidence it can be concluded that workplace physical activity and exercise interventions hold a promise for the future, but also that more high quality studies are needed to be able to make a balanced judgement on the cost-benefit and cost-effectiveness of such interventions. **References** van Dongen JM, Proper KI, van Wier MF, van der Beek AJ, Bongers PM, van Mechelen W, van Tulder MW. A systematic review of the cost-effectiveness of worksite physical activity and/or nutrition programs. *Scand J Work Environ Health* 2012 van Dongen JM, Proper KI, van Wier MF, van der Beek AJ, Bongers PM, van Mechelen W, Tulder MW. Systematic review on the financial return of worksite health promotion programmes aimed at improving nutrition and/or increasing physical activity. *Obes Rev* 2011. Groeneveld IF, van Wier MF, Proper KI, Bosmans JE, van Mechelen W, van der Beek AJ. Cost-effectiveness and cost-benefit of a lifestyle intervention for workers in the construction industry at risk for cardiovascular disease. *J Occup Environ Med* 2011;53(6):610-617.

**15:00 - 16:30****Invited symposia****IS-BN01 Importance of Feedback in Motor Control and Learning**

---

**AUGMENTED FEEDBACK: FROM BEHAVIORAL PRINCIPLES TO NEURAL MECHANISMS**

Swinnen, S.

*KU Leuven*

Processing sensory input and using this source of information to support action is critical for performance and learning of gross and fine motor skills, such as the control of balance, lifting an object, and coordinating the upper and/or lower limbs. Here, I will start with an overview of some general principles of feedback that have inspired research on human motor performance and learning during the past decades. I will particularly elaborate on how extrinsic feedback can be augmented to the feedback that is normally available through our sensory sources and whether this may have positive or negative consequences for performance, learning and retention. I will then elaborate on the neural correlates of movement performed in the presence or absence of augmented visual feedback in view of the distinction between internal versus external movement generation. Internally-generated movement is generally based on a medial (Basal Ganglia to Supplementary Motor Area) brain activation network and external generation on a parieto-premotor network. Finally, I will provide a neural basis for Schmidt's guidance hypothesis of information feedback, addressing the 'double edged sword' surrounding feedback. More specifically, I will discuss how augmented feedback can give a boost to performance, yet may hamper motor consolidation and retention. This has important implications for rehabilitation intervention because our general aim is to help patients to improve performance not only in the presence of various modes of augmented feedback but also in their local habitat where these sources of augmented feedback may no longer be present.

**ADAPTIVE FEEDFORWARD AND FEEDBACK STRATEGIES IN SENSORIMOTOR CONTROL**

Franklin, D.W.

*University of Cambridge*

The sensorimotor control system has exceptional abilities to perform skilful action despite ever changing conditions. I will discuss how this adaptability can result through intrinsic feedback mechanisms in two different ways: sensory feedback driving feedforward adaptation; and feedforward adaptation in turn adapting the feedback responses and tuning them to the environment. When we learn a new skill, sensory feedback from previous errors are incorporated into the feedforward motor command to gradually refine our movements. I will describe a model of motor learning based on the simultaneous optimization of stability, accuracy and efficiency. This model of motor learning offers new insights as to how the brain controls the complex musculoskeletal system and iteratively adjusts motor commands to improve motor skills with practice. However learning can also be used to adjust intrinsic feedback control. I will discuss new experiments in which we examine the control and modulation of involuntary visuomotor responses. These rapid visuomotor responses generate corrective arm movements to small positional changes in the visual feedback of the hand during movements. I will describe experiments demonstrating that these feedback responses can be precisely tuned by the sensorimotor control system to the environment.

**THE ROLE OF INTRINSIC AND EXTRINSIC FEEDBACK IN HUMAN MOTOR LEARNING**

Lundbye-Jensen, J.

*University of Copenhagen*

It is evident that the central nervous system has an impressive capability of forming and maintaining multiple long-term motor memories. The human capacity of learning new motor skills has a tremendous importance across the lifespan. The practice of movements is essential for the acquisition of new motor skills, and once we have acquired skills such as bicycling, ice skating or driving a car, these skills are often retained for a very long time. When we practice a motor task and acquire new skills, our movements are gradually refined over time. This gradual optimization of the feedforward motor command is to a large extent driven by errors in previous movements arising from a comparison between the predicted consequences of the movement and the actual outcome (perceived feedback from the body and the surrounding world). In my presentation, I will focus on motor behavior and the role of intrinsic and extrinsic feedback mechanisms in motor learning. I will present behavioral and electrophysiological results from recent experiments, which demonstrate that sensory feedback may provide strong error and learning signals for the central nervous system. Not only can sensory feedback update the feedforward motor command, learning is also accompanied by optimized feedback control. In this way, feedback is an essential part of learning.

15:00 - 16:30

## Invited symposia

**IS-PM01 JSPFSM Exchange Symposium: Physiological and environmental factors influencing sports performance****PERIPHERAL VISUAL PERCEPTION DURING EXERCISE: WHY WE CANNOT SEE**

Ando, S.

*Fukuoka University*

Vision is one of the most important sensory modalities in humans. The visual field is defined as the area perceived by the eyes while people fixate on a point, and is composed of the central and peripheral visual fields. Many sports require high-level visual perceptual skills under conditions of physiological stress. In sports such as football, players gather visual information from the periphery of the visual field to see other players and objects beyond the central visual field. Thus, peripheral visual perception may play an important role in sports performance. In recent years, increasing empirical evidence suggests that acute exercise affects peripheral visual perception. A behavioral study has shown that peripheral visual perception may be vulnerable to exercise as compared with central visual perception (Ando et al. 2008). The following study suggested that the detrimental effects of exercise on peripheral visual perception are not primarily ascribed to low visual resolution, but to the impaired top-down control of visual attention (Ando et al. 2012). During incremental exercise, peripheral visual perception was impaired when engaged at exercise at high workloads above the ventilatory threshold (Ando et al. 2005). Furthermore, high aerobic capacity attenuated the increase in peripheral visual reaction time during strenuous exercise, suggesting that oxygen availability play a role in peripheral visual perception (Ando et al. 2005). Peripheral visual perception was impaired to some extent during exercise under mild hypoxia relative to normoxia although the differences between normoxia and hypoxia failed to reach statistical significance (Ando et al. 2010). Further analysis demonstrated that decreases in cerebral oxygenation were closely associated with the impairment in peripheral visual perception during exercise (Ando et al. 2010). In contrast, peripheral visual perception was not impaired even during strenuous exercise under hyperoxia where oxygen availability was elevated (Ando et al. 2009). These findings suggest that a decrease in cerebral oxygenation is associated with impairment in peripheral visual perception during strenuous exercise. The decrease in cerebral oxygenation during exercise means that oxygen availability may be insufficient to meet metabolic demand. It is plausible that decreases in cerebral oxygenation have detrimental effects on visual perceptual performance during exercise. References Ando et al. (2008) *Int J Sport Med*, 29, 994-998. Ando et al. (2012) *Physiol Behav*, 106, 117-121. Ando et al. (2005) *Eur J Appl Physiol* 94, 461-467. Ando et al. (2010) *J Appl Physiol* 108, 1210-1216. Ando et al. (2009) *Eur J Appl Physiol* 106, 61-69, 2009

**ENDURANCE EXERCISE PERFORMANCE AND BODY TEMPERATURE UNDER VARIOUS HUMIDITY CONDITIONS IN THE HEAT**

Otani, H., Watson, P., Maughan, R.J.

*Himeji Dokkyo University*

Endurance exercise performance and body temperature under various humidity conditions in the heat Hidenori Otani 1,2, Phillip Watson 2, Ronald J. Maughan 2 1 Faculty of Health Care Sciences, Himeji Dokkyo University, Japan 2 School of Sport, Exercise and Health Sciences, Loughborough University, UK Introduction: It is well known that endurance exercise performance is impaired in the heat. Galloway and Maughan (1997) demonstrated a progressive reduction in endurance exercise capacity in the heat as the ambient temperature increased. However, although the importance of the relative humidity (RH) for effective thermoregulation and endurance exercise performance in the heat has been recognized, there have been no systematic studies to confirm and quantify this effect. The aim of this study was to examine the effect of RH on endurance exercise performance and body temperature in the heat. Methods: Eight healthy males completed four cycling trials at 70% of their maximum oxygen uptake until volitional exhaustion. Experimental trials were undertaken in a climatic chamber with the ambient temperature at 30°C and RH was maintained at either 24%, 40%, 60% or 80%. Rectal temperature, skin temperature (chest, upper arm, thigh and calf), heart rate, skin blood flow and blood pressure were recorded at rest and during exercise. Expired air was collected every 15 minutes during exercise. Blood samples were collected before exercise, at 15 and 30 minutes during exercise, and immediately after exhaustion. Results: Exercise time to exhaustion ( $\pm$  SD) was  $68 \pm 19$ ,  $60 \pm 17$ ,  $54 \pm 17$  and  $46 \pm 14$  minutes in the 24, 40, 60 and 80% trials, respectively; exercise time was less in the 60% ( $P = 0.013$ ) and 80% ( $P = 0.005$ ) trials than in the 24% trial. There was no difference in rectal temperature between the trials. Rectal temperature at exhaustion was  $39.0 \pm 0.3^\circ\text{C}$  in the 24, 40 and 60% trials and  $39.1 \pm 0.3^\circ\text{C}$  in the 80% trial. The rate of rise in rectal temperature during exercise was faster ( $P < 0.001$ ) in the 80% trial than in the 24% trial. Mean skin temperature at the point of exhaustion was higher ( $P < 0.001$ ) in the 80% trial than in the 24% trial. Heart rate, skin blood flow and cutaneous vascular conductance during exercise were not different between the trials. Total sweat loss was similar between the trials, but sweating rate was higher in the 60% ( $P = 0.002$ ) and 80% ( $P = 0.003$ ) trials than in the 24% trial. There were no differences in the calculated rates of fat and carbohydrate oxidation between the trials. Percentage changes in plasma volume, serum osmolality, serum sodium, serum potassium and blood glucose during exercise were not different between the trials. Conclusion: This study demonstrates a progressive reduction in endurance exercise performance in the heat as RH increases. Early fatigue in the higher humidity trials is accompanied by a faster rate of rise in core temperature and a higher skin temperature. Reference: Galloway SDR, Maughan RJ. *MSSE* 29, 1997.

**CEREBRAL BLOOD FLOW REGULATION IN INTERNAL CAROTID AND VERTEBRAL ARTERIES DURING ORTHOSTATIC STRESS**

Ogoh, S.1,4, Sato, K.1, Fisher, J.2, Seifert, T.3, Overgaard, M.3, Secher, N.3

*1 Japan Women's College of Physical Education, Japan; 2 University of Birmingham, UK; 3 University of Copenhagen, Denmark; 4 Toyo University, Japan*

Introduction: Global cerebral blood flow (CBF) is decreased during orthostatic stress (Alperin et al. 2005). However, the effect of orthostatic stress on the distribution of blood flow to carotid or vertebro-basilar systems remains unclear. Given its importance for the neural regula-

tion of the circulation, CBF regulation in the medulla oblongata (vertebra-basilar system) may be more important for orthostatic tolerance than in the cerebral cortex (carotid system) (Deegan et al. 2010). The purpose of the present study was to compare blood flow regulation in the carotid and vertebro-basilar circulations during orthostatic stress in healthy young subjects. Methods: Blood flow in the internal carotid artery (ICA) and vertebral artery (VA) at supine rest (Supine) and 60° head-up tilt (HUT) were measured using Doppler ultrasonography. Dynamic cerebral autoregulation (CA) was also determined during Supine and HUT conditions, from the rate of regulation (RoR) in cerebrovascular conductance of the ICA and VA during acute hypotension induced by the release of bilateral thigh cuffs. Results: HUT significantly decreased ICA blood flow by  $-9.4 \pm 1.7\%$  ( $P < 0.01$  vs. Supine), while ICA conductance was unchanged. In contrast, there was no significant difference in VA blood flow between Supine and HUT, while VA conductance significantly increased ( $3.9 \pm 0.6\%$ ;  $P < 0.05$ ). In addition, dynamic CA in both the ICA and VA was attenuated during HUT, however, the magnitude of the attenuation in dynamic CA to orthostatic stress was greater in the VA ( $0.25 \pm 0.03$  /s in Supine vs.  $0.16 \pm 0.02$  /s in HUT;  $P < 0.05$ ) compared with the ICA ( $0.23 \pm 0.02$  vs.  $0.20 \pm 0.03$ ). Discussion: Our findings indicate that there are notable regional differences in CBF regulation during orthostatic stress. The results of the present study suggest that although the preservation of VA blood flow would be beneficial for the vertebra-basilar system to regulate systemic circulation against orthostatic stress, the posterior cerebral circulation may be more vulnerable than the anterior (carotid) cerebral circulation to an acute change in perfusion pressure. References: Alperin N, Lee SH, Sivaramakrishnan A & Husek SG (2005). *J Magn Reson Imaging* 22, 591–596. Deegan BM, Cooke JP, Lyons D, Ólaighin G & Serrador JM (2010). *Conf Proc IEEE Eng Med Biol Soc* 2010, 2505–2508.

## SUBSTRATE METABOLISM DURING EXERCISE IN THE COLD

Helge, J.

*University of Copenhagen*

This talk will focus on the effect of prolonged exercise in a cold environment and substrate metabolism during exercise in the cold. During very prolonged exercise in cold conditions energy turnover is increased and under strenuous conditions energy balance may be compromised (1). Substrate metabolism during exercise in the cold is influenced by a number of factors; exercise intensity, temperature, duration of cold exposure, behavioural adaptation and training status. The literature is by no means clear cut, but overall a majority studies demonstrate higher carbohydrate utilization during exercise in the cold. Regular prolonged whole body moderate intensity exercise in cold conditions where large distances are traversed on cross country skis, lead to adaptations in skeletal muscle both arm and leg, but does not necessarily change maximal aerobic capacity (2). It is likely that dietary supply and composition as well as body composition may exert a major influence on the adaptive patterns observed through prolonged exposure to cold during exercise. In Inuit, that have been chronically exposed and adapted to cold conditions for generations, there are physiological differences both at the whole body and within the skeletal muscle. The capacity to perform upper body exercise at a markedly higher oxygen uptake than Caucasian in a similar training condition and enhanced muscle mitochondrial capacity are possible adaptive patterns in Inuit. References (1) Stroud MA, Ritz P, Coward WA, Sawyer MB, Constantin-Teodosiu D, Greenhaff PL, Macdonald IA. Energy expenditure using isotope-labelled water ( $2\text{H}_2^{18}\text{O}$ ), exercise performance, skeletal muscle enzyme activities and plasma biochemical parameters in humans during 95 days of endurance exercise with inadequate energy intake. *Eur J Appl Physiol* 1997;76:243-52. (2) Helge JW. Arm and leg substrate utilization and muscle adaptation after prolonged low-intensity training. *Acta Physiol (Oxf)* 2010;199:519-28.

15:00 - 16:30

## Oral presentations

### OP-PM03 Neuromuscular Physiology 1

#### FATIGUE INDUCES A GREATER DECLINE IN EXPLOSIVE THAN MAXIMAL FORCE PRODUCTION WITH EVIDENCE FOR NEURAL AND CONTRACTILE MECHANISMS

Buckthorpe, M.W., Pain, M.T.G., Folland, J.P.

*Loughborough University*

**Introduction** The human capacity for explosive force (EF) production is considered functionally more important than maximal voluntary force (MVF) during explosive movements, such as sprinting, jumping or when restabilising the musculo-skeletal system following a loss of balance and thus in preventing injury (1). Fatigue is thought to increase injury risk (2), however, the effect of fatigue on EF and the mechanisms responsible (neural or contractile) have received little attention. This study assessed the neural and contractile contributions to fatigue during EF production. **Method** Eleven healthy untrained males ( $24 \pm 4$  yrs) completed 10 sets of voluntary maximal explosive isometric contractions of the knee extensors ( $5 \times 3$ -s duration, 2-s rest). Sets were separated by 5-s, during which twitch and octet (8 pulses at 300 Hz; evokes the muscle's maximal rate of force development [RFD]) contractions were electrically evoked via supramaximal stimulation of the femoral nerve. EF was measured over the initial 50 (Octet) and 150 ms (volitional) of contraction. Peak octet force (PF) and MVF were also assessed. Voluntary EF was reported in absolute and relative (%MVF) terms. Surface EMG RMS amplitude was recorded over the superficial agonists (VL, VM and RF) during the initial 150 ms of contraction and at MVF (500 ms epoch). EMG was normalised to  $M_{\text{max}}$  Area during the same set of contractions before being averaged across the agonists. To assess fatigue paired t-tests were used to i) compare measurements during the initial vs. final sets and ii) contrast the fatigue induced reduction in different parameters. Results Voluntary EF after 50-150 ms of contraction declined by 47-52% with a 42% reduction in MVF (All,  $P < 0.001$ ). Relative EF decreased by 12-18% ( $P \leq 0.038$ ). The decline in octet force at 50 ms (23%,  $P < 0.001$ ) and PF (28%,  $P < 0.001$ ) were less than the equivalent changes in voluntary force (All,  $P \leq 0.027$ ). Agonist EMG during the initial 150 ms of contraction and at MVF decreased by 15-28% (All,  $P \leq 0.010$ ). **Conclusion** EF exhibited a marked decline with fatigue, which was more pronounced than the decrease in MVF, as shown by the reduction in relative EF. This finding may help explain the greater incidence of injuries associated with fatigue (i.e., at the end of a football match). Contractile fatigue was demonstrated by declines in Octet EF after 50 ms and at PF, but these changes were smaller than volitional decrements. The decline in agonist EMG and the greater decrease in voluntary than Octet EF demonstrated a substantial central neural component to the reduction in volitional EF. (1) Aagaard et al. (2002). *J Appl Physiol* 93, 1318–1326. (2) Hawkins et al. (2001). *Br J Sports Med* 35, 43–47.

**PERIPHERAL FATIGUE INDUCED BY REPEATED TETANI EVOKED VIA ELECTROMYOSTIMULATION**

MATKOWSKI, B.1, PLACE, N.2, LEPERS, R.1, WESTERBLAD, H.3, MARTIN, A.1

1: *Université de Bourgogne (Dijon, France)*, 2: *Université de Genève (Genève, Switzerland)*, 3: *Karolinska Institutet (Stockholm, Sweden)*

**Introduction** The level of central fatigue is commonly quantified by the interpolated twitch technique (ITT). It has recently been shown with mouse intact single fibres that ITT takes into account peripheral properties of fatigue and thus may overestimate the extent of central fatigue measured after exercise (Place et al. 2008). In a first experiment on human muscle, we observed a progressive increase in the interpolated twitch amplitude, whereas the electromyostimulation (EMS)-induced tetanic torque and post tetanic twitch amplitude decreased. However, twitches were induced by supramaximal nerve stimulation, i.e. all motor units (MUs) were activated while during EMS only a fraction of total MUs were activated. Therefore, the present study was designed to monitor fatigue development in active MUs during repeated tetanic stimulation induced by EMS in human quadriceps muscle. **Methods** Experiments were performed on 9 healthy men. The quadriceps muscle was fatigued by a series of 15 EMS-induced contractions (6s on-6s off), whereas a twitch was evoked using the same current intensity 2s after each EMS contraction (post tetanic twitch). This protocol was performed in isometric condition with a knee angle of 90°. The intensity used for the EMS-induced contractions was set to 20% initial maximal voluntary contraction (MVC) and kept constant throughout the 15 contractions. MVC were performed before and after the EMS-induced contractions, and a set of 10 different frequencies (from 5 to 100Hz) were randomly evoked by EMS before and after the fatiguing contractions. **Results** The repeated tetanic contractions induced by EMS resulted in a decreased MVC torque ( $-21.3 \pm 7.7\%$ ;  $P < 0.001$ ). The EMS-induced tetanic torque and the potentiated peak twitch were significantly depressed ( $-59.0 \pm 17.5\%$  and  $-65.6 \pm 9.5\%$  respectively;  $P < 0.001$ ). Torque was decreased ( $P < 0.001$ ) at all stimulation frequencies over 10Hz after as compared to before fatigue. When the torque/frequency curves were normalized to the torques measured at 100Hz, we found a right-ward shift of the torque/frequency relationship after fatigue. **Discussion** The reduction in the post tetanic twitch amplitude was parallel to the reduction in the EMS-induced torque, which indicates that the loss of force observed during fatigue could mainly be attributed to a reduction in the force of the active MUs throughout fatigue rather than MUs derecruitment. **References** Place N et al. (2008). *J Physiol* 586: 2799-2805

**MODULATION OF SPINAL EXCITABILITY BY A SUB-THRESHOLD STIMULATION OF M1 AREA**

Grospretre, S., Papaxanthis, C., Martin, A.

*INSERM U1093*

**Introduction** In human, it is well known that muscle performance differs between shortening and lengthening contraction. This is not only due to the mechanical properties of the muscle (Katz 1939) but also to the characteristics of its activation (Enoka 1996). The command reaching the motoneuronal pool depends on the efficiency of the spinal transmission, that can be evaluated by the H reflex (Hmax/Mmax ratio). It has been previously shown that spinal efficiency decreases during passive muscle lengthening in comparison to passive shortening (Duclay & Martin 2005). These changes have been attributed to presynaptic inhibition of Ia afferent fibres. However, the decreased spinal efficiency observed during passive lengthening is reduced when the muscle is active (Duclay & Martin 2011). The aim of the present study was to examine how the cortico-spinal command can influence the spinal efficiency during lengthening contraction. To achieve this aim, H reflex stimulation was conditioned by a sub-threshold motor evoked potential. This has been done at rest and under isometric, shortening and lengthening voluntary contractions. **Methods** H reflexes of triceps surae (TS) muscles were elicited by stimulating the posterior tibial nerve, in 11 healthy young subjects. These H reflexes were conditioned by sub-threshold (intensity under motor threshold) Transcranial Magnetic Stimulation applied over M1 area of TS muscles, with a 5ms interval. Conditioned and unconditioned H-reflexes were elicited during different passive solicitations of the muscle (static rest, passive lengthening and shortening) and contraction modes with a force level corresponding to 20% of maximal voluntary contraction (in concentric, eccentric and isometric). **Results** Sub-threshold TMS pulse facilitated H responses only during passive and active lengthening of the muscle, increasing H amplitude by 62 % in eccentric condition and by 27 % in passive lengthening. During lengthening, Ia- $\alpha$  connection is subjected to presynaptic inhibitions, which reduce spinal efficiency. So, sub-threshold TMS pulse seems to act at a spinal level by partially cancelling these inhibitions. **Discussion** These results suggest the existence of a specific circuit in the spinal cord, involving an interneuron that could inhibit, at a presynaptic level, the connection between Ia afferent and motoneurons. The cortical command could increase muscle activation by reducing the amount of presynaptic inhibition, instead of modulating directly the motoneurone excitability. **References** Duclay J, Martin A. (2005). *J neurophysiol*, 94: 3555–3562. Duclay J, Pasquet B, Martin A, Duchateau J. (2011). *J Physiol* 589.11: 2901-2916. Enoka RM. (1996). *J Appl Physiol* 81:2339-2346. Katz B. (1939). *J Physiol* 96: 45-64.

**FATIGUE RESISTANCE OF THE KNEE EXTENSOR MUSCLES IN PATIENTS WITH POST-POLIO SYNDROME**

Voorn, E.

*Academic Medical Center Amsterdam*

**FATIGUE RESISTANCE OF THE KNEE EXTENSOR MUSCLES IN PATIENTS WITH POST-POLIO SYNDROME** Voorn, E.1,2, Beelen, A.1, Nolle, F.1, Gerrits, H.L.2, de Haan, A.2, 1: Department of Rehabilitation, Academic Medical Center, University of Amsterdam 2: Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands **Introduction** Post-polio Syndrome (PPS) is a complex of late onset neuromuscular symptoms with new or increased muscle weakness or abnormal muscle fatigability as key symptoms. Several neuromuscular adaptations to the acute polio and the secondary decline have been described that may contribute to the abnormal muscle fatigability reported by many individuals with PPS. Capillary density and oxidative enzyme activity were found to be decreased in PPS, indicating a lower aerobic capacity. Although these factors may lead to premature muscle fatigue, the few studies that evaluated the muscular fatigability in PPS show contradictory results. Therefore the objective of this study was to compare fatigue resistance of the knee extensor muscles between patients with PPS and healthy subjects. **Methods** We assessed fatigue resistance of the knee extensor muscles in 34 patients with PPS (11 men, age  $59.5 \pm 6.6$  years) and 14 healthy individuals (7 men, age  $59.5 \pm 7.5$  years), using isometric contractions on a dynamometer evoked by percutaneous electrical stimulation (1 s on, 1 s off, 50 Hz during 5 min), leading to an initial torque level of 30-40% of maximal voluntary torque (MVT). Measurements were performed at a knee angle of 60°. Peak torque of each contraction was expressed as a percentage of the first contraction. Fatigue resistance was defined as the percentage torque that remained over the last 90 contractions of the protocol. A two-factor ("PPS" and "gender") analysis of variance was used to test for differences between groups. Gender was added as a factor since there are sex differences in muscle fatigue resistance (Wüst et al., 2008). **Results** MVT was higher in healthy subjects compared to PPS ( $183.4 \pm 35.9$  versus  $104.4 \pm 44.9$  Nm;  $p = 0.000$ ). Relative initial torque of the fatigue protocol was similar in both groups ( $30.2 \pm 5.7$  versus  $33.0 \pm 9.4$  %MVC;  $p = 0.308$ ). Fatigue resistance did not differ between patients with PPS and healthy subjects ( $51.9 \pm 9.8$  vs  $51.6 \pm 11.1$  %;  $p = 0.921$ ). Women had a significantly higher fatigue resistance compared to



men ( $54.1 \pm 10.0$  versus  $47.9 \pm 9.2$  %;  $p = 0.018$ ), but no significant interaction was found between "PPS" and "gender". Discussion Our findings do not support the hypothesis that fatigue resistance of the quadriceps muscles in patients with PPS is lower compared to healthy subjects. Therefore, muscle fatigability experienced by PPS patients can not be explained by an increased intrinsic fatigability of the muscle fibers and is more likely the result of muscle weakness that requires individuals to work at higher relative intensities, inducing early fatigue. Reference Wüst et al. (2008). *Exp Physiol* 93, 843-850

### COMPARISON OF NEUROMUSCULAR ADJUSTMENTS ASSOCIATED WITH SUSTAINED ISOMETRIC CONTRACTIONS PERFORMED WITH DIFFERENT MUSCLE GROUPS

Neyroud, D., Rüttimeann, J., Maffioletti, N.A., Millet, G.Y., Mannion, A.F., Place, N.

*University of Geneva*

COMPARISON OF NEUROMUSCULAR ADJUSTMENTS ASSOCIATED WITH SUSTAINED ISOMETRIC CONTRACTIONS PERFORMED WITH DIFFERENT MUSCLE GROUPS Neyroud D.(1), Rüttimeann J.(1), Maffioletti N.A.(2), Millet G.Y.(3), Mannion A.F.(2), Place N(1). (1) ISMMS, Faculty of Medicine, University of Geneva, Switzerland (2) Neuromuscular Research Laboratory, Schulthess Clinic, Zurich, Switzerland (3) Université de Lyon, F-42023, Saint-Etienne, France Introduction Time to exhaustion of a sustained submaximal isometric contraction (endurance time, ET) depends on several factors such as muscle phenotype, the extent of voluntary activation and/or muscle length. However, it is not known if the mechanisms underlying voluntary exhaustion and the reduction in maximal voluntary contraction (MVC) induced by a sustained fatiguing contraction are muscle group dependent. In the present study, we tested the hypothesis that neuromuscular adjustments associated to a sustained voluntary contraction until exhaustion depend on the muscle group considered. Methods Thirteen healthy men ( $25 \pm 2$  yrs) volunteered to participate in two testing sessions (at least 48-h apart) involving the performance of two sustained contractions at 50% MVC force (optimal joint angle) until voluntary exhaustion. In each session, one upper limb and one lower limb were tested (either the knee extensors and thumb adductor or the plantar flexors and elbow flexors). Muscle fatigability was measured via (i) ET of the sustained contraction and (ii) MVC force reduction. Changes in voluntary activation (index of central fatigue) and contractile properties (index of peripheral fatigue) were derived from doublet responses evoked during and after the MVC. Results ET differed ( $p < 0.05$ ) between muscle groups ( $220 \pm 64$  s for plantar flexors,  $114 \pm 27$  s for thumb adductor,  $77 \pm 25$  s for knee extensors and  $72 \pm 14$  s for elbow flexors). However, MVC force reduction at voluntary exhaustion was similar ( $p > 0.05$ ) for the different muscles (-30 to -40%). Voluntary activation was found to be altered only for plantar flexors (from  $95 \pm 5\%$  to  $82 \pm 9\%$ ,  $p < 0.05$ ). Potentiated doublet amplitude was more depressed for upper limb muscles ( $-60 \pm 20\%$ ,  $p < 0.05$ ) than for knee extensors ( $-28 \pm 15\%$ ,  $p < 0.05$ ), whereas the reduction was only marginal for plantar flexors ( $-7 \pm 12\%$ ,  $p < 0.05$ ). Conclusion The present findings confirm that ET is muscle group-dependent (Frey-Law & Avin 2010). More interestingly, the mechanisms underlying voluntary exhaustion differ with respect to the duration of the task. For example, plantar flexors showed the longest endurance time, which was associated with central fatigue and minimal peripheral fatigue in comparison to the other muscle. Finally, these results expand upon recent findings (Neyroud et al. in press) showing that maximal strength loss and ET represent two different indexes of muscle fatigability. Frey-Law & Avin. *Ergonomics* 53:109-129, 2010 Neyroud D et al. *Med Sci Sports Exerc*, in press (DOI: 10.1249/MSS.0b013e318245cc4d)

### SENSORIMOTOR TRAINING INFLUENCES BALANCE CONTROL AND PNP IN LYMPHOMA PATIENTS UNDERGOING THERAPY

Streckmann, F., Leifert, J.A., Kleber, M., Kneis, S., Bertz, H., Gollhofer, A.

*Department of Hematology/Oncology, Freiburg University Medical Center Freiburg, Germany; Department of Sport Science, University of Freiburg, Germany*

Introduction Lymphoma patients (pts) receiving therapy often suffer from severe balance problems corresponding with therapy induced peripheral neuropathy (PNP), progressive loss of lean muscle mass and weakness. Not only does this influence patients' quality of life, but also the dosage and schedule of therapy. Sensorimotor training is associated with neural adaptations that affect reflex pathways, improve proprioception and intermuscular coordination. In a prospective, randomized study, we assessed the improvement of balance control, reduction of therapy induced side effects. Methods 25 pts (median age 46, range 19-75) were randomized either to an intervention group (IG, n=13) or a control group (CG, n=12). The IG participated in an exercise program, consisting of aerobic endurance, strength and sensorimotor training, twice a week. Pts were evaluated four times: before therapy (T0), after 12 (T1), 24 (T2) and 36 weeks (T3). Balance control was determined by analysing sway paths and failed attempts during a bi- and monopodal stance in a static and dynamic (with a balancepad) condition on a force plate (GKS 1000) and in a perturbed condition on an oscillating measuring plate (Posturomed®). Status of peripheral deep sensibility was evaluated by tuning fork and medical reports. Results We found significant differences between the groups in cumulative sway paths, failure rates and the extent of PNP. Postural sway improved in the IG (-5cm) at all time points (T1:  $p = .001$ ; T3:  $p = .01$ ), compared to a decline (+29cm) in the CG. At T1/T3, 100% of the IG completed the monopodal static stance compared to only 50%/55% in the CG ( $p = < .001$ ;  $p = .001$ ). The failure rate (92%) in the CG rose under dynamic conditions, compared to 0% in the IG at T3 ( $p < .001$ ). The extent and diversification of PNP correlated with these results. At T0, both groups suffered from PNP (25%), compared to 8% (IG) and 50% (CG) at T3 ( $p = .001$ ). Conclusion Sensorimotor training is a feasible and very promising method to support cancer pts during therapy and help preserve their functionality for activities of daily living. It not only improves balance control but also reduces the intensity of therapy-induced PNP, associated with an improvement in quality of life. References Gisler-Hofmann T, (2008). Plastizität und Training der sensorimotorischen Systeme, *Sportmed.&Sporttraumat.*:56 (4), 137-149. Gollhofer A, Granacher U, Taube W, Melnyk M, Gruber M: motor control and injury prevention. *Deutsche Zeitschrift für Sportmedizin* 57:266-270, 2006 Wonders KY, Reigle BS, Drury DG. Treatment strategies for chemotherapy-induced peripheral neuropathy: potential role of exercise. *Oncol Rev.* 2010;4 (2):117-125.

15:00 - 16:30

## Oral presentations

### OP-PM04 Brain and Exercise Performance

#### EFFECTS OF ACUTE INJECTION OF CAFFEINE ON EXERCISE PERFORMANCE, THERMOREGULATION AND BRAIN NEUROTRANSMISSION IN THE RAT

Xinyan, Z.

*Hiroshima University*

EFFECTS OF ACUTE INJECTION OF CAFFEINE ON EXERCISE PERFORMANCE, THERMOREGULATION AND BRAIN NEUROTRANSMISSION IN THE RAT Zheng, XY., Hasegawa, H. Hiroshima Univ (Hiroshima, Japan) Introduction In 2004, caffeine has been released from the list of banned substances by the International Olympic Committee, and widely used by athletes. The dose of caffeine, which can improve the endurance performance, ranges from 3 to 9 mg/kg. In addition, it has been reported that acute administration of caffeine (2-40 mg/kg) produced changes in the core body temperature of rats during rest. In the past, caffeine has been shown to increase dopamine (DA) concentrations in many regions of the brain. However, mechanisms of thermoregulation and central fatigue remain elusive. The purpose of this study was to clarify the effects of caffeine on thermoregulation, neurotransmitters in the preoptic area and anterior hypothalamus (PO/AH) and endurance exercise performance in rats. Methods To measure the core body temperature (Tcore), the changes in the extracellular monoamines in the PO/AH and the thermoregulatory responses of rats simultaneously, we combined *in vivo* brain microdialysis, biotelemetry and oxygen consumption. Tcore, tail skin temperature (Ttail) which is an index of heat loss, oxygen consumption (VO<sub>2</sub>) which is an index of heat production were measured. Brain microdialysis samples were collected every 10 min, and these samples analyzed by HPLC for DA, norepinephrine (NA) and serotonin (5-HT). On the day of the exercising experiment, after 1h of baseline collections on the treadmill, rats received intraperitoneally 10 mg/kg of caffeine or saline. After 1h of administration, the animals were exercised until fatigue at a speed of 18 m/min, 5% grade on the treadmill in a normal environment (23°C). Results Acute injection of 10 mg/kg caffeine increased run time to fatigue (Saline: 104 ± 36 min; Caffeine: 139 ± 34 min; p < 0.05). The combination of caffeine and exercise increased Tcore, VO<sub>2</sub>, Ttail and the extracellular DA in the PO/AH. In addition, NA increased during exercise, neither caffeine nor exercise changed 5-HT. Discussion We observed acute injection of caffeine improved the endurance exercise performance which is consistent with the previous study (Ryu et al., 2001). We firstly evidenced that caffeine increased the DA release in the brain during exercise, and supported the hypothesis of Davis et al. (2003). The present results indicated that caffeine has a hyperthermic effect and a performance-enhancing effect, which is mediated by increasing the extracellular concentrations of DA in the PO/AH (Roelands et al., 2011). References Davis JM, Zhao Z, Stock HS, Mehl KA, Buggy J, Hand GA (2003). *Am J Physiol Regul Integ Comp Physiol*, 284, 399–404. Roelands B, Buyse L, Pauwels F, Delbeke F, Deventer K, Meeusen R (2011). *Eur J Appl Physiol*, 111(12), 3089–3095. Ryu S, Choi SK, Joung SS, Suh H, Cha YS, Lee S, Lim K (2001). *J Nutr Sci Vitaminol*, 47, 139–140.

#### BRAIN GLYCOGEN SUPERCOMPENSATION FOLLOWING EXERCISE IS ENHANCED WITH GLUCOSE SUPPLEMENTATION: IMPLICATIONS FOR BRAIN GLYCOGEN LOADING

Matsui, T.1,2, Soya, H.1

*1: University of Tsukuba (Tsukuba, Japan), 2: JSPS Research Fellow (Tokyo, Japan)*

Brain glycogen supercompensation following exercise is enhanced with glucose supplementation: Implications for brain glycogen loading Matsui, T.1, 2, Soya, H.1 1: University of Tsukuba (Tsukuba, Japan), 2: JSPS Research Fellow (Tokyo, Japan) Introduction Muscle glycogen (Gly) loading, 3 days of a hyper-carbohydrate diet, enhances endurance performance due to mitigation of muscle fatigue through increasing muscle Gly levels in humans and rats (Pitsiladis & Maughan, 1999). Muscle Gly loading was established based on the muscle Gly increase (supercompensation, SC) following exercise through blood insulin effect with glucose supplementation (Bergstrom and Hultman, 1966). The brain contains glycogen in astrocytes, which store energy for neurons. We recently found that brain Gly SC also occurs following exercise (Matsui et al. 2012). Here, to establish brain Gly loading for mitigation of central fatigue, we aimed to clarify the effect of glucose supplementation on brain Gly SC following exercise. Methods Rats were separated into 4 groups (Sedentary-Saline (S-S), Sedentary-Glucose (S-G), Exercise-Saline (E-S), and Exercise-Glucose (E-G)), and exercised on a treadmill at 20 m/min to exhaustion. Sedentary groups of animals were placed on a stationary treadmill. Immediately after exhaustion, rats were injected with 50% glucose or saline (0.2 ml/300 g B.W.) into the jugular vein through a previously inserted catheter. At 6 hours post-exercise, the brain was fixed by high-power microwave irradiation (MI), which can momentarily inactivate glycogenolysis enzymes. Following MI, samples from the five brain loci (the cortex and hippocampus etc.), and soleus muscle were collected to determine Gly. Results Blood glucose and lactate levels did not change in all groups. Soleus muscle Gly levels in S-G and E-G increased by approximately 40% compared with S-S and E-S (p < 0.01). In the brain, Gly levels in E-S and E-G were approximately 30% higher than in S-S and S-G (p < 0.01), and Gly levels of the hypothalamus and brainstem in E-G were approximately 30% higher than E-S (p < 0.01). Blood insulin levels correlated positively with soleus muscle Gly levels (r = 0.39, p < 0.05), but did not correlate with brain Gly levels. Discussion we have provided novel evidence that glucose supplementation is not prerequisite for brain Gly SC following exercise in contrast to skeletal muscles. Further, blood insulin levels correlated positively with soleus muscle Gly levels, but did not correlate with brain Gly levels. Therefore, brain Gly SC following exercise should occur irrespective of blood insulin unlikely in the skeletal muscles. However, brain Gly SC following exercise is enhanced with glucose supplementation like in skeletal muscles, suggesting the possibility of brain Gly loading for the enhancement of endurance performance due to mitigation of central fatigue. References Pitsiladis YP, Maughan RJ. (1999). *J Physiol*, 517, 919–30. Bergstrom J, Hultman E. (1966). *Nature*, 210, 309–310. Matsui T & Soya H et al. (2012). *J Physiol*, 590, 607–616.

## EFFECTS OF INDUCED ALKALOSIS AND CAFFEINE SUPPLEMENTATION ON 2000 M ROWING PERFORMANCE

Carr, A.1, Gore, C.2, Dawson, B.1

1. *The University of Western Australia (Perth, Australia)* 2. *Australian Institute of Sport (Canberra, Australia)*

**Introduction** Short-term, high intensity exercise performance can be enhanced with caffeine supplementation (Jackman et al., 1996) and sodium bicarbonate ingestion (Carr et al., 2011). Both agents may therefore improve performance in 2000 m rowing events, which require 6-8 min efforts at a high percentage of VO<sub>2</sub>max (Hagerman et al., 1978). The purpose of this study was to determine the effect of ingested caffeine, sodium bicarbonate, and their combination on 2000 m performance (mean power, Watts), as well as on induced alkalosis (blood and urine pH and blood bicarbonate concentration [HCO<sub>3</sub><sup>-</sup>]), blood lactate concentration ([La<sup>-</sup>]), gastrointestinal symptoms, and rating of perceived exertion (RPE). **Methods** In a double-blind, crossover study, 8 well-trained rowers performed 2 x 2000 m rowing-ergometer baseline tests and 4 x 2000 m rowing-ergometer tests after ingesting 6 mg/kg caffeine, 0.3 g/kg body mass (BM) sodium bicarbonate, both supplements combined, or placebo. Capillary blood samples were collected pre-ingestion, pre-test, and post-test. Pairwise comparisons were made between protocols, and differences were interpreted in relation to the likelihood of exceeding the smallest-worthwhile-change thresholds for each variable. A likelihood of >75% was considered a substantial change (Hopkins et al., 2009). **Results** Caffeine elicited a substantial improvement in 2000 m mean power, with mean (± SD) values of 354 ± 67 Watts vs. placebo with 346 ± 61 Watts; but not for caffeine + bicarbonate combined (352 ± 63 Watts). Pre-test [HCO<sub>3</sub><sup>-</sup>] reached 29.2 ± 2.9 mmol/L with caffeine + bicarbonate and 29.1 ± 1.9 mmol/L with bicarbonate supplementation. There were substantial increases in pre-test [HCO<sub>3</sub><sup>-</sup>] and pH, as well as post-test urine pH after bicarbonate and caffeine + bicarbonate compared with placebo. All subjects reported side effects after ingesting bicarbonate. **Discussion** The major finding was an improvement of ~2% in 2000 m rowing performance with 6 mg/kg BM caffeine supplementation, consistent with previously reported enhancements for competitive rowers (Bruce et al., 2000). However, when caffeine is combined with sodium bicarbonate, gastrointestinal symptoms may prevent performance enhancement. **References** Bruce C, et al. (2000). *Med Sci Sports Exerc*, 32 (11), 1958-1963. Carr A, et al. (2011). *Sports Med*, 41 (10), 801-814. Hagerman F, et al. (1978). *J Appl Physiol*, 45 (1), 87-93. Hopkins W, et al. (2009). *Med Sci Sports Exerc*, 41(1), 3-12. Jackman M, et al (1996). *J Appl Physiol*, 81(4), 1658-1663.

## EXERCISE IN VIRTUAL REALITY: LPP RESPONSE AND COGNITIVE PERFORMANCE

Vogt, T.1, Schneider, S.1, Herpers, R.2, Strüder, H.K.1

1 *German Sport University Cologne*, 2 *Bonn-Rhine-Sieg University of Applied Sciences*

**Introduction** In today's digital age virtual reality is ubiquitous and often used to train skills under safe conditions (e.g. flight simulation). Thus, it has previously been used in the field of sport and exercise science to investigate motor learning and cognitive function [1]. In addition, psycho-physiological research on event-related brain potentials, e.g. late positive potentials (LPP), allow for neural interpretation of cognitive performance [2]. However, little is actually known about underlying neurological processes of exercise-affected cognitive performance in virtual reality. Therefore this study aimed to investigate neurophysiological effects of virtual reality on cognitive performance in relation to exercise. **Methods** Using a bicycle ergometer, 12 healthy volunteers (27.75 ± 3.05 years, 177.17 ± 8.34 cm, 72.58 ± 8.01 kg) performed self-paced exercise (HR 140 ± 24.05 bpm) or passive drive (constant automatic 15 km/h) in immersive visualisation (3D) and non-immersive visualisation (2D). At the same time, mental arithmetics were performed to assess cognitive performance. Consecutive EEG was recorded on 32 positions according to the international 10-20 system [3]. Positive peak values of LPP amplitude and latency were exported and analysed [2]. **Results** Analysis of LPP measured during 3D revealed significant increases for LPP amplitude (p<0.01) and latency (p<0.001) compared to 2D, related to exercise. In contrast, cognitive performance decreased (p<0.01) during 3D compared to 2D. **Discussion** With respect to previously shown effects of visual attention focussing on LPP [2], in relation to exercise, greater LPP amplitudes as well as delayed latencies can be regarded as indicators for mental function speed [4]. As to the literature our findings give reason to believe that exercising during immersive visualisation has overstraining neurophysiological effects on cognitive performance, indicated in late positive potential response. Therefore training recommendations need to beware overstraining in virtual reality. **References** [1] Holden MK. Virtual environments for motor rehabilitation: review. *Cyberpsychol Behav* 2005;8(3):187-219. [2] Hajcak G, MacNamara A, Olvet DM. Event-related potentials, emotion, and emotion regulation: An integrative review. *Developm Neuropsych* 2010; 35:129-155. [3] Schneider S, Brümmer V, Carnahan H, Kleinert J, Piacentini MF, Meeusen R, Strüder HK. Exercise as a countermeasure to psycho-physiological deconditioning during long-term confinement. *Behav Brain Res* 2010;211(2):208-14. [4] Yagi Y, Coburn KL, Estes KM, Arruda JE. Effects of aerobic exercise and gender on visual and auditory P300, reaction time, and accuracy. *Eur J Appl Physiol* 1999;80:402-8.

## ACUTE COGNITIVE WORKLOAD HAMPERS SUBJECTIVE RECOVERY, BUT DOES NOT ACCELERATE EXHAUSTION IN A MAXIMAL EFFORT TEST ON A TREADMILL

Sanchez-Delgado, G.1, Conde-Gonzalez, J.1, Perales, J.C.2, Pinar, M.I.1, Cárdenas, D.1, De Teresa-Galvan, C.3, Ruiz, J.R.1

1,2: *University of Granada (Spain)*, 3: *Junta de Andalucía (Spain)*

**Aim:** The aims of the present study were: (1) To investigate the effect of acute mental workload on time-to-exhaustion and perceived exertion in a concomitant maximum effort test on a treadmill. And, secondly, (2) to check whether physical effort and recovery modulated performance in the mental workload task. **Methods:** The physical load task was an incremental maximum effort test on a treadmill, followed by an 8-minutes recovery period. The mental workload task was a working memory task (N-back), with two modalities: a highly loading one (3-back), and a less loading one (1-back). 14 men (aged 18-22) went through 5 conditions, run in counterbalanced order: 1) Physical load/high mental workload; 2) Physical load/low mental workload; 3) Physical load/no mental workload; 4) No physical load-high mental workload; 5) No physical load-low mental workload. Conditions 1-3 were carried out on the treadmill, and varied in the degree of mental workload. Conditions 4 and 5 included no physical task, and varied in the degree of mental workload. We measured time-to-exhaustion in conditions 1, 2 and 3. After every two minutes, participants reported their perceived exertion (RPE-CR10). In conditions 1, 2, 4 and 5, we registered accuracy in the cognitive task. **Results:** Mental workload had no effect on time-to-exhaustion in conditions 1-3 (M=683.28s, 711.00s, and 681.07s; SE=32.47s, 36.44s, and 36.07s, respectively). Perceived exertion during effort did not differ across those conditions either (M=6.79, 6.93, and 6.52; SE=.43, .41, and .47). However, perceived exertion during recovery was affected by mental workload (M=2.21, 2.35, and 2.52; SE=.17, .21, and .23; F(2,26)=2.38, p<.01), and perceived exertion decreased more slowly as mental workload increased (F(10,130)=3.96, p<.01, for the relevant interaction). Physical effort hampered performance in the mental workload task. Considering conditions 1, 2, 4, and 5, the difference between physical load conditions (1, 2) and no physical load condi-

tions (3, 4) was maximal around the exhaustion point [17 points for the difference between conditions 4 and 5, and .27 points for the difference between conditions 1 and 2,  $F(7, 91)=4.03$ ,  $p<.01$ , for the corresponding interaction]. Performance in the mental workload task was always above chance. Conclusions: i) concomitant mental workload did not accelerate exhaustion, yet slowed subjective recovery down; ii) the presence of physical workload affected performance in a concomitant cognitive, mentally loading task, without causing complete disengagement from it. \*This research has been carried out in collaboration with the Centro Andaluz de Medicina Deportiva (Consejería de Turismo, Comercio y Deporte, Junta de Andalucía) and funded by a Iniciación a la investigación grant from the University of Granada, for the first author, and by MICINN grant (PSI2009-13133) for the third one.

### IMPACT OF STRENUOUS EXERCISE ON THE RELEASE OF CARDIAC BIOMARKERS

Le Goff, C., Melon, P., Kaux, J.F., Fillet, M., Chappelle J.P.

*University Hospital of Liège*

Background: Cardiac troponins (cTn) are considered as the best biomarkers for detection of myocardial cell injury and NT-proBNP as the best for the cardiac insufficiency. In this study, cTnT was measured by new commercially available high-sensitive methods in subjects undergoing the Maasmaraathon. Our aim was to compare cTnT and NT-proBNP levels in sportive subjects before and after a strenuous exercise. Materials and Methods: Twenty eight subjects (26 ♂, 42.5±11yo) underwent a race of 42.195 kilometers between Visé (Belgium) and Maastricht (The Netherlands). We drew blood samples before (T0), just after (T1) and three hours after the race (T3). For all patients, cTnT concentrations were measured by high sensitive methods (hsTnT, Roche Diagnostics) on heparin plasma. The NT-proBNP was also determined with the kit Roche on heparin plasma. The protocol was approved by the ethics committee of the University of Liège (Belgium). All subjects gave their informed consent. All statistical analyses were performed using Medcalc version 8.1 for Windows.  $p$ -value  $<0.01$  was regarded as statistically significant. Results and discussion: A significant difference between hsTnT concentrations at T0 and T1 ( $p<0.0001$ ) was measured as well as between T0 and T3 ( $p<0.001$ ) for NT-proBNP, but not between T1 and T3. This observation appeared only after a strenuous exercise but today this type of exercise is not reproduced easier in a laboratory of sport. Moreover, at this moment, nobody knows if these observations would have cardiac consequences at long terms. Conclusions: Measurement of cardiac troponins by high sensitive methods allows detecting significant release of biomarkers from the heart during exercise. The levels of NT-proBNP were found significantly increased but in less extent than TnTs. We think that the TnTs could be an interesting marker in the future to help sport medicine to detect risk of developing a cardiac problem.

**17:00 - 18:30**

## Plenary sessions

### PS-PL01 Cycling Economy: From Performance to Business

#### PROFESSIONAL ROAD CYCLING: A BUSINESS NETWORK PERSPECTIVE

Lagae, W., Dejonghe, T.

*KU Leuven - Lessius University College Antwerp*

Professional road cycling: a business network perspective Although cycling is (1) a very popular sport in core European countries, (2) is developing in other countries and (3) was one of the first commercial sports to be practised professionally, the business of professional road cycling has been insufficiently researched (Brewer, 2002, Rebeggiani & Tondani, 2008, Benijts, et al, 2011). The product 'professional road cycling' is an individual sport practiced in teams, rather capital intensive, outdoor sport organized on public ground. Professional cycling is built around the world calendar of the Union Cycliste International, that consists of a non-homogeneous set of one-day and stage races. An additional peculiarity, especially of relevance in media coverage and television broadcasts, is that teams are labelled through the name(s) of the title sponsor. Teams depend, within their business-to-business environment, strongly on sport sponsorship deals as revenues from television rights, prize money and gate revenues are limited (Lagae, 2005). In addition, road cycling is vulnerable to doping, which has become a more prominent issue for corporate sponsors, who are entitled to cancel their barter trade or sport sponsoring agreements if evidence (and sometimes only indication of speculative nature) is found of either a team's or a rider's involvement in doping. Cycling is also characterized by a large and heterogeneous set of stakeholders with various interdependencies. The influence of stakeholders on the governance of cycling, ownership and distribution of television and marketing rights and anti-doping policy are hot topics (Morrow & Idle, 2008; Benijts, T. & Lagae, W. (2012). References Benijts, T. and Lagae, W. (2012), Using program theory to evaluate sport league reforms: the case of professional road cycling, *European Sport Management Quarterly*, Vol. 12 No. 1, (accepted). Benijts, T., Lagae, W. and Vanclooster, B. (2011), "The influence of sport leagues on the business-to-business marketing of teams: the case of professional road cycling", *Journal of Business and Industrial Marketing*, Vol. 26 No. 8, pp. 602-613. Brewer, B.D. (2002), "Commercialization in professional cycling 1950-2001: institutional transformations and the rationalization of doping", *Sociology of Sport Journal*, Vol. 19 No. 3, pp. 276-301. Lagae, W. (2005), *Sports Sponsorship and Marketing Communications. A European Perspective*, Harlow, Prentice Hall/Financial Times. Morrow, S. and Idle, C. (2008), "Understanding change in professional road cycling", *European Sport Management Quarterly*, Vol. 8 No. 4, pp. 315-335. Rebeggiani, L. and Tondani, D. (2008), "Organizational forms in professional cycling – an examination of the efficiency of the UCI ProTour", *International Journal of Sport Finance*, Vol. 3 No. 1, pp. 19-41.

#### WINNING THE TOUR DE FRANCE: A SPORT SCIENCE PERSPECTIVE

Martin, D.

*Australian Institute of Sport and Edith Cowan University*

Introduction The Tour de France is the most popular bike race in the world attracting ~15million spectators annually. In 2011 cyclists raced 3,430 km (1100-1200km per week) in 3wks. Of the 198 professional cyclist that began the race only 167 finished. For the first time, the winner of the 2011 Tour was an Australia (CE). From a sport science perspective the story of how a competitive teenage mountain biker became a Tour de France Champion is interesting because CE was involved with sport science teams throughout his development; first at the Aus-

tralian Institute of Sport and later with the MAPEI Sport Centre in Italy. The long-term relationship between CE and sport science allows many interesting questions to be addressed such as What is the physiological profile of a Tour de France Champion? What are the physiological demands of competition? What type of physical training leads to success? Physiology - Between 18-24yrs CE can be characterized as: 62-68kg; 172-173cm; 380-455 W and 6.1-7.3 W.kg<sup>-1</sup> at VO<sub>2</sub>pk; 4.59-5.65 L.min<sup>-1</sup> and 73-87 ml.kg<sup>-1</sup>.min<sup>-1</sup> VO<sub>2</sub>pk. Economy (mean±SD; range) was 80.2±1.9; 77.5-82.5 W.(VO<sub>2</sub> L.min<sup>-1</sup>)-1 or 401±10; 387-413W at 5 L.min<sup>-1</sup> VO<sub>2</sub>. GE was 22.6 ±0.6; 21.8-23.4% and DE was 23.6±1.1; 21.9-25.4%. Maximum Mean Power for 30minutes (MMP30min) was consistently 390-400W or 6.0-6.3 W.kg<sup>-1</sup>. These results were amongst the highest values recorded within the population of AIS cycling scholarship holders. Additionally, CE's aerobic power and his gross efficiency compared favourably to data published on other Tour de France Champions. Demands of Competition - CE frequently raced with a calibrated cycling power meter providing insight into physical demands of competition. In 1999, CE produced >6 W.kg<sup>-1</sup> for more than 40min when climbing to victory in the Tour of Tasmania. Research examining energy intake and energy expenditure during stage races provided rationale for feeding strategies and recovery practices. Early on, CE revealed he could perform well in Time Trials and Hill Climbs. Training - As a young AIS scholarship holder CE engaged in a high volume training program (~30,000-35,000k per year). Training was primarily composed of long slow distance (4-6hr rides), "strength endurance" intervals (low cadence hill climbing), threshold intervals and MTB racing. CE was exposed to altitude training, resistance training, heat acclimatisation, and tapering. CE had a high capacity for training volume and possessed a very competitive attitude and a desire to learn. Overall, CE was exposed to a supportive but incredibly competitive and challenging environment. Because other professional cyclists possess physiological traits similar to CE, it is likely environmental influences contributed substantially to his recent victory in the Tour de France.

---

**Thursday, July 5th, 2012**

---

**08:00 - 09:30**

## Invited symposia

### IS-PM11 Skeletal Muscle Stem Cells

---

#### **SKELETAL MUSCLE STEM CELLS: AN INTRODUCTION**

Kadi, F.

*Institution of Health and Medicine*

The systemic and local tissue benefits of exercise are generally accepted, although sometimes poorly understood. Muscle satellite cells are largely responsible for the regenerative capacity of skeletal muscle. In response to external stimuli, such as muscle loading, the activation of satellite cells is followed by (a) cellular proliferative expansion, which is necessary to maintain adequate pool of satellite cells for future rounds of regeneration, and (b) differentiation towards a myogenic lineage. Within the satellite cell niche, critical growth factors and support cells interact with satellite cells. The exact signals and pathways involved in the exercise-related satellite cell activation and differentiation are not well defined. The exact role of satellite cell proliferation in the initial stages of muscle hypertrophy deserves further attention.

#### **FIBER TYPE SPECIFICITY; THE ROLE OF SATELLITE CELLS IN THE SKELETAL MUSCLE ADAPTIVE RESPONSE**

Verdijk, L.B.

*Maastricht University Medical Centre+*

The regenerative capacity of skeletal muscle tissue depends on a pool of undifferentiated myogenic precursor cells, known as satellite cells. In adult muscle, satellite cells typically remain quiescent in their niche between the basal lamina and the sarcolemma. However, in response to injury and/or exercise stimuli, satellite cells become activated. After proliferation, satellite cells can fuse together with existing myofibers, or return to quiescence to replenish the resident pool of muscle stem cells by self-renewal. Changes in satellite cell content as well as satellite cell function have been suggested to represent key factors in regulating the skeletal muscle adaptive response to various stimuli, such as exercise, but also in response to different (pathological) conditions, such as aging and/or disuse. At present, much of the knowledge on satellite cell biology and their role in skeletal muscle fiber regeneration and growth stems from extensive *in vitro* and animal work. However, the molecular mechanisms that control satellite cell activation, proliferation and differentiation *in vivo* in humans remain to be elucidated. Previous research has shown differences in satellite cell content in humans depending on age, training status, and underlying disease. Few studies have also assessed satellite cell activation following exercise, using various markers indicative of different stages of the cell cycle (e.g. Ki67, MyoD, DLK1). However, the vast majority of studies investigating satellite cells in humans have typically assessed mixed muscle tissue without differentiating between type I and II muscle fibers. It has been well-established that the myocellular response to exercise and aging occurs in a muscle fiber type specific manner. Therefore, recent work in the field of satellite cell plasticity tends to focus more on muscle fiber type specificity. Our lab as well as others have shown that type II muscle fiber atrophy in the elderly is accompanied by a type II muscle fiber specific reduction in satellite cell content. More recently, we reported that 12 wk resistance type exercise training in elderly men results in specific hypertrophy of the type II muscle fibers and a concomitant increase in type II muscle fiber satellite cell content. We have now begun to assess satellite cell content as well as satellite cell activation, proliferation and differentiation status in a fiber type specific manner in response to different modes of physical activity and/or disuse in various populations. We believe that this work will further elucidate the role of satellite cells in regulating the fiber type specific skeletal muscle adaptive response to exercise and to various conditions of skeletal muscle atrophy and/or disuse in humans.

#### **REGULATION OF HUMAN MUSCLE STEM CELLS FOLLOWING EXERCISE**

Parise, G.

*McMaster University*

The role of muscle stem cells (satellite cells) in promoting muscle growth and adaptation in humans has largely been understudied. Nonetheless, excellent work has been reported by groups from around the world. The fact that a satellite cell response is triggered following an acute bout of exercise is generally accepted as fact. What remains a significant point of contention is whether or not satellite cells play a role in promoting growth in adulthood. Additionally, very little is known about the regulatory mechanisms that govern satellite cell function and fate. Over the last five years we and others have made a significant effort to reveal regulatory mechanisms that may govern satellite cell activation, proliferation and differentiation in humans. Modest progress has been made, however the regulatory mechanisms that drive the satellite cell response in humans are now being revealed. To date we have identified key roles for myostatin in the activation of satellite cells following exercise and IL6 in the proliferation of satellite cells. We have also identified how these factors are affected by age in their ability to promote satellite cell activation and proliferation. Collectively, we are just beginning to appreciate the complex regulatory mechanisms that govern human satellite cell function.

08:00 - 09:30

## Oral presentations

### OP-SH02 Sport and Exercise Psychology

#### COACH-PROVIDED AUTONOMY SUPPORT, INTRINSIC MOTIVATION AND ENJOYMENT AS PREDICTORS OF OBJECTIVELY MEASURED PHYSICAL ACTIVITY LEVELS IN GRASSROOTS FOOTBALLERS.

Fenton, S.A.M., Duda, J.L.I., Barrett, T.G.I., Quedsted, E.I

*1: University of Birmingham*

Introduction: Children who spend less time in moderate to vigorous activity (MVPA) are at higher risk for developing obesity and its associated co-morbidities. Therefore, it is important to understand factors that are predictive of children's physical activity patterns. Organised youth sport is a potential vehicle through which MVPA can be increased in children and adolescents. Guided by self-determination theory, this study tested a model which assumed links between perceptions of autonomy support provision by the coach, to the level of intrinsic motivation and enjoyment in grassroots footballers. These latter variables were examined in relationship to objectively measured MVPA and time spent engaged in sedentary behaviour (SB). Method: 92 male grassroots footballers aged 10-16 were recruited from 20 football clubs. All participants completed a multi-section questionnaire assessing their perceptions of the coach created climate (via a newly developed measure, pulling from previously validated measures of the psychological environment), intrinsic motivation (BRSQ-2) and their interest and enjoyment as related to football (IMI subscale). Measures of height and weight were taken (and BMI calculated) and players were asked to wear an accelerometer (GT3X; Actigraph) for 7 days. Results: Controlling for BMI, path analysis indicated players' perceptions of coach provided autonomy support to positively predict intrinsic motivation ( $\beta = .422, p < .001$ ) which in turn predicted enjoyment ( $\beta = .712, p < .001$ ). Enjoyment was found to be positively associated with overall levels of MVPA ( $\beta = .341, p < .001$ ) and negatively relate to SB ( $\beta = -.354, p < .001$ ). Mediation analysis demonstrated enjoyment fully mediated the relationship between intrinsic motivation and MVPA ( $z = 2.02, p < .05$ ) and SB ( $z = -2.22, p < .05$ ). Discussion: Results demonstrate that players who perceive their coaching environment to be more autonomy supportive are more likely to be intrinsically motivated to take part in sport, experience higher levels of enjoyment, and be more active in their daily lives (which includes their football participation). Given that physical activity habits formed in childhood often carry over into adulthood, it seems prudent to identify factors which can contribute to children leading a more physically active lifestyle. The development of theory-based interventions to foster the provision of autonomy support and enhanced intrinsic reasons for engagement, which can be implemented within organised youth sport, present a potential avenue through which overall physical activity levels of young people can be increased.

#### THE EFFECT OF CHALLENGE AND THREAT STATES ON PERFORMANCE: AN EXAMINATION OF POTENTIAL MECHANISMS

Moore, L.

*University of Exeter*

THE EFFECT OF CHALLENGE AND THREAT STATES ON PERFORMANCE: AN EXAMINATION OF POTENTIAL MECHANISMS Moore, L.J., Vine, S.J., Wilson, M.R., & Freeman, P. University of Exeter Introduction Challenge and threat states have been shown to predict future 'real-world' performance, with a challenge state resulting in superior performance relative to a threat state (Blascovich et al., 2004). However, no research has examined the immediate effect of these states on experimental performance. Therefore, the present study examined the influence of challenge and threat states on golf putting performance and the potential mechanisms through which these states operate (attentional, kinematic, and physiological). Methods One hundred and twenty seven participants (mean age = 19.47, SD = 2.48) were randomly assigned to a challenge or threat group. Challenge and threat states were manipulated via task instructions and were assessed using cardiovascular (challenge and threat index; Blascovich et al., 2004) and self-report (cognitive appraisal ratio; Tomaka et al., 1993) measures. Participants performed six golf putts whilst performance (mean radial error), gaze (quiet eye duration), putting kinematics (clubhead acceleration), and muscle activity (extensor carpi radialis) were continuously recorded. Results Results supported the effectiveness of the manipulation. The challenge group reported a ratio score less than one, reflecting a challenge state ( $M = 0.76, SD = 0.39$ ), whilst the threat group reported a ratio score greater than one, reflecting a threat state ( $M = 1.39, SD = 0.62$ ). Further, the challenge group exhibited a larger index value than the threat group, indicating greater challenge ( $M = 0.43, SD = 2.15$  vs.  $M = -0.44, SD = 1.69$ ). The challenge group displayed lower mean radial error ( $p < .001$ ), longer quiet eye durations ( $p < .05$ ), less clubhead acceleration (all  $ps < .05$ ), and less muscle activity (both  $p < .05$ ) than the threat group. Mediation analyses confirmed that only putting kinematic variables mediated the relationship between group and mean radial error. Discussion These results suggest that a performer's pre-competition psychophysiological state impacts upon their subsequent performance, with a challenge state likely to result in better performance than a threat state. Moreover, mediation results imply that these states impact performance at a kinematic level, influencing the quality of task-related movements. Thus, coaches and applied practitioners should encourage performers to perceive upcoming competitions as a challenge rather than a threat. References Blascovich, J., Seery, M.D., Mugridge, C.A., Norris, R.K., & Weisbuch, M. (2004). Predicting athletic performance from cardiovascular indexes of challenge and threat. *J Exp Soc Psychol*, 40, 683-688. Tomaka, J., Blascovich, J., Kelsey, R.M., & Leitten, C.L. (1993). Subjective, physiological, and behavioural effects of threat and challenge appraisal. *J Pers Soc Psychol*, 65, 248-260.

#### THINKING TOO MUCH WHEN FACING PRESSURE? THE STORY OF DECISION REINVESTMENT

Laborde, S.

*German Sport University*

Thinking too much when facing pressure? The story of decision reinvestment S. Laborde German Sport University, Cologne, Germany University of Caen, France The role of decision reinvestment on performance breakdown under pressure was investigated in two studies, combining the field and the lab. Study 1. The aim of this study was to explore the relationship between decision reinvestment with stress and coping appraisals. From an initial screening of 243 regional handball players, 100 players were selected, and were divided into four

groups according to their gender (male vs. female) and to their reinvestment score (high vs. low). Their coping and stress appraisals were assessed during three competitions. Results showed that high reinvesters (HR) players perceive a stress intensity similar to low reinvesters (LR) players, but that they have a lower perception of stressor controllability, coping effectiveness and subjective performance than their LR counterparts. No differences were found in the use of coping strategies between HR and LR players. The tendency to choke under pressure of HR players is discussed according to the saturation of their working memory. Study 1 had two main limitations: 1) the physiological parameters linked with the stress and coping appraisals were not assessed; 2) the subjective performance measure does not reveal the underlying mechanisms explaining the influence of decision reinvestment on performance. Study 2 was designed to address these limitations. Study 2. The aim of this study was to explore the decision-making component of performance through the option-generation paradigm, as well as to assess the physiological reaction to stress based on heart rate variability. Thirty regional handball players (Mean=23.3 years, age range = 17-31 years) took part in this study. In a within-subject design, they were asked to complete an option-generation task with 31 3D videos in two conditions, low pressure and high pressure. In addition players were asked to fill in the decision-specific reinvestment scale, and were attributed after a median split to either the HR or the LR group. Results indicated that the pressure manipulation was successful. In the low pressure condition, no differences in decision-making performance were observed between LR and HR players, Wilks' Lambda=.801  $F(6, 23)=.954, p>.05$ . When comparing the low pressure and high pressure condition, a MANOVA indicated that the overall decision-making performance decreased significantly more in the HR group in comparison to the LR group, Wilks' Lambda=.583,  $F(6, 23)=2.740, p=.037, \eta^2=.42$ . Study 2 showed that decision reinvestment has an influence on the option-generation process of the athlete, and that this influence might be associated to a specific physiological activity under pressure. Findings are discussed according to the Thayer's neurovisceral integration model and to the Take-the-First heuristic.

### **PREDICTORS OF INTRA-INDIVIDUAL CHANGE IN THE PSYCHOLOGICAL DEVELOPMENT OF DISADVANTAGED YOUTH OVER THE COURSE OF AN EDUCATIONAL SPORTS PROGRAMME**

Cowan, D.T., Taylor, I.M., Baker, J.S.

*University of the West of Scotland*

**Introduction** The sports context represents a potentially fruitful vehicle for positive youth development to occur (Danish et al., 2005), however, merely the participation in organised sports programmes is not sufficient to facilitate positive psycho-social growth. Rather, the quality of adult mentoring within such programmes, usually carried out by the sports coach, is assumed to play a central role in this process (Vella et al., 2011). Nonetheless, the exploration of the specific interpersonal ingredients within the coach-participant relationship required to foster positive developmental outcomes is still in its infancy. Grounded in self-determination theory (Ryan & Deci, 2000), the purpose of this study was to longitudinally examine the relationships among disadvantage youth sports programme attendees' perceptions of the coach interpersonal environment, their own psychological need satisfaction, and three important developmental outcomes; namely self-esteem, resiliency, and goal setting. **Methods** 26 disadvantaged youth completed a weekly multi-section questionnaire over the course of the programme measuring perceptions of coach interpersonal styles, psychological need satisfaction, self-esteem, resiliency, and goal-setting. Results Multilevel growth models revealed that participants' self-esteem, resiliency, and goal setting increased over the course of the programme. Increases in relatedness need satisfaction beyond participants normal levels was positively associated with the three developmental outcomes. Further, increased perceptions of socio-emotionally involved coaching styles was the most consistent predictor of all three psychological needs (i.e., autonomy, competence, and relatedness), compared to autonomy supportive and structured coaching styles. **Discussion** This study contributes to the existing literature by suggesting theoretically sound mechanisms required to elicit change in important positive youth development outcomes amongst disadvantaged youth. From a theoretical standpoint, the role of interpersonal involvement in future self-determination theory-based interventions is emphasised. **References** Danish, S., Forneris, T., & Wallace I. (2005). Sport-based life skills programming in the schools. *Journal of Applied School Psychology*, 21, 41-62. Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68-78. Vella, S., Oades, L., & Crowe. (2011). The role of the coach in facilitating positive youth development: Moving from theory to practice. *Journal of Applied Sport Psychology*, 23, 33-48.

### **THE ASSOCIATION BETWEEN EXERCISE ATTITUDES AND EXERCISE BEHAVIOR PARTLY REFLECTS GENETIC EFFECTS UNDERLYING BOTH ATTITUDES AND BEHAVIOR**

Huppertz, C., Bartels, M., Jansen, I.E., Boomsma, D.I., Willemsen, G., de Moor, M.H.M., de Geus, E.J.C.

*Vrije Universiteit Amsterdam*

**AIM:** Based on social cognitive models of health behaviors it has been proposed that individual differences in leisure time exercise behavior are strongly determined by the perceived benefits and barriers to an individual. At first sight this appears to contrast with the results of large scale twin studies showing a major influence of genetic factors on exercise behavior in adults. We attempt to unite these findings by testing for potential underlying factors affecting both actual exercise behavior as well as the perception of its benefits and barriers. **METHODS:** Survey data were obtained from 5153 twins and siblings (18-50 years) who participate in research of the Netherlands Twin Register. Weekly MET hours spent on leisure time exercise behavior were assessed as well as perceived benefits of and barriers to exercising. A bivariate genetic model was fitted to the data in openMx, to estimate heritabilities and genetic correlations. **RESULTS:** Significant heritability was found for exercise behavior ( $h^2=47\%$ ), perceived benefits ( $h^2=26\%$ ) and the 5 main perceived barriers derived from a factor analysis: Facilities/Support ( $h^2=46\%$ ), Time Barriers ( $h^2=30\%$ ), Energy/Discipline ( $h^2=41\%$ ), Physical self-efficacy ( $h^2=44\%$ ), and Pleasure/Interest ( $h^2=47\%$ ). Attitudes were significantly associated with exercise behavior (for benefits:  $r=.33$ ; for the 5 barriers  $r$  ranged between  $-.46$  and  $-.21$ ) and explained 36% of its variance. Bivariate genetic modeling showed that for all six attitudes, the genetic correlations (range:  $-.73$  to  $.71$ ) and the unique environmental correlations ( $-.25$  to  $.21$ ) with exercise behavior were significant. **CONCLUSION:** We conclude that underlying genetic factors partly explain the association between exercise attitudes and exercise behavior. Potential mechanisms will be discussed.

### **IMPACT OF THRESHOLD MESSAGES ON THE PERCEIVED RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND HEALTH**

Knox, E.C., Webb, O.J.

*Loughborough University*

**Introduction** Mass media campaigns promoting physical activity typically recommend a 'threshold' level of participation (i.e. 150 minutes/week). Research into environmental hazards (e.g. radon gas) indicates that thresholds disrupt individuals' understanding of the



dose-response relationship between an exposure/behaviour and resultant health effects (Johnson, 2003). The risks/benefits of behavior can be perceived as negligible if performed below the threshold yet substantial where the threshold is met, producing a 'discontinuous' relationship between behaviour and perceived effects. This is the first study to explore if threshold messages produce discontinuity effects for physical activity. Method A convenience sample (N=825) was approached in a UK town centre and asked to participate in a structured interview. Individuals either received a 'threshold' message ("Regular physical activity protects your health. Each week adults should accumulate 150 minutes") or control message ("Regular physical activity protects your health. Each week adults should engage as regularly as possible"). Participants used a 15-point scale (-7 to +7) to report the health effects that they perceived from seven durations of physical activity which were presented in counterbalanced order (10, 70, 130, 150, 170, 230, and 290 minutes/week). For each duration, ANOVA assessed group differences in perception ratings. Additional moderators were examined, including demographics and current physical activity level. Results The control group showed an appropriate curvilinear dose-response association between duration and perceived health effects. At the threshold and above, perception ratings were consistent across groups. Conversely, for durations below 150 minutes perceived health effects were significantly lower in the threshold group versus controls (10 mins, -0.9 vs. -0.1; 70 minutes, +1.7 vs. +2.5; 130 minutes, +3.2 vs. +3.8, all  $p < .05$ ). As threshold recipients' perceptions 'caught up' with controls at the 150 minute mark they produced a discontinuous 's-shaped' association between duration and perceived health effects. Discussion Individuals receiving a threshold message perceived lower benefits from modest physical activity regimens. Evidence suggests that small behavioral changes are most feasible (e.g. stair use at work) and can improve specific health markers (e.g. fat mass) even if individuals' overall physical activity levels remain below 150 minutes/week (Meyer et al., 2010). Hence, it is vital that campaigns convey the value of accruing even small amounts of additional physical activity. Current threshold messages appear problematic in this regard and may not, therefore, deliver optimal behavior change. References Johnson BB (2003). Risk Anal, 23 (1), 91-103. Meyer P, et al (2010). Eur J Prev Cardiol, 17, 569-75.

**08:00 - 09:30**

## Oral presentations

### OP-BN02 Gait and running patterns

#### ASSOCIATIONS BETWEEN DIFFERENT GAIT STRATEGIES AND KNEE ADDUCTION MOMENT

Kulmala, J.P., Äyrämö, S., Avela, J.

*University of Jyväskylä*

**Introduction** The gait-induced knee adduction moment reflects mechanical loading condition of the medial compartment of the knee joint. High knee adduction moments are linked with the development and progression of degenerative joint diseases such as knee osteoarthritis (1). Inter-subject variability in knee extensor-flexor moment pattern has been recognized in previous studies (2,3). However, only joint moments in the sagittal plane have been reported in these studies and therefore the relationship between knee extension-flexion moment pattern and knee adduction moment remains unknown. Therefore, the purpose of this study was to cluster subjects to different groups based on their knee joint moment profiles and then examine whether different gait patterns are associated with atypically high knee adduction moments. **Methods** Twenty-four healthy men underwent 3D gait analysis. Inverse dynamics was used to compute external joint moments. The subjects were divided into several groups using the K-means method based on the magnitude of knee joint moments. Kruskal-Wallis and Mann-Whitney with bonferroni correction were used to detect univariate group differences. **Results** Three clusters with clearly distinct knee joint moment profiles were identified. In the frontal plane, the subjects in cluster 1 (C1, n=11) had 43% and 44% lower peak knee adduction moment compared to cluster 2 (C2, n=7,  $P < 0.01$ ) and cluster 3 (C3, n=6,  $P < 0.05$ ), respectively. In the sagittal plane, C2 produced 33% higher knee flexion moment compared to C1 ( $P < 0.05$ ) and 59% when compared to C3 ( $P < 0.01$ ). The opposite pattern was present in the knee extension moment where C3 produced 76% and 44% higher peak values than the subjects in C2 ( $P < 0.01$ ) and C3 ( $P < 0.01$ ), respectively. **Discussion** To the best of our knowledge, this is the first study to use cluster analyses in order to show an association between the knee sagittal plane moment profile and magnitude of the knee adduction moment during the stance phase of gait. Similarly to previous studies, distinct knee moment patterns in the sagittal plane were found. Interestingly, those subjects who showed atypically high knee flexion (C2) or extension (C3) moments also produced higher knee adduction moments compared to the general gait pattern (C1). These findings suggest that both knee extensor and flexor dominated walking strategies lead to high knee medial compartment loading and thus may increase the risk of knee joint osteoarthritis. **References** 1) Andriacchi et al. 2004. Ann Biomed Eng. 32(3): 447-457 2) Winter. 1984. Hum Mov Sci. 3:51-76 3) Simonsen et al. 1997. Scand J Med Sci Sports 7:1-13.

#### EFFECT OF MIDSOLE THICKNESS ON RUNNING PATTERNS

Chambon, N.1,2, Delattre, N.1, Berton, E.2, Rao, G.2

*1: Oxylane Research (Villeneuve d'Ascq, France), 2: ISM (Marseille, France)*

**Introduction** Since emergence of highly cushioning shoes, the natural running pattern has changed. Observing habitually barefoot runners, Lieberman et al. (2010) showed that they tended to impact the ground with the forefoot and create less impact force. Using kinematics and dynamics variables, Hamill et al. (2011) showed that short-term adaptations when running barefoot differ from running with shoes of different thicknesses and higher midsole thickness at the heel than the forefoot (4mm drop). Therefore, this study aimed at analysing complete short terms adaptations (kinematics, dynamics, and muscular) occurring when habitually shod runners ran barefoot or with shoes of different thicknesses but no drop. **Methods** Fifteen subjects ran barefoot and with 5 different conditions of shoe sole thickness: 0mm, 2mm, 4mm, 8mm and 16mm. All shoes had identical upper, and no drop. In each condition, subjects performed 5 trials at 3.3m/s on a track after 3 minutes of adaptation on a treadmill at the same speed. Analog data (Kistler force plate, Endevco accelerometer and Delsys EMG electrodes over 11 lower limb muscles) were sampled at 2000Hz while segments positions (8 Vicon T40 cameras) were sampled at 125Hz. **Results** Results shown that stance phase duration was shorter for barefoot condition and 0mm shoe. In terms of kinematics and muscular activity, most changes took place at ankle joint with barefoot condition differing greatly from the others. At initial contact, the ankle joint was plantar flexed while running barefoot ( $-1.5 \pm 8.2$ deg) but dorsi flexed for all the shoes ( $9.7 \pm 9.3$ deg). No condition showed a rear-foot strike even if barefoot condition showed the lowest foot/floor angle. There was no effect on knee and hip

flexion angles. Pre-activation of gastrocnemius was most important for barefoot condition than for shoe conditions. However no difference was observed on tibial acceleration and vertical ground reaction force (VGRF) between conditions (including barefoot). Discussion While opposed to Hamill et al. (2011), the absence of difference between shod and barefoot conditions on VGRF and tibial acceleration can be explained by the absence of drop in our test shoes. Presence of a drop seems to modify the striking pattern. Our results also showed that kinematics and muscular short-term adaptations took place mainly at the ankle joint. These local adaptations were sufficient to accommodate for the absence of cushioning. A longitudinal protocol is needed to investigate whether habitually shod runner could retrieve a natural running pattern similar to that of habitually barefoot runners following long-term adaptation. References Lieberman DE, et al. (2010). *Nature*, 463(7280), 531-535. Hamill J, et al. (2011). *Footwear Science*, 3(1), 33-40.

### **BODY CENTER OF MASS TRAJECTORY SHOWS HOW RACE WALKERS ELUDE "FROUDE LAW"**

Pavei, G.

*Università degli Studi di Milano*

BODY CENTER OF MASS TRAJECTORY SHOWS HOW RACE WALKERS ELUDE "FROUDE LAW" Pavei, G.1, Cazzola, D.1, La Torre, A.2, Minetti, A.E.1 1: Human Physiology Department, University of Milan, 2: Department of Sport, Nutrition and Health Sciences, University of Milan. Introduction Froude number,  $Fr = v^2/gl$  (where  $v$  is the speed of progression (m/s),  $g$  is gravity acceleration ( $9.81\text{m/s}^2$ ),  $l$  is the leg length (m)) is used to compare dynamic similar gait (Alexander, 1989).  $Fr=1$  defines the maximal speed value for pendulum-like locomotion such as walking. Race Walking is an Olympic discipline, which is supposed to be the fastest expression of walking. Assuming athletes' leg length  $l = 1\text{m}$ , the maximal speed according to "Froude Law" is  $3.13\text{m/s}$  much lower than race pace (20km:  $4.16\text{m/s}$ ; 50km:  $3.61\text{m/s}$ ). Alexander (1984) suggested a possible explanation of this discrepancy by differences in kinematic: he suggested that the straight knee at heel strike and the back movements would maximise the radius of the inverted pendular motion. The aim of the study was to analyse the race walkers' Body Center of Mass (BCoM) pattern in order to find how they elude the "Froude Law". Methods 16 Athletes race-walked on a treadmill at incremental speed  $2.77\text{--}4.72\text{m/s}$  at a step of  $0.138\text{m/s}$  every minute. Kinematic acquisitions were made by 8 Vicon 1.3Mp Cameras at  $300\text{Hz}$ . The mathematical description of the BCoM pattern was done with 10 harmonics Fourier Analysis and Lissajous Contour as explain by Minetti and co-workers (2011) with a custom-written software in LabVIEW (National Instrument, USA). Results Athletes' leg length average  $0.93\pm 0.04\text{m}$ , which allowed for a theoretical ( $Fr=1$ ) maximal speed of  $3.02\text{m/s}$ . The Lissajous Contour of the BCoM during race walking showed a characteristic pattern different both from walking and running: during single support BCoM reached the lowest position, while it is highest during double support. At velocity  $\leq 4.4\text{m/s}$  two forward 'protrusions' were present in the lowest part of contour. Discussion The pattern of race walkers' BCoM was found to be dynamically opposite when compared to walking. In fact, during the single support phase of normal walking, BCoM shows the lowest speed and reaches the highest point of a contour resembling a circumference arc, as in an inverted pendulum. Also, the forward 'protrusions' of race walk contours indicate that speed increases in the middle of the support phase. This confirms that race walk rules constraint to adopt a trajectory different from walking but, by deviating from a circle arc, there is no issue of extending the radius. Although a variation of walking, race walking is not a pendulum-like gait, thus it does not undergo the "Froude Law". References Alexander RM. (1984). *American Scientist*. 72. 348-354. Alexander RM. (1989). *Physiol Rev*. 69. 1199-1227. Minetti AE, Cisotti C, Mian O. (2011). *J Biomech*, 44, 1471-77.

### **CONTROL OF PROXIMAL-TO-DISTAL AND DISTAL-TO-PROXIMAL RESISTIVE INTERACTION TORQUE DURING RHYTHMIC MULTI-JOINT COORDINATION**

Stosic, J.

*Centre for Sensorimotor Neuroscience, The University of Queensland, Australia*

When multi-joint movements are coordinated, interaction torques inevitably emerge between adjacent segments in both the proximal-to-distal (PD IT) and distal-to proximal direction (DP IT). Whether their control is the same is difficult to evaluate because mass-segmental differences between the two segments and the simultaneous occurrence of IT in two directions of either assistive (in the direction of movement) or resistive (that opposes the movement) type of IT. For the purpose of the present study, two-degrees of freedom (DOF) elbow joint complex that allows movement at two independent DOF, flexion-extension (FE) and supination-pronation (SP) was selected to test the effect of resistive PD and DP IT on coordination stability during rhythmic coordination. This part of the human body was chosen because natural IT is negligible in each of two DOF when either flexion-extension (FE) or supination-pronation (SP) is produced and therefore allows for artificial IT manipulation using the robot motor arm. Eight subjects were asked to produce in-phase movement pattern (simultaneous FS followed by EPI), while artificial IT promoted 90 degrees out of phase (i.e. supination was late in relation to flexion for PD IT, while extension was late in relation to pronation for DP IT). The level of interaction torque was equalized across DOF to account for segmental-mass differences in FE and SP DOF. This was achieved by evaluating the effort that IT causes when it is artificially induced on SP DOF as a function of FE movement, and vice versa (i.e. the same effort was targeted for both IT while subjects produced in-phase pattern). The effort was expressed as the percentage of maximal EMG values that were obtained from four muscles (biceps, triceps, brachioradialis, and pronator teres) during isometric MVC in eight directions: F, E, S, P and their combinations. To validate EMG procedure additional four levels of IT were used (80 %, 90 %, 110 % and 120 % of the baseline) across both IT directions (1 block -10 conditions fully randomized). In total, subjects produced 2 blocks (20 trials) of in-phase pattern. The main finding of the study is that there were no differences in coordination stability between PD and DP IT patterns. It may be that neural control of the two IT does not differ, since possible control differences due mechanical factors are neutralized by setting the same effort across both DOF. Alternatively, given that range of IT torques was small (baseline IT was set to represent only 10 % more of the EMG obtained in performing free in-phase pattern (i.e. without IT)), the question remains whether there would be differences in coordination stability of PD IT and DP IT if the broader range of IT was used.

### **THE IMPACT OF DIFFERENT FOOTWEAR ON RUNNING KINEMATICS AND JUMPING STABILIZATION IN YOUNG HEALTHY ATHLETES**

Zech, A., Argubi-Wollesen, A., Rahlf, A.L., Mattes, K., Reer, R.

*University of Hamburg*

Introduction Differences between barefoot and footwear situations have been shown for running kinematics or vertical force impact (e.g. Liebermann et al 2010). Based on the hypothesis that barefoot running is more flexible and natural as well as less injurious, the development of minimal (barefoot-like) footwear has recently gained increasing attention. The objective of this study was to compare running kinematics and jumping stabilization time between barefoot and different footwear situations (running socks, Nike free 3.0 and Asics).

**Methods** The trial was based on a randomized study design. 35 healthy athletes with an experience in long distance running volunteered for participation. The tests were performed under barefoot, running socks (Leguano® barefoot shoes), Nike free 3.0® and Asics GT-2160® conditions in randomized order. The test protocol included two minutes of treadmill running at 8, 10 and 12 km·h<sup>-1</sup> in each condition. 3-D kinematic analysis (Vicon Motion Systems) was used to assess ankle and knee joint kinematics as well as cadence and step length during running. Afterwards, the participants performed a unilateral jump-landing task on a force plate in which time to stabilization (TTS) was assessed. Differences between shoe conditions were analyzed by using ANOVA. Results Significant differences ( $p < 0.001$ ) between all footwear situations were found for ankle and knee kinematics under the three speed conditions. The ankle dorsiflexion at foot strike was highest during barefoot running (e.g. 12 km·h<sup>-1</sup>:  $6.62 \pm 5.65^\circ$ ), followed by running socks ( $8.42 \pm 6.01^\circ$ ), Nike free 3.0 ( $11.00 \pm 4.79^\circ$ ) and Asics ( $12.3 \pm 5.1^\circ$ ). Similar results were shown for knee flexion at foot strike as well as cadence and step length during running. No significant differences between all footwear conditions were found for TTS during jump landing. **Conclusions** The results showed that with increasing flexibility of footwear there are less differences to barefoot running kinematics. The most barefoot-like condition was shown for the running socks followed by the Nike free 3.0 and Asics. However, the footwear situation seems to have no influence on sensorimotor control during jump landing. Lieberman DE, Venkadesan M, Werbel WA, Daoud AI, D'Andrea S, Davis IS, Mang'eni RO, Pitsiladis Y. Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature*. 2010;463(7280):531-5.

### LONGITUDINAL CHANGES IN GAIT PARAMETERS IN 4-6-YEAR OLD CHILDREN

Marusic, U., Gerzevic, M., Plevnik, M., Pisot, R.

*University of Primorska*

**Introduction** The understanding of age related changes in gait parameters is essential for early diagnosing of pathological gait in children. Following research findings in secular body size changes (Malina, 2004) we can also aspect changes of the period when children achieve adult-like gait parameters. These peculiarities and inactive lifestyles or inadequate adaptations of fundamental motor patterns (FMP) and developmental irregularities of FMP cause motor deformations. We focus our research into investigating FMP on a population of healthy children. We assume that inadequately developed FMP can have a negative effect on the upgrade of motor stereotypes and consequently on inadequate and irregular physical activity in adulthood. Incorrect functioning of the skeleto-muscular and/or neuro-muscular system could have numerous negative consequences reflected in an individual's work and life, but predominantly in their health. **Methods** Fifty-six healthy children (22 male, 34 female) were involved in a longitudinal study which lasted for three years. Each child's parents were fully informed about the possible risk and nature of the investigation, therefore, they signed an informed consent. Spatial-temporal gait parameters were measured on a treadmill (foot rotation, step width, step length, step time, stance phase, load response, single support, pre-swing, swing phase, total double support, stride length, stride time and cadence). A repeated measures ANOVA was used to test the differences among the parameters of the three years. Statistical significance was accepted as  $p < 0.05$ . **Results** Results showed that there were significant differences in all parameters among the three years, with the exception of foot rotation. Significant differences in step width, step length and step time, stance phase, total double support and cadence were observed between three age groups ( $p < 0.05$ ). Swing phase duration (%) between 4- and 6-year olds and 5- and 6-year olds was significantly longer ( $p < 0.05$ ) but there were no differences between 4- and 5-year-old children. When spatial gait parameters were normalised by the subjects' height similar significant differences were seen. **Discussion** The purpose of the present study was to examine how chosen gait parameters change in children gait pattern during a three-year period. We can conclude that some tendencies in connections with adult-like gait parameters are already present. In further analyses we will try to explain the presented data including other kinematics, kinetics and EMG data. We also have to consider the impact of treadmill which influences the specific adaptation of gait performance in children (Stolze et al., 1997). References Malina RM. (2004). *Antropol. Review*, 67, 3-31. Stolze H, Kuhtz-Buschbeck JP, Mondwurf, Boczek-Funcke A, Johnk K, Deuschl G, Illert M. (1997). *Clin Neurophysiol*, 105, 490-497.

08:00 - 09:30

## Oral presentations

### OP-PM05 Training and Testing 1

#### ENERGY STORAGE CAPACITY DURING HOPPING AND JUMP PERFORMANCE BEFORE AND AFTER A 6-WEEK HIGH INTENSITY RESISTANCE TRAINING WITH OR WITHOUT WHOLE-BODY VIBRATION

Rosenberger, A., Beijer, A., Mester, J., Zange, J., Rittweger, J.

*German Aerospace Center*

Energy storage capacity during hopping and jump performance before and after a 6-week high intensity resistance training with or without whole-body vibration Rosenberger, A.(1,2), Beijer, A.(1,2), Mester, J.(2), Zange, J.(1,3), Rittweger, J. (1,3) 1: German Aerospace Center (Cologne, Germany), 2: German Sport University Cologne (Cologne, Germany), 3: University of Cologne (Cologne, Germany) **Introduction** Whole-body vibration training (WBVT) is highly investigated to optimize current training concepts in recreational and athletic sports (for review see Rittweger, 2010). However, little is known about the energy storage capacity of muscles after high intensity whole-body vibration training. We tested the hypothesis that 6 weeks of high intensity resistive vibration exercise (RVE) in comparison to resistive exercise (RE) improves the ability of leg muscles to store kinetic energy and consequently improves jump performance. **Methods** 26 healthy and recreationally active male subjects (age:  $25.2 \pm 4.2$  yrs.) were included in this two-group parallel-designed study. Subjects trained 2-3 times per week for 6 weeks with weights on a guided barbell. A session consisted of three sets of 8 squats and 12 heel raises. The initial training load was set at 80% of their 1-Repetition-Maximum and training weight (RE and RVE) and vibration frequency (RVE only) were incremented during the training period. Contact time was measured for drop jump (DJ) and multiple one leg hopping (M1LH). Peak force and power was measured for CMJ, DJ, and M1LH. Jump height was measured for CMJ and M1LH. Data was recorded using a force plate (Leonardo Mechanograph, Novotec Medical GmbH, Pforzheim, Germany). **Results** CMJ: jump height increased in both groups (RE:  $42.2 \pm 4.6$  cm vs.  $44.3 \pm 4.0$  cm, RVE:  $41.7 \pm 2.2$  cm vs.  $44.6 \pm 3.6$  cm,  $P < 0.001$ ) without any treatment\*time interaction ( $P = 0.56$ ). Similarly, peak power was increased after training in both groups (RE:  $47.7 \pm 6.5$  W/kg vs.  $50.2 \pm 5.7$  W/kg, RVE:  $48.5 \pm 4.0$  W/kg vs.  $52.4 \pm 4.6$  W/kg,  $P < 0.001$ ), but this time more in RVE than in RE ( $P = 0.043$ ). No effect of treatment, time or any interaction was found for peak force ( $P \geq 0.3$ ). DJ: A

significant interaction effect for post\*treatment contact time (RE:  $183 \pm 22$ ms vs. RVE:  $168 \pm 19$ ms,  $P=0.033$ ) was found. No main or interaction effects were found for peak power or peak force. MLH: No main or interaction effect was observed for hopping height, peak power, peak force or contact time ( $P \geq 0.1$ ). Discussion Both training interventions improved jump height in CMJ, but superposition of WBV increased jump power in CMJ and shortened contact time in DJ. The decreased contact time in DJ is most likely explained by a shortened reaction time or an improved inter- and intramuscular coordination, resulting in enhanced neuromuscular stiffness. Whether or not that effect was the mechanism behind the power-enhancing effect in the CMJ will be subject to future investigation. References Rittweger J (2010). *Eur J Appl Physiol*, 108, 877-904.

### SUBMAXIMAL POWER OUTPUT IS RELATED TO MAXIMAL PERFORMANCE IN ERGOMETER ROWING

Otter, T.A., Brink, M.S., Diercks, R.L., Lemmink, K.A.P.M.

*Hanze University of Applied Sciences Groningen*

Introduction Rowers and coaches are always looking for ways to improve training to optimize rowing performance. In order to monitor training status, it is necessary to evaluate rowing performance regularly. It is viable to test rowing performance in a way, which is less stressful than a maximal performance test. For that reason, the purpose of this study was to determine if performance parameters of a new submaximal ergometer rowing test (SERT) is related to 20 minutes of maximal ergometer rowing. Methods Eleven elite rowers (age:  $22.2 \pm 1.3$  years ; height:  $189.4 \pm 5.7$ cm ; weight:  $81.9 \pm 6.1$ kg) completed the SERT consisting of three stages at fixed predetermined heart rates on a rowing ergometer (Concept2, Model D). Based on the LSCT protocol for cyclists, rowers performed 6 minutes at 70% of maximal heart rate (HRmax) followed by 6 minutes at 80%HRmax and 3 minutes at 90%HRmax at a free chosen cadence (Lamberts et al., 2011). Power output was calculated by flywheel kinematics during the three stages of the SERT, which proved to have good validity on a Concept2 ergometer (Otter et al., in prep). Within three days after the SERT, a maximal rowing performance test of 20 minutes was performed on a rowing ergometer during which virtual boat distance (20minD) was recorded. Both tests were performed under standardized conditions (Temperature: 11-13°C – Humidity: 60-80%). Results Mean power output averaged over the last minute of the first, second and third stage of the SERT (PO70, PO80 and PO90) were  $166.9 \pm 18.0$ W,  $214.9 \pm 30.0$ W and  $285.9 \pm 34.8$ W, respectively. Mean 20minD was  $5836.5 \pm 96.4$ m. A good correlation was found between PO80 and PO90 and 20minD ( $r = 0.71$ ,  $p = 0.015$  and  $r = 0.86$ ,  $p = 0.001$ , respectively) with low typical errors of measurement (1.3% and 0.9%, respectively). Conclusion The submaximal ergometer rowing test is related to 20 minutes of maximal ergometer rowing. This suggests that rowing performance can be monitored more frequently and less stressful by using mean power output during the two last stages of the SERT. References Lamberts, R. P., Swart, J., Noakes, T. D., & Lambert, M. I. (2011). A novel submaximal cycle test to monitor fatigue and predict cycling performance. *British Journal of Sports Medicine*, 45(10), 797-804. Otter, T.A., Lemmink, K.A.P.M., Hofmijster, M. (in prep.) Validation of power output calculated by flywheel kinematics of a Concept 2 rowing ergometer.

### CAN MATCH RUNNING PERFORMANCE BE AFFECTED BY AN IMPROVEMENT IN MAXIMAL AEROBIC SPEED?

Simpson, B., Buchheit, M., Al Haddad, H., Mendez-Villanueva, A.

*ASPIRE*

CAN MATCH RUNNING PERFORMANCE BE AFFECTED BY AN IMPROVEMENT IN MAXIMAL AEROBIC SPEED? Simpson, BM, Buchheit, M, Al Haddad, H, and Mendez-Villanueva, A ASPIRE (Doha, Qatar) Introduction Aerobic capacity is thought to be an essential quality for successful participation in soccer. Data from cross-sectional studies suggest that position-dependent correlations may exist between maximal performance in incremental tests (i.e., maximal aerobic speed, MAS) and very high intensity activities during soccer matches (VHIA) (Buchheit et al., 2010; Mendez-Villanueva et al, 2012). However, there is very limited data on longitudinal changes in MAS and their effect on VHIA. Therefore, and the aim of the present study was to examine, in highly-trained soccer players, whether substantial improvements in MAS can translate to improved VHIA. Methods Seventeen highly-trained youth male soccer players (age:  $14.1 \pm 0.8$ y; height:  $164.9 \pm 6.3$ cm) were selected based on data eligibility (i.e., players that showed substantial increases (greater than  $\Omega$  CV) in MAS between two consecutive testing periods) and have played a minimum of 2 international club games within 1-2 months from/to each testing period. Time-motion analyses were performed using a global positioning system (1-Hz). VHIA were calculated as running speed  $>16.1$ km.h<sup>-1</sup>. Results Substantial improvements in MAS were associated with a small increase in VHIA for full backs (ES = 0.35, 90%CI (0.09; 0.61)), small decrease in centre backs (ES = -0.51, 90% CI (-1.00; -0.01)) and no changes in midfielders and wingers (ES = 0.03 & 0.10, 90% CI (-0.45; 0.51) & (-0.30; 0.50), respectively). Discussion We found that improved MAS may not have a direct impact on high-intensity match running performance. One must consider the fine interaction between tactical, technical and psychological components. Our results confirm that playing structure (e.g., tactical choices) has an important role in influencing the expression of MAS during soccer match play, and hence, match running performance (Buchheit et al., 2010; Mendez-Villanueva et al, 2012). References Buchheit M, Mendez-Villanueva A, Simpson BM, and Bourdon PC. Match running performance and fitness in youth soccer. *Int J Sports Med* 2010. Mendez-Villanueva A, Buchheit M, Simpson BM, Bourdon P. Match play intensity distribution in youth soccer. *Int J Sports Med* 2012 (In press).

### CLUSTER TRAINING VS SETS TO FAILURE: MONITORING MECHANICAL AND METABOLIC EFFECTS OF DISTRIBUTION OF REST BETWEEN REPETITIONS

Carballeira, E.I, Iglesias-Soler, E.I, Sánchez-Otero, T.I, Mayo Mouriz, X.I, Castro-Gacio, X.I

*1. UDC (A Coruña, Spain)*

Introduction The introduction of pauses between intra-set repetitions has been suggested as an alternative to resistance training by sets to failure (FS), so the mechanical performance improves (Haff et al., 2008; Iglesias-Soler et al., 2012) and a high number of repetitions are performed without losing velocity (Iglesias et al., 2010). This set configuration has been denominated as Cluster Training or Cluster set (CS). The purpose of this study was to compare acute mechanical and metabolic effects of two sessions of resistance training equated by volume and total resting time but with different set configuration: sets to failure (FS) versus distribution of rest between every repetition (CS). Methods Ten male judo athletes completed a session consisting of three sets to failure of parallel back squat with 4 repetition-maximum load and resting three minutes between sets. After at least 72 hours recovery period, subjects developed the same volume, but the total resting time was distributed between individual repetitions. Before and after session, isometric force and mean propulsive velocity (MPV) with a load corresponding to the maximum propulsive power were assessed. Results Average MPV during session was significantly higher in CS regarding FS (+19.84%,  $0.42 \pm 0.04$  vs  $0.35 \pm 0.08$  m.s<sup>-1</sup>,  $p=0.009$ ). Furthermore, CS produced lower blood lactate concentration after session (maximum average value  $1.52 \pm 0.77$  vs  $3.95 \pm 1.82$  mmol.l<sup>-1</sup>; session effect:  $p=0.001$ ) and higher MPV with a load corre-

sponding to the maximum propulsive power (MPV immediately after session  $0.64 \pm 0.09$  vs.  $0.59 \pm 0.12$  m.s<sup>-1</sup>); session effect:  $p=0.019$ ). Discussion This study showed differences on performance in output velocity along the sessions with volume and total resting time equated, as a consequence of set configuration in parallel back squat exercise. Moreover, comparison between FS and CS indicates that distribution of the resting time between every repetition leads to sessions with an improved mechanical stimulus (Haff et al., 2008), a reduced glycolytic involvement and a decreased acute loss of performance after the training session. References Haff G, Hobbs R, Haff E, Sands W, Pierce K, Stone M. (2008). *Strength Cond J*, 30(1), 67-76. Iglesias E, Boulosa DA, Dopico X, Carballeira E. (2010). *J Strength Cond Res*, 24, 1566-1572. Iglesias-Soler E, Carballeira E, Sanchez-Otero T, Mayo X, Jimenez A, Chapman A. (2012). *Int J Sports Med*. DOI: 10.1055/s-0031-1299699

### THE INFLUENCE OF INTENSITY AND EXERCISE VARIABILITY IN MAXIMUM STRENGTH AND QUADRICEPS CROSS SECTION AREA GAINS IN A STRENGTH TRAINING PROGRAM

Ugrinowitsch, C., da Fonseca, R.M., Roschel, H., de Souza, E.O., Laurentino, G., Tricoli, V.

*School of Physical Education and Sport, University of Sao Paulo*

Introduction Several authors have advocated that periodized strength training programs produce greater strength gains and muscle hypertrophy than non-periodized programs. In addition, some exercise prescription entities suggest that varying strength training exercises across a training period is more effective than fixed exercise programs to produce such gains. However, empirical support to these suggestions is equivocal. Therefore, the aim of this study was to evaluate the variability of intensity and exercise of the strength training on strength gains and muscle cross-sectional area (CSA). Methods Forty-nine untrained male subjects were divided into five groups: constant exercise-varied intensity (ICEV), constant intensity-constant exercise (ICEC), varied exercise-varied intensity (IVEV), varying intensity-constant exercise (IVECO) and control (C). Strength training for the lower limbs was performed for twelve weeks. The maximal strength was assessed using the squat one repetition maximum test (1RM) and quadriceps femoris muscle CSA measured by MRI. Results All groups had significant gains both in maximum strength and CSA in relation to the pre-training ( $P < 0.05$ ). There were no significant differences between groups for both variables. Discussion The inclusion of the variation of exercise alone or combined with the variation in the stimulus intensity during a strength training program appears to produce no additional gains in muscle strength and AST. References: Monteiro, AG, Aoki, MS, Evangelista, AL, Alveno, DA, Monteiro, GA, Picarro, Ida, C and Ugrinowitsch, C. Nonlinear periodization maximizes strength gains in split resistance training routines. *J Strength Cond Res* 23: 1321-1326, 2009. Rhea, MR, Ball, SD, Phillips, WT and Burkett, LN. A comparison of linear and daily undulating periodized programs with equated volume and intensity for strength. *J Strength Cond Res* 16: 250-255, 2002.

### LOADING RATE DEPENDENCY OF IN VIVO PATELLAR TENDON MECHANICAL PROPERTIES

Kösters, A.1, Wiesinger, H.P.1, Müller, E.1, Seynnes, O.R.2

*1: Department of Sport Science and Kinesiology (Salzburg, Austria), 2: Norwegian School of Sport Sciences (Oslo, Norway)*

Introduction The mechanical properties of the patellar tendon (PT) are typically obtained in vivo by using ultrasonographic imaging during an isometric ramp contraction (MVC) over a predefined time window (e.g. 4-10sec). This technique is limited by the variability of self-paced torque development and by inter-individual differences in maximal torque. Studies addressing loading rate dependency of tendon mechanics in vivo are scarce and, due to methodological factors, indicate conflicting results (Kubo et al., 2002; Pearson et al., 2007). The purpose of this study was to investigate the effect of controlled loading rate on the mechanical properties of the PT. Methods 20 male subjects ( $24 \pm 3$  years,  $180 \pm 6$  cm,  $76 \pm 8$  kg) participated in this study. Real-time ultrasound imaging was used to record PT length changes during ramp contractions. A visual feedback enabled subjects to accurately pace their contractions at loading rates of 50, 80 and 110Nm/s. Two ramp contractions were performed at each loading rate in a randomized order. Knee extension torque and electromyographic activity of the biceps femoris were synchronized with ultrasound and recorded for off line calculation of PT force and mechanical properties at a common force level. Inter-day reliability was determined in a subgroup of 10 subjects. Results Partial results indicate that PT strain was systematically different at all loading rates. Significant differences in tendon stiffness were observed between 50Nm/s and 110Nm/s ( $2182 \pm 891$  versus  $3460 \pm 956$  N.mm<sup>-1</sup>). Reliability tests show that using the present methods, moderate to high reliability ( $ICC = 0.852$  to  $0.931$ ) can be obtained for measurements of PT force, strain, stress and stiffness. Discussion These results are in line with in vitro studies showing the influence of strain rate on tendon mechanical properties (Lieber et al., 2000). However, they demonstrate that rate dependency of tendon stiffness as measured in vivo is limited to broad variations in loading rate. Importantly, these findings also point out the limitations of the methodology used in the majority of studies to test tendon mechanics, where loading rate is uncontrolled and depends on individual maximal forces. References Kubo, K. et al. (2002). Measurement of viscoelastic properties of tendon structures in vivo. *Scand J Med Sci Sports*, 12(1), 3-8. Lieber, R. L. et al. (2000). Effects of muscle contraction on the load-strain properties of frog aponeurosis and tendon. *Cells Tissues Organs*, 166(1), 48-54. Pearson, S. J. et al. (2007). Creep and the in vivo assessment of human patellar tendon mechanical properties. *Clin Biomech (Bristol, Avon)*, 22(6), 712-717.

**08:00 - 09:30**

## Oral presentations

### OP-PM06 Skeletal Muscle Physiology

#### EFFECT OF ACUTE EXERCISE ON MUSCLE SUBSTRATE UTILIZATION AFTER 2 WEEKS OF UNILATERAL LEG IMMOBILIZATION

Olsen, A.B., Hansen, A.V., Gram, M., Reihmane, D., Mogensen, M.H., Dela, F., Helge, J.W.

*Center for Healthy Aging*

EFFECT OF ACUTE EXERCISE ON MUSCLE SUBSTRATE UTILIZATION AFTER 2 WEEKS OF UNILATERAL LEG IMMOBILIZATION Olsen, AB., Hansen, AV., Gram, M., Reihmane, D., Mogensen, MH., Dela, F., and Helge, JW. Center for Healthy Aging, Dept. of Biomedical Sciences, University

of Copenhagen. Background Endurance training induces a shift towards a higher lipid oxidation at a given exercise intensity and this is indicated by a lower respiratory quotient (RQ) in trained compared to non-trained (Kiens et al., 1993). With increasing exercise intensity, fuel utilization changes towards carbohydrate oxidation. We studied the effect of immobilization on substrate utilization during moderate-intensity exercise. Our hypothesis was that with 2 weeks of immobilization the RQ would be increased in the immobilized leg (IM) and either decreased or unchanged in the control leg (C). Materials and methods 12 healthy males ( $23 \pm 0.7$  years, BMI  $23.6 \pm 0.7$ ,  $\text{VO}_2\text{-max}$   $46.7 \pm 1.7$  ml/min/kg, whole-body fat  $21.5 \pm 1.8\%$  [Mean $\pm$ SEM]) had one leg immobilized for 2 weeks. After immobilization subjects performed 45 min of dynamic knee-extension exercise with both legs in two kicking-ergometers (absolute workload  $18.1 \pm 0.6$  Watts; relative workload for IM  $62 \pm 5\%$  and for C  $52 \pm 3\%$ ). During exercise blood flow was measured by ultra sound Doppler and arterial and dual venous blood samples were obtained. Results After immobilization  $\text{VO}_2\text{-max}$  decreased by 6% ( $46.7 \pm 1.7$  vs.  $43.9 \pm 2.4$  ml/min/kg), whole-body fat and lean body mass were unchanged. Leg lean mass decreased in IM ( $10.2 \pm 0.4$  vs.  $9.8 \pm 0.3$  kg) and was lower in IM compared to C ( $9.8 \pm 0.3$  kg vs.  $10.4 \pm 0.3$  kg). During exercise oxygen uptake, arterial-venous oxygen extraction and arterial blood flow were similar in the two legs. The average RQ during exercise was not significantly different between IM and C ( $0.96 \pm 0.02$  vs.  $0.96 \pm 0.01$ ). There was no difference in glucose uptake between IM and C during exercise, however there was a significantly higher glucose uptake in IM at 45 min than at 15 min ( $p=0.03$ ). During exercise lactate release was significantly higher in IM compared to C after 30 min ( $0.45 \pm 0.13$  vs.  $0.12 \pm 0.11$  mmol/min,  $p=0.01$ ) and 45 min ( $0.45 \pm 0.11$  vs.  $0.01 \pm 0.11$  mmol/min,  $p=0.02$ ). Discussion In the present study the immobilization did not induce changes in RQ, and thus leg substrate utilization, during exercise despite the decrease in lean mass and higher lactate release in the immobilized leg. Even though the whole body fitness level was decreased, the local immobilization induced changes were, in contrast to our proposed hypothesis, insufficient to induce a change in leg substrate utilization in this exercise model. Reference List Kiens B, Essen-Gustavsson B, Christensen NJ, & Saltin B (1993). Skeletal muscle substrate utilization during submaximal exercise in man: effect of endurance training. *J Physiol* 469, 459-478.

### **METABOLIC CHARACTERISTICS AND MUSCLE DAMAGE PROFILE OF REPEATED BOUTS OF ECCENTRIC CYCLING IN COMPARISON TO CONCENTRIC CYCLING**

Penailillo, L., Blazevich, A., Numazawa, H., Nosaka, K.

*Edith Cowan University*

Introduction Metabolic cost of eccentric (ECC) cycling is lower at a given intensity (1), and ECC cycling training produces greater muscle mass and strength gains compared with concentric (CON) cycling (2). ECC cycling has been reported to result in prolonged strength loss and myofibrillar disruption (3). It is important to know muscle damage profile in ECC cycling to safely implement it in training. Although it is well known that the magnitude of muscle damage is attenuated when the same ECC exercise is repeated, it is unknown whether this is also the case for ECC cycling. Thus, this study compared the first and second ECC cycling bouts and a bout of CON cycling. Methods Ten men ( $28.4 \pm 8.2$  y) performed a single bout of CON cycling and two bouts of ECC cycling with a two-week interval between bouts. All bouts consisted of 30 min cycling at 60% of the maximal CON power output at 60 rpm ( $169.2 \pm 52.6$  W). Heart rate (HR), oxygen consumption ( $\text{VO}_2$ ), blood lactate (BLa) and rate of perceived exertion (RPE) were measured during cycling, and tympanic temperature (TEMP) was assessed before and immediately after cycling. Maximal voluntary isometric contraction strength of knee extensors (MVC), squat jump (SJ) and counter movement jump height (CMJ), muscle soreness and plasma creatine kinase activity (CK) were measured before, immediately after and 1-4 days after exercise. Changes in these variables over time were compared across the three bouts by a two-way repeated measures ANOVA. Results The average HR,  $\text{VO}_2$ , BLa and RPE were lower ( $P<0.05$ ) during the first ECC cycling (ECC1) than CON cycling, and HR and BLa were even lower ( $P<0.05$ ) during the second ECC cycling (ECC2) compared with ECC1. TEMP increased only after CON cycling by  $0.45^\circ\text{C}$ . Decreases in MVC, CMJ and SJ, and increase in muscle soreness were greater ( $P<0.05$ ) after ECC1 than CON and ECC2. Increases in CK were small after all bouts. Following ECC2, little changes in the variables were found such that MVC, CMJ and SJ did not decrease from baseline and no muscle soreness was developed, which were similar to those seen after CON. Discussion The results confirmed that ECC cycling is less metabolically demanding than CON cycling at the same work. The new findings of the present study were that metabolic demand was further reduced during the second than the first ECC cycling bout, and muscle damage was little or minimum after the second ECC cycling. This is in line with the repeated bout effect shown in other ECC exercises. Thus, muscle damage should not limit the use of ECC cycling. References 1) Perrey et al. (2001) *J Appl Physiol* 91:2135-42 2) LaStayo et al. (2000) *Am J Physiol Regul Integr Comp Physiol* 278: R1282-8 3) Friden et al. (1983) *Int J Sports Med* 4:170-6

### **SKELETAL MUSCLE SATELLITE CELL RESPONSIVENESS TO A SINGLE BOUT OF EXERCISE IS BLUNTED IN THE ELDERLY**

Snijders, T.1, Verdijk, L.B.1, McKay, B.2, Parise, G.2, Greenhaff, P.3, van Loon, L.J.C.1

1. Maastricht University Medical Centre+, Maastricht, the Netherlands. 2. McMaster University, Hamilton, Canada. 3. University of Nottingham Medical School, Nottingham, United Kingdom.

BACKGROUND It has been suggested that the skeletal muscle adaptive response to resistance type exercise training is impaired in the elderly. Skeletal muscle satellite cells (SC) have been shown to be instrumental in the muscle adaptive response to exercise. After a single bout of exercise SC become activated, and proliferate/differentiate to allow the post-exercise muscle adaptive response to occur. The aim of the present study was to compare muscle fiber type-specific SC content and SC activation status at regular time intervals following a single bout of resistance type exercise between young and elderly men. METHODS Ten healthy young ( $22 \pm 1$ y) and 10 healthy elderly ( $73 \pm 1$ y) men performed a single bout resistance type exercise. Nutritional intake was standardized from 24h prior to exercise to 72h of post-exercise recovery. Muscle biopsies were collected before exercise and after 12, 24, 48 and 72h of post-exercise recovery. At all time points fiber type-specific SC content and activation status were assessed by immunohistochemical analyses. SC activation status was assessed by co-staining Pax7 with MyoD or Myostatin. In addition, mRNA and protein expression of key proteins (i.e. MyoD, myogenin and myostatin) in the regulatory pathways of SC lineage determination were determined at the different time points by rtPCR and western blotting. RESULTS Type I muscle fiber SC content had increased significantly after merely 12h of post-exercise recovery in both the young and elderly subjects ( $P<0.05$ ). In contrast, it took 48h and 72h for type II muscle fiber SC content to exceed baseline values in the young and older subjects, respectively ( $P<0.05$ ). The increase in type II muscle fiber SC content tended to be greater in the young compared with the elderly during the 72h of post-exercise recovery ( $P=0.095$ ). The number of myostatin+ SC in both the type I and II muscle fibers was significantly reduced after 12, 24 and 48h of post-exercise recovery in both groups ( $P<0.05$ ). However, after 24 and 48h of recovery the number of myostatin+ SC were significantly lower in the young compared with the elderly ( $P<0.05$ ). The number of MyoD+ SC had increased as early as 12h post-exercise in the young. In contrast, a delayed and blunted response in the increase in MyoD+ SC was observed in the elderly ( $P<0.05$ ). CONCLUSION A single bout of exercise increases type I and II muscle fiber SC content during 72 h of post-

exercise recovery in young and elderly males. The increase in type II muscle fiber SC content is delayed in the elderly when compared with the young, and is accompanied by a blunted SC activation response.

### REGULATION OF HUMAN SKELETAL MUSCLE MICROVASCULAR BLOOD FLOW: EFFECTS OF AGE, EXERCISE AND BIO-ACTIVE NUTRIMENTS

Phillips, B., Varadhan, K., Atherton, P.J., Rennie, M.J., Smith, K., Williams, J.P.

*University of Nottingham*

Introduction: Perfusion of the skeletal muscle microvasculature is crucial for control of whole-body glycaemia, maintenance of muscle proteostasis, and in the case of exercise; performance, recovery and adaptation (1). Yet, despite this crucial role of the micro-vessels within human skeletal muscles, little is understood in relation to: (i) how nutrition (amino acids/ carbohydrate) influences microvascular flow, (ii) whether microvascular flow is impaired in conditions of metabolic decline (i.e. ageing), and (iii) whether bioactive nutriment (cocoa flavonols) may influence it. Therefore, we adopted the novel approach of contrast-enhanced ultrasound (CEUS) to address these questions. Methods: We recruited 10 young ( $23 \pm 2$  y, BMI;  $24.1 \pm 1.7$  kg•m<sup>2</sup>) and 22 older men ( $71 \pm 1$  y, BMI;  $25.9 \pm 0.5$  kg•m<sup>2</sup>). Young and older men ( $n=10$ /group) were studied under both fasted and fed (IV Glamin 102 mg•kg<sup>-1</sup> and 20% dextrose; blood glucose  $\sim 7$  mmol•l<sup>-1</sup>) conditions with femoral artery 'leg' blood flow (LBF) being measured over 40 min in each condition, before infusion of Definity™ perflutren microbubbles to assess microvascular blood flow (indexed as microvascular blood volume; MBV) in m. vastus lateralis using CEUS (2). Additional older men ( $n=6$ /group) were recruited to assess the effects of 20 wk supervised resistance exercise training (RET) or bioactive vasodilatory supplements ( $\sim 1$  g.day<sup>-1</sup> cocoa-flavanol supplementation for 7 d prior to study) on MBV. Results: Increases in LBF after feeding were evident in young ( $0.51 \pm 0.02$  vs.  $0.57 \pm 0.04$  l.min<sup>-1</sup>,  $P < 0.05$ ) but not older men ( $0.32 \pm 0.04$  vs.  $0.33 \pm 0.03$  l.min<sup>-1</sup>, NS). Similarly, increases in MBV after feeding were observed in young ( $+20.68 \pm 7.19\%$ ,  $P < 0.05$ ) but not older men ( $+5.95 \pm 4.56\%$ , NS). Intriguingly, a regimen of RET ( $+67.29 \pm 14.04\%$ ,  $P < 0.05$ ) but not cocoa-flavanol supplementation ( $+4.61 \pm 13.82\%$ , NS) faithfully restored youth-like increases in MBV after feeding. Discussion: We conclude that RET, but not cocoa-flavanol supplementation rejuvenates age-related declines in postprandial microvascular hyperaemia. Therefore, RET-induced improvements in MBV likely underlie some of the established metabolic benefits of RET (i.e. improved vascular function/ glycaemic control) previously reported in ageing (3; 4). References 1. Dawson D, Vincent MA, Barrett EJ, Kaul S, Clark A, Leong-Poi H, Linder JR (2002). Am J Physiol Endocrinol Metab, 282 (3):E714-20. 2. Sjoberg KA, Rattigan S, Hiscock N, Richter EA, Kiens B (2011). Am J Physiol Heart Circ, 301 (2): H450-8. 3. Phillips B, Williams J, Atherton P, Smith K, Hildebrandt W, Rankin D, Greenhaff P, Macdonald I, Rennie MJ (2012). JAP, 112 (3): 347-53. 4. Williams AD, Almond J, Ahuja KD, Beard DC, Robertson IK, Ball MJ (2011). J Sci Med Sport, 14 (4):331-7.

### ASSOCIATION OF SNAP23 WITH THE MITOCHONDRIAL NETWORK IS REDUCED IN SKELETAL MUSCLE OF OBESE FEMALES

Clark, J.A., Shaw, C.S., Davis, E., Pilling, J., Wagenmakers, A.J.M.

*University of Birmingham*

Introduction SNAP23 has been implicated in the development of insulin resistance as hijacking of SNAP23 by lipid droplets (LD) has been shown to limit GLUT4 docking with the plasma membrane (PM) in oleate incubated cardiomyocytes. Further, a decreased content of SNAP23 has been observed in PM fractions of skeletal muscle of type 2 diabetic patients. Finally, it has been proposed that SNAP23 may also play a role in lipid oxidation through LD-mitochondria interactions. The aim of this study was to investigate the distribution of SNAP23 in skeletal muscle of non obese and obese women using immunofluorescence microscopy to further investigate the hijacking hypothesis and explore its potential role in fatty acid (FA) oxidation. Methods Participants were six non obese (NO) (age:  $62 \pm 3$  years, BMI:  $22.6 \pm 1.4$ , HOMA-IR  $3.9 \pm 1.2$ ) and six obese (OB) women (age:  $68 \pm 3$  years, BMI:  $33.3 \pm 1.6$ , HOMA-IR:  $6.2 \pm 1.3$ ) undergoing elective orthopaedic surgery. Biopsies were obtained from the m. gluteus maximus during hip arthroplasty. Cryosections ( $5\mu\text{m}$ ) were labelled with antibodies targeting SNAP23, mitochondria and the PM. LD were stained using oil red O. Results and Discussion SNAP23 partially colocalised with the PM in both NO and OB individuals (Pearson's correlation NO:  $r = 0.39 \pm 0.01$ , OB:  $r = 0.37 \pm 0.03$ ,  $P = 0.640$ ). SNAP23 also partially colocalised with mitochondria in the NO and OB individuals with significantly more colocalisation in NO than OB (NO:  $r = 0.34 \pm 0.03$ , OB:  $r = 0.27 \pm 0.03$ ,  $P = 0.037$ ). SNAP23 weakly colocalised with LD in both NO and OB individuals with no difference between groups (NO:  $r = 0.12 \pm 0.02$ , OB:  $r = 0.07 \pm 0.02$ ,  $P = 0.277$ ). There was no difference in LD or mitochondria content between NO and OB in either type I or type II fibres ( $P < 0.05$ ). However LD content was greater in type I fibres compared to type II fibres in both NO ( $P = 0.03$ ) and OB individuals ( $P = 0.01$ ) and mitochondria content was also greater in type I compared to type II fibres in both groups (NO:  $P = 0.02$ , OB:  $P = 0.02$ ). This study did not confirm the hijacking hypothesis as there was little association of SNAP23 with LD and the association of SNAP23 with the PM was not influenced by obesity or insulin sensitivity. The presence of SNAP23 at the mitochondria supports its proposed role to channel FA released from LD hydrolysis into the mitochondria for oxidation. The reduced association between SNAP23 and the mitochondrial network in obesity may point at a decreased capacity for FA oxidation and provide a mechanism for the reduced LD oxidation that occurs in obese individuals during exercise.

### SEVERE ACUTE HYPOXIA BLUNTS THR172-AMPKA PHOSPHORYLATION IN RESPONSE TO SPRINT EXERCISE THROUGH A SER485-AMPKA1/SER491-AMPKA2 PHOSPHORYLATION MECHANISM IN HUMAN SKELETAL MUSCLE.

Morales-Álamo, D., Ponce-Gonzalez, J.G., Guadalupe-Grau, A., Rodríguez-García, L., Feijoo, D., Perez-Suarez, I., De la Calle-Herrero, J., Fuentes, T., Dorado, C., Guerra, B., Calbet, J.A.L.

*Dep of Physical Education, Univ. of Las Palmas de Gran Canaria, Spain*

Aim: To determine if potential changes in sprint-exercise elicited Thr172-AMPKalpha phosphorylation are associated to the anaerobic component of the exercise, which is exaggerated when the sprint is performed in severe acute hypoxia. Moreover, by determining the glucose and plasma insulin response, combined with the assessment of Ser485-AMPKalpha1/Ser491-AMPKalpha2 and Ser473/Thr308-Akt phosphorylation, we expected to determine if the degree of Thr172-AMPKalpha phosphorylation is modulated by hypoxia in a Ser485-AMPKalpha1/Ser491-AMPKalpha2 phosphorylation-dependent mechanism. Methods: Ten healthy males (age:  $25 \pm 5$  yrs; VO<sub>2</sub>max:  $51 \pm 6$  ml.kg<sup>-1</sup>.min<sup>-1</sup>; means  $\pm$  SD) performed on separate days and random order two 30s-isokinetic Wingate tests at 100 rpm under N and H (FIO<sub>2</sub>=0.104, barometric pressure 730 mmHg). Immediately before the start, at the end of the test, and at 30 and 120 min into the recovery period, muscles biopsies and muscle signalling assessed by Western blot. On separate experiments, cycling economy, O<sub>2</sub> demand and the O<sub>2</sub> deficit incurred during the Wingate test was determined. Results: Peak power output, peak blood lactate and

fatigue index were similar in N and H. Mean power output and mean VO<sub>2</sub> were, respectively, 6% and 37% lower in H than in N. O<sub>2</sub> deficit (in ml of O<sub>2</sub>/w) was greater in H than N (P<0.05). Similar serum glucose and insulin responses were observed in both conditions. Serum glucose and insulin concentration was similarly elevated after the sprints in both conditions. Carbonylated plasma proteins were increased immediately after and during the 120 min following the sprint, but only after the hypoxic sprints (condition x time interaction P<0.05). Thr172-AMPKalpha phosphorylation was increased by 3.1 fold 30 min after the Wingate test in normoxia (P<0.05). Hypoxia prevented the exercise-induced Thr172-AMPKalpha phosphorylation. Ser485-AMPKalpha1/Ser491-AMPKalpha2 phosphorylation level was increased by 60% immediately after sprint performed in hypoxia (P<0.05), while it remained unchanged after the normoxic sprint (condition x time interaction, P<0.05). The AUC of the Thr308-Akt phosphorylation response was 87% higher after the sprint in hypoxia (P<0.05). Conclusion: we have shown that the signaling response to sprint exercise in human skeletal muscle is modified when the sprint is performed in severe acute hypoxia. Severe acute hypoxia blunted the expected increase in Thr172-AMPKalpha phosphorylation likely due to increased Ser485-AMPKalpha1/Ser491-AMPKalpha2 phosphorylation. Supported by MICINN (DEP2010-21866).

**08:00 - 09:30**

## Invited symposia

### **IS-SH03 Winning the Gold Medal War: The Production of Elite Sporting Success**

---

#### **THE MEASUREMENT AND FORECASTING OF SUCCESS IN ELITE SPORT**

Shibli, S.

*Sheffield Hallam University*

This presentation is concerned with the measurement and forecasting of performance in elite sport using the Olympic Games as a case study. There are two unusual features of performance that become apparent when examining Olympic Games' data. First, the International Olympic Committee does not recognise the Olympic Medals' Table as an order of merit, yet increasing numbers of nations are implementing policies to improve their standing in such tables (De Bosscher et al 2008). Second, more nations than ever before are winning medals in the Olympic Games and at the same time more nations than ever before are not winning medals at the Olympic Games. This strange fact is explained by the fact that more nations than ever before are taking part in the Olympic Games. The majority of nations that take in the Olympic Games will go home empty handed, but this does not mean that their athletes have in anyway failed. This presentation will demonstrate a variety of methods that can be used to demonstrate positive aspects of athletic performance that are not reliant on winning medals. For those nations that do win medals in the Olympic Games, to what extent is their success predictable? Ahead of the Athens 2004 Bernard and Busse (2004) stated that medal winning success was largely predictable and demonstrated a forecasting model that was 96% accurate. More recently, Shibli and Bingham (2008) forecast that China would win 46 gold medals in Beijing using simple linear regression and a quantified home nation effect. This forecast was 90% accurate (China actually won 51 gold medals) and significantly outperformed other forecasting models. Using the same technique a forecast will be made of how Great Britain and Northern Ireland should reasonably be expected to perform in London 2012. The presentation will conclude by demonstrating that as more and more nations pursue success in the Olympic Games and the number of medal winning opportunities remains essentially fixed, there are two consequences. First, the price of success increases. Second, as many nations are unable to produce medal winning athletes, they will increasingly need to look to other measures of achievement by which to assess their performance. An emerging issue in elite sport policy will be the need for effective management of nations' expectations. Perhaps Baron de Coubertin was right all along: 'it is not the winning that counts but the taking part.' Bernard, A., and Busse, M. (2004). Who wins the Olympic Games? Economic resources and medal totals. *Review of Economics and Statistics*, Vol. 86, No. 1, pp413-417 De Bosscher, V., Bingham, J., Shibli, S., Van Bottenburg, M and De Knop, P. (2008a) The Global Sporting Arms Race; An International Comparative Study on Sports Policy Factors Leading to International Sporting Success, Meyer & Meyer Sport (UK) Ltd, Oxford Shibli, S. and Bingham, J. (2008) A forecast of the performance of China in the Beijing Olympic Games 2008 and the underlying performance management issues, *Managing Leisure: An International Journal*, 13, 3-4, 272-292

#### **HIGH PERFORMANCE MANAGEMENT IN THE NATIONAL SPORT ORGANISATIONS: THE CASE OF CANOE/KAYAK**

Sotiriadou, P.

*Griffith University*

This study explored the high performance policies of Australia Canoeing in order to transfer and apply existing knowledge on factors that affect Olympic performance to sport specific context. Using the policy factors identified by De Bosscher et al. (2006) this study used semi-structured interviews with the Australian Institute of Sport and Australia Canoeing's high performance staff and athletes. The aims of the study were to examine the participants' personal views of the factors that contribute to international success, and to explore the participant's views of the importance of policy factors identified in previous research on international success. The findings highlight numerous sport-specific (e.g., boat technology) and country-specific (e.g., laid-back culture) factors that influence the potential of the sport to succeed internationally. These factors appear to drive the relative importance of the policy factors (e.g., coach education, planning systems, athlete pathways and support, competition opportunities). In conclusion studying HP policies on a sport-by-sport basis is essential in obtaining significant practical applications for policy directors. The results complement existing knowledge on the HP policy domain as they pinpoint the importance of country and sport-specific policy analyses. Acknowledgement: The author wishes to thank Lisa Gowthorp for her contribution in collecting the data.



**ISSUES OF PRIORITIZATION AND LEGITIMATION IN ELITE SPORT POLICIES**

Van Bottenburg, M., De Bosscher, V., Shibli, S., Westerbeek, H.

*Utrecht University (first author)*

**INTRODUCTION** As a result of the global sporting arms race (De Bosscher et al., 2008), governing organizations in elite sport are searching for increasing efficiency of their investments, for example by prioritizing policies and investing in a relatively small number of sports through identifying those that have a real chance of success at world level. This way of strategic thinking is now applied in many countries. **AIM** This study aims to identify if and how nations are adopting a prioritization policy of elite sports funding. **METHODS** Data were collected by researchers in 16 countries who took part in a large-scale "SPLISS-III" project. An overall sport policy inventory was used as a pre-defined framework to gather data from secondary sources via document review and primary sources such as interviews with national policy makers. Note: Data collection was only completed by 7 countries (BRA, EST, FIN, JAP, POR, ESP, SUI, NED) by the time of writing this abstract and will be finished by the time of the ECSS conference. **RESULTS** Interestingly, five countries do not fund non-Olympic sports as a priority sport (JAP, FRA, POR, BRA, EST). While only four countries indicated that there is a policy that sets out to prioritize particular sports for elite sport funding, closer analysis of the exact amounts of funding on a sport by sport basis shows that all countries prioritize: within the Olympic sports, all countries have spent over 60% of elite sports funding on 8 or fewer sports out of a total of 20 or more (i.e. CR8). For example in Japan and Finland, 21 elite sport disciplines receive 25% of the funding and 9 and 8 sports respectively receive the remaining 75% of the funding. The concentration ratio – CR4 is on average 40% (meaning that four sports receive 40% of the funding), ranging from 29% in Brazil to 52% in Denmark **DISCUSSION** Increasingly, countries are trying to invest 'smarter' in elite sport by implementing a prioritization policy of elite sport funding. National policies have taken this decision but not much is known about the possible unintended side-effects of this policy, for example in the sports that lost their funding, or for less welldeveloped sports; as well as the impacts on other sport policy goals, such as raising sport participation. Targeting strategies are performance-based, often using the number Olympic medals as a criterion for evaluation. This is a typical input-output evaluation. The question remains: (why) are medals important? Why would nations continue to take part in this global sporting arms race? The measurement of outcomes, or the long-term effects of success remain an unexplored area of research. **REFERENCES** De Bosscher, V., Bingham, J., Shibli, S., van Bottenburg, M., & De Knop, P. (2008). A global sporting arms race: An international comparative study on sports policy factors leading to international sporting success. Aachen, Germany: Meyer & Meyer. **ACKNOWLEDGEMENTS** We acknowledge and thank all the researchers and their partners involved in the SPLISS project.

**08:00 - 09:30**

**Invited symposia****IS-BN02 The Motor Control of Human Locomotion: the Role of Stretch Reflex in Natural Human Movement****THE STRETCH REFLEX IN HUMAN RUNNING**

Cronin, N.

*University of Jyväskylä*

During human running, short latency stretch reflexes (SLRs) have been observed at specific latencies after foot-ground contact in the gastrocnemius and soleus muscles. These responses are characterised by a short-lasting burst of muscle activity superimposed on the pre programmed activity that starts prior to ground contact, as measured with surface electromyography. The size of the SLR dramatically decreases in the presence of ischemia, which is known to suppress Ia afferent activity, confirming the major (but not exclusive) contribution of the Ia pathway to this reflexive component. The precise function of the SLRs observed in running is a matter of ongoing study. In cats, the SLR has been shown to compensate for transient decreases in muscle stiffness in response to a joint perturbation, thereby minimising muscle yielding. Evidence has also been presented in support of this hypothesis in humans using seated experimental paradigms. However, studies of SLR responses during the more complex task of human running have focused on the existence of the SLR, as well as variations in its timing and the neural pathways that contribute to it, but the functional importance of the SLR in this context is largely unexplored. In recent work we have attempted to address this issue by using Achilles tendon vibration to modify the size of the SLR during running. Achilles tendon vibration decreases the efficacy of Ia afferent activity, and although muscle spindle type II and Golgi tendon organ Ib afferents are also influenced by this method, they are much less sensitive to vibration than Ia afferents. Results obtained with this method showed that suppression of predominantly Ia afferent mediated SLR responses using Achilles tendon vibration led to evidence of ankle yielding at slow to intermediate running speeds (7-12 km/h), but not at the fastest speed of 15 km/h. These results provide strong evidence for a role of the SLR in ankle stiffness regulation during the early contact phase of human running. In addition, the results suggest that the functional importance of the SLR in triceps surae muscles is speed-dependent, being greater at slow to intermediate running speeds than at faster speeds.

**STRETCH REFLEXES IN HUMAN JUMPING MOVEMENTS**

Gruber, M., Gollhofer, A.

*University of Konstanz and University of Freiburg*

During jumping movements, that allow stretching and subsequent shortening of muscle-tendon units (SSC), like hopping or drop jumping, an early burst of EMG activity at a latency consistent with a simple monosynaptic reflex arc can be easily observed for the soleus muscle. Based on the onset-latency of about 35-45 ms from touch-down the burst was suggested to be a stretch reflex response, now commonly labelled short latency response (SLR). Besides the analogy of the SLR and the stretch-reflex latency, the high excitability of the H-reflex at the time of touch-down and the possibility to reduce the SLR with ischaemic blockade of the lower limb and with short-term inflation of a cuff placed directly over the muscle pointed towards a stretch reflex contribution to the SLR in hopping. In a recent study we provided more direct evidence for stretch reflexes indeed contributing to the SLR in soleus muscle. Shifting the height of a programmable

platform up or down between two hops, which advanced or delayed the touch-down without the subject's knowledge, consequently advanced or delayed the SLR. In a second study we could show that these reflexes work in concert with higher order structures. We inhibited the motor cortex with a magnetic stimulus and we were able to selectively suppress the SLR. Thus, it seems that sensory feedback and descending drive from the motor cortex are integrated to drive the motor neuron pool during the SLR. The functional relevance of stretch reflexes during the SSC in jumping movements has been discussed thoroughly over the years. From animal models and human studies there is good evidence that stretch reflexes potentially increase muscle force and stiffness at least in moderate to submaximal SSC tasks of moderate duration – like e.g. submaximal hoppings or drop-jumps from low to moderate fall heights.

### **STRETCH REFLEXES IN RESPONSE TO UNEXPECTED BALANCE DISTURBANCES**

Duysens, J.

*KU-Leuven*

During walking there is evidence that short latency stretch reflexes (SLRs) are important in given phases of the step cycle (for example hamstrings muscles at end swing) but during gait perturbations it is less clear how important such reflexes can be. For example, in stumbling or in walking on inverting surfaces there are SLRs but they are small and have little muscle specificity. It was argued that SLRs provide a brief stiffening of muscles that are stretched but these responses contribute little to the overall behavior following the perturbation. In contrast, stretch responses with a long (or medium) latency (LLR) are much larger and more muscle specific. In stumbling reactions these responses are very prominent in the hamstrings and they are smaller in elderly than in young adults. In responses to ankle inversion (caused by stepping on a trapdoor placed on a treadmill) the LLR responses can be part of a whole body response. However, these responses are late and cannot provide quick adjustments. For example in ankle inversions during walking these responses appear after the inversion is over and therefore they are not able to protect the subjects during the inversion. Instead it is argued that these responses may play a role in the phase immediately following inversion, when stability has to be regained. Subjects with chronic ankle instability (CAI) have often recurrent ankle sprains, indicating they are not dealing as efficiently with ankle perturbation as controls. In recent work we have examined whether this could be related to deficiencies in preparing and executing landing of the foot. The working hypothesis is that these subjects either show changes in muscle activations in anticipation of landing or they have deficient late stretch responses which causes instability after landing. To imitate as closely as possible the conditions which often lead to ankle inversion, an experiment was designed in which subjects with or without CAI were to jump on a hard floor on which occasionally an object was placed (a plate imitating the foot of a companion player). It was found that CAI subjects indeed showed differences both in preparatory EMG activity as in LLRs. In contrast there was no difference in SLRs.

**08:00 - 09:30**

### **Invited symposia**

#### **IS-PM04 Exercise and Testing in Patient Populations (\*) sponsored by Xlab.dk**

### **EXERCISE AND TESTING IN PATIENT POPULATIONS; CORONARY HEART DISEASE AND HEART FAILURE**

Conrads, V.

*Antwerp University Hospital*

Regular physical activity has become an essential component of the 'feel good-look good hype'. Many healthcare workers, however, do not fully appreciate the direct benefits of exercise training. Being physically fit and 'working out' does not only prevent cardiovascular disease indirectly, by modifying risk factors such as overweight, hypertension and lipids. It also, for instance, directly reverses endothelial dysfunction, which is considered a key player in the development and progression of atherosclerosis. As a result, exercise training has evolved from a vague healthy lifestyle advice to a class I A indication for patients after myocardial revascularisation and for those with chronic heart failure. This lecture will touch upon both translational and clinical evidence that underscore the potential of exercise training as a valuable adjunct preventive measure and treatment modality. In addition, the value of exercise testing in order to assure safety and efficacy in these patients will be stressed.

### **TESTING, EXERCISE AND TRAINING IN OBESE PATIENTS; EFFECTS ON FITNESS AND FAT OXIDATION**

Helge, J.

*University of Copenhagen*

Obesity is increasing worldwide and unfavourable changes in lifestyle towards unhealthy diet and inadequate physical activity level are probably central to this increase. A key intervention in treatment and prevention of obesity is increasing daily physical activity and adapting regular daily exercise in this population. This requires particular knowledge on specificity and concerns of applying exercise, training and also testing in obese and severely obese subjects. An issue in this is the non-uniformity of the obese population indicated by NHANES data from 1999-2004 demonstrating that, as many as 32 % of obese individuals actually exhibit a metabolically healthy phenotype and the remainder an metabolically unhealthy phenotype (1). This talk will focus on the measurement of aerobic and metabolic fitness in the obese population. Subsequently the effects of acute exercise on substrate metabolism in obese subjects and the implications therefore on metabolic health will be discussed. Based on this the notion, that obesity is accompanied by an impaired ability to oxidize fat during exercise and a decreased mitochondrial function in skeletal muscle will be discussed. 1. Wildman,RP, Muntner,P, Reynolds,K, McGinn,AP, Rajpathak,S, Wylie-Rosett,J, Sowers,MR: The obese without cardiometabolic risk factor clustering and the normal weight with cardiometabolic risk factor clustering: prevalence and correlates of 2 phenotypes among the US population (NHANES 1999-2004). *Arch Intern Med* 168:1617-1624, 2008

**EXERCISE AND TESTING IN COP PATIENTS**

Ringbæk, T.

*Hvidovre University hospital, Copenhagen*

Pulmonary rehabilitation is a well-established treatment modality for chronic obstructive pulmonary disease (COPD). The rationale for its use is the observation that breathless people limit their exercise and become cardiovascularly deconditioned, leading to further exercise limitation and a spiral of decline. Exercise training breaks this cycle leading to an improvement in exercise capacity and health-related quality of life, and decreasing breathlessness. In contrast to physical training in healthy individuals, pulmonary rehabilitation is applied to patients with airflow limitation, and some have hypoxaemia and myopathy as well. These conditions influence the exercise training in COPD. The exercise interventions in COPD patients and their effectiveness are reviewed.

**08:00 - 09:30****Oral presentations****OP-PM07 Exercise and Cardiac Physiology****FACTORS EXPLAINING TRAINING-RELATED DIFFERENCES IN EPOC HALF LIFE**

Mann, T., Lambert, M.I.

*University of Cape Town*

**Introduction** Although post-exercise oxygen consumption (EPOC) has traditionally been investigated for its potential role in weight loss, EPOC may also be used as a measure of the time taken to reverse exercise-induced changes in homeostasis and how this changes with training. For example, trained individuals recover more rapidly following exercise at a set % of VO<sub>2</sub>max (Hagberg 1980, Short 1997). However, the effects of training are multi-faceted and it is unclear to what extent changes in metabolic recovery are related to changes in body composition, autonomic balance, muscle adaptation and absolute intensity of the exercise bout. Therefore the aim of this study was to investigate to what extent the half life (HL) of EPOC could be explained by participant characteristics, training status and responses associated with the exercise dose, following a standardized exercise bout. **Methods** Untrained individuals (n=11) and moderately-trained (n=13) and well-trained (n=12) runners were recruited and visited the laboratory on 2 occasions for the measurement of height and body mass, a Dual X-ray absorptiometry scan and 2 Bruce protocol maximal treadmill tests, 1 per visit. The 3rd and final visit involved a standardized protocol of 15min rest, a 3km treadmill run at 70% of VO<sub>2</sub>max and 65min of resting recovery. Respiratory gases and heart rate were measured for each phase of the protocol. A one-phase exponential decay curve was fitted to recovery oxygen consumption measurements and the HL of the curve used as the dependent variable for multiple regression analysis. The following variables were investigated for their ability to predict HL: age, gender, mass and body fat% (participant characteristics); weekly training km, VO<sub>2</sub>max and Bruce protocol time to exhaustion (training status); absolute oxygen consumption (ml/kg/min), energy expenditure (cal/kg), RER, %maximum heart rate, total exercise heart beats (ex hb's) and RPE (exercise dose). **Results** Variables within the participant characteristics, training status and exercise dose categories were able to explain 58%, 53% and 68% of the variation in HL respectively. The strongest single predictor of HL was ex hb's (R<sup>2</sup> = 0.56) and the best subset of 3-4 predictive variables consisted of body fat %, exercise RER and ex hb's. Each variable contributed significantly to the outcome (p < 0.05) and together accounted for 71% of variation in HL (SEE = 4.0 s). **Discussion** It may be concluded that decreased recovery HL with exercise training represents the integrated effect of altered body composition and substrate metabolism and decreased cardiovascular load during exercise. This study provides preliminary support for HL as an integrated measure of training adaptation. Understanding the remaining 29% unexplained variation could be the focus of further study as could the possible practical applications of the HL measurement for monitoring and assessment. **References** Hagberg J, Hickson R, Ehsani A, Holloszy J. (1980). JAP 48, 2, 218-24. Short K, Sedlock D. (1997). JAP 83, 1, 153-59.

**TREATMENT WITH THE ALPHA-CALCITONIN GENE-RELATED PEPTIDE RECEPTOR ANTAGONIST CGRP<8-37> PREVENTS EXERCISE-INDUCED CARDIAC HYPERTROPHY IN MICE**

Gubser, M.I, Rieger, G.I, Hoppeler, H.I, Vogel, J.2, Baum, O.1

*1 Institute of Anatomy, University of Bern, Switzerland, 2 Institute of Veterinary Physiology, Vetsuisse Faculty University of Zürich, Switzerland*

**Introduction** It is discussed that a specific intertissue cross-talk between skeletal muscles and heart influences physiological cardiac hypertrophy in response to endurance training. However, the molecular nature of this process is unknown. Previous studies showed that exercising skeletal muscles release alpha-calcitonin gene-related peptide (CGRP) in close correlation with workload into the vascular system. In addition, CGRP incubation yielded larger cardiac myocytes in vitro (Vogel et al. unpublished). We therefore hypothesized that CGRP is involved in the onset of cardiac hypertrophy as a result of endurance training. **Methods** Two cohorts of C57BL/6-mice (n=8 each) were subjected to a 3-week period of treadmill exercise, consisting of five 45-min units per week with increasing velocity and incline to a maximum of 20 m/min at 9-degrees. Fifteen minutes prior to each training unit, one cohort of mice was injected s.c. with 20 nmol of the CGRP(8-37) peptide, a CGRP receptor antagonist, dissolved in 200 µl PBS, while the control mice received 200 µl PBS only. Two performance tests were conducted before and after the training period to determine peak power outcome (PPO) and time-to-exhaustion (TTE). To assess exercise-induced cardiac hypertrophy, heart dimensions were measured in vivo prior to and after the training period using magnetic resonance imaging (MRI), small animal MR system Bruker PharmaScan 47/16 (Bruker, BioSpin MRI, Ettlingen, Germany). A cine FLASH sequence was acquired using the self-gating technique IntraGate (ParaVision 5.0, Bruker BioSpin MRI) to enable determination of the myocardial volume (MV) as well as the endsystolic (ES) and enddiastolic (ED) volumes. Time points of maximal and minimal ventricular dimensions defined ES and ED volume, respectively. **Results** Treadmill training induced a significant increase in PPO and TTE of CGRP(8-37)-treated and PBS-treated mice with no significant differences between the cohorts. However, endurance training resulted in a significant enlargement (+13%) of the MV volume in PBS-treated mice, but not in CGRP(8-37)-treated animals. The ratio between ED volume and MV volume, that is not altered under physiological conditions, was significantly increased (+21%; P ≤ 0.05) in CGRP(8-37) but not PBS-

treated mice when comparing pre- and post-training measures. Discussion Administration of the CGRP antagonist CGRP(8-37) blocked exercise-induced cardiac hypertrophy in the mice. This suggests that CGRP might be a hitherto unrecognized effector system probably triggered by active skeletal muscles to promote physiological adaptation of the heart during exercise. MG and GR as well as JV and OB contributed equally to this study

### GENOTYPE X HYPOXIA INTERACTION IN ENDURANCE PERFORMANCE

Masschelein, E., Ramaekers, M., Van Thienen, R., Hespel, P., Thomis, M.

*KU Leuven*

**Introduction:** Physiological adaptations to hypoxia have been extensively studied. However, these adaptations are marked by strong variation (Martin et al., 2010). Factors that contribute to this variation are poorly understood. We examined the importance of genetic factors in inter-individual variability in responses to hypoxia using a monozygotic (MZ) genotype x hypoxia (G x H) interaction twin design. **Methods:** Twenty-seven healthy male subjects (age:  $24.9 \pm 4.4$  years) of which 12 MZ twins pairs and one MZ triplet participated in an experimental session in normoxia (20.93% O<sub>2</sub>) and severe hypoxia (11% O<sub>2</sub>, ~5000m altitude) in a normobaric hypoxic facility. During the first 5-h rest period, oxygen content was held constant at 20.93% in normoxia while in hypoxia oxygen content was progressively decreased from 20.93% to 11%. Following a 5-h rest period, a 3-h experimental protocol started consisting of a 1-h rest period, a 30-min reaction time test, a 20-min submaximal cycling exercise (SUB, 1.2 W/kg body weight) and a maximal incremental exercise (MAX, 50W + 20W/min). Acute mountain sickness (AMS) symptoms were assessed using the Lake Louise Scoring System at the end of the protocol. G x H was tested by a two-way analysis of variance for repeated measures (twins x hyp/normoxic condition) and refers to a phenotype for which the response to hypoxia is significantly influenced by genetic variation. **Results:** At rest and SUB, hypoxia per se increased heart rate (HR), minute ventilation (VE), carbon dioxide output (VCO<sub>2</sub>), respiratory exchange ratio (RER) and blood lactate (La) ( $P < 0.01$ ) and decreased oxygen saturation (SpO<sub>2</sub>) ( $P < 0.001$ ). At MAX, hypoxia decreased peak HR, SpO<sub>2</sub>, VE, VO<sub>2</sub>, VCO<sub>2</sub>, La and time to exhaustion ( $P < 0.001$ ) and increased RER ( $P < 0.05$ ). In hypoxia, the severity of AMS increased ( $P < 0.001$ ) and the incidence of AMS was 26%. In response to hypoxia, there were considerable differences between subjects. However, this was not randomly distributed among subjects. Significant G x H was found at rest for HR, SpO<sub>2</sub> and RER (ICC = 0.79 – 0.85, F-ratio = 3.8 – 5.6,  $P < 0.05$ ), at SUB for HR, SpO<sub>2</sub> and La (ICC = 0.75 – 0.89, F-ratio = 2.9 – 8.0,  $P < 0.05$ ) and at MAX for HR, SpO<sub>2</sub>, La, VO<sub>2</sub>, VCO<sub>2</sub>, RER (ICC = 0.74 – 0.91, F-ratio = 2.9 – 10.4,  $P < 0.05$ ). Significant G x H was found for change in time to exhaustion (ICC = 0.74, F-ratio = 2.84,  $P < 0.05$ ). Furthermore, significant G x H was found for the severity of AMS (ICC = 0.74, F-ratio = 2.84,  $P < 0.05$ ). **Conclusion:** These results strongly suggest that a genetic component is involved in the response to hypoxia. **References:** Martin, D.S., Levett, D.Z., Grocott, M.P., & Montgomery, H.E. (2010). Variation in human performance in the hypoxic mountain environment. *Exp Physiol*, 95, 463-470.

### A RANDOMISED TRIAL OF 6-MONTHS INTENSIVE ENDURANCE VS. RESISTANCE EXERCISE TRAINING IN HEALTHY HUMANS: IMPACTS ON CARDIAC AND VASCULAR REMODELING

Spence, A.1, Carter, H.1, Naylor, L.1, George, K.2, Green, D.1,2

*1.UWA (Perth, Australia) 2.LJMU (Liverpool, UK)*

**Introduction** Chronic exercise training is known to induce cardiac morphological changes (Spence et al. 2011 & Naylor et al. 2008), however no studies have directly compared the impacts of endurance and resistance training on cardiac and vascular remodeling. We present the first prospective, longitudinal, randomised study comparing the effects of these distinct exercise modalities on cardiac and vascular structure in healthy humans. **Methods** Following random assignment to either endurance (END n=10) or resistance (RES n=11) training groups, participants underwent an intensive, supervised, 24-week training program. Both programs followed a progressively overloaded, periodised approach with the END program involving running at individually prescribed intensities. The RES program included elements of Olympic weightlifting with loads given as percentage of maximal lifts. Measures were taken before and after training and included assessment of femoral artery (FA) diameter using high-resolution ultrasound and cardiac morphology using MRI. **Results** Aerobic fitness increased significantly in END ( $\Delta = 3.5 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ,  $P < 0.05$ ) but was unchanged in RES ( $\Delta = 0 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ,  $P = \text{NS}$ ). Muscular strength significantly improved in both groups, but to a greater extent in RES ( $27.3 \pm 4.6$  vs.  $37.5 \pm 4.9\%$ ,  $P < 0.001$ ). In the END participants, FA diameter was significantly larger following training ( $6.2 \pm 0.2$  to  $6.5 \pm 0.3 \text{ mm}$ ,  $P = 0.05$ ), but unchanged in response to RES ( $6.7 \pm 0.2$  to  $6.7 \pm 0.2 \text{ mm}$ ,  $P = \text{NS}$ ). Left ventricular end-diastolic volume (EDV) increased 3-fold more in END compared to RES ( $+8.9$  vs.  $+3.1 \text{ mL}$ ) although neither change achieved statistical significance. **Discussion** This is the first study to compare conduit artery and cardiac remodeling in response to divergent modalities of intensive, closely supervised exercise training. We observed distinct patterns of cardiac and large artery remodeling between these exercise modes. These findings suggest that endurance exercise training has impacts on the cardiovascular system, which enhance structural capacity, whereas resistance training is not associated with remodeling in the heart or femoral arteries. **References** Spence A, Naylor L, Carter H, Buck L, Dembo L, Murray C, Watson P, Oxborough D, George K, Green D. (2011) *J Physiol*. 589(22):5443–5452. Naylor L, George K, O'Driscoll G. (2008) *Sports Med*. 38(1):69–90.

### ACUTE EFFECT OF ISCHEMIC PRECONDITIONING ON LACTATE ACCUMULATION, TIME-TRIAL PERFORMANCE AND VASCULAR FUNCTION

Bailey, T.G., Birk, G.K., Jones, H., Gregson, W., Atkinson, G., Cable, N.T., Green, D., Thijssen, D.H.J.

*Liverpool John Moores University*

Repeated bouts of ischemia followed by reperfusion, known as ischemic preconditioning (IPC), protects against cardiac damage after a myocardial infarction or cardiac surgery. Recent studies have established that IPC also improves maximal exercise performance. In this study, we examined the hypothesis that the performance effects of IPC relate to changes in blood lactate accumulation (bLa) and endothelial function. In a randomised, crossover study, 13 healthy men performed exercise preceded by lower limb IPC (4x5 min 220 mmHg bilateral occlusion) or a sham occlusion (SHAM; 4x5 min 20 mmHg bilateral occlusion). Subjects performed a graded treadmill running test, with 5x3min submaximal stages (10-14 km·h<sup>-1</sup>), followed by increments of 1 km·h<sup>-1</sup> every 2 min until volitional exhaustion. Accumulation of bLa was examined at the end of each 3 min stage and the onset of blood lactate accumulation (OBLA) was calculated. Subsequently, subjects performed a 5-km time-trial (5kmTT). Brachial artery endothelial function was examined using flow-mediated dilation (FMD) prior to any exercise and immediately post 5kmTT. A novel covariate-controlling approach using Generalised Estimating Equations (GEE) was used to analyse the effects of trial (IPC vs. SHAM) and time on bLa and FMD. A student's t-test was used to assess any differences in OBLA and 5kmTT performance. Data are described as mean (95% CI). Accumulation in bLa was 1.1 (0.6 to 1.5) mMol·l<sup>-1</sup> lower at

14 km·h<sup>-1</sup> (P=0.023) when exercise was preceded with IPC compared to SHAM. This coincided with a trend for delayed OBLA after IPC (mean diff. of 1.5 km·h<sup>-1</sup>, -0.18 to 3.87, P=0.071). After IPC, the 5kmTT was completed 36.0s (5.0 to 64.1s, P=0.027) faster compared to SHAM. In SHAM, FMD decreased from 5.1% (4.4 to 5.9) to 3.7% (2.6 to 4.8) post 5kmTT (P=0.02), whereas it was maintained in the IPC condition; 5.4% (4.4 to 6.4) and 5.7% (4.6 to 6.8, P=0.60), respectively. This is the first study to show that IPC improves 5kmTT performance and attenuates the rise in bLa observed during running exercise. This suggests that prior IPC allows for higher work-rates for a given increase in bLa concentration. IPC also prevented the typical decrease in endothelial function associated with strenuous exercise. Taken together, our findings provide novel insight to support a physiological basis for IPC as an effective pre-exercise intervention to improve running performance in healthy males.

## 08:00 - 09:30

### Oral presentations

#### OP-PM08 High Intensity Training

##### LOW-VOLUME HIGH-INTENSITY INTERVAL EXERCISE TRAINING IMPROVES BRACHIAL ARTERY FLOW-MEDIATED DILATION IN PATIENTS WITH CORONARY ARTERY DISEASE

Currie, K.D., McKelvie, R.S., MacDonald, M.J.

*McMaster University*

LOW-VOLUME HIGH-INTENSITY INTERVAL EXERCISE TRAINING IMPROVES BRACHIAL ARTERY FLOW-MEDIATED DILATION IN PATIENTS WITH CORONARY ARTERY DISEASE Currie, K.D.1, McKelvie, R.S.1-3, MacDonald, M.J.1 1: Department of Kinesiology, McMaster University (Hamilton, Canada), 2: Department of Medicine, McMaster University (Hamilton, Canada), 3: Hamilton Health Sciences (Hamilton, Canada) Introduction The physiological merits of low-volume high-intensity interval exercise training (HIT) have been established in healthy populations (Hood et al., 2011; Rakobowchuk et al., 2008); however, its significance in clinical populations requires further examination. This study examined the effects of 3-months of HIT and the current standard of care (moderate-intensity endurance exercise, END) on brachial artery endothelial-dependent dilation in patients with coronary artery disease (CAD). Brachial artery endothelial-dependent dilation was assessed using the flow-mediated dilation (FMD) test, and was selected as the primary outcome given its association with CAD severity (Kaku et al., 1998), and future risk (Yeboah et al., 2007). Methods Twenty-two men with documented CAD were stratified into END or HIT programs based on their pre-training FMD score. Both programs involved 2 supervised sessions per week on a cycle ergometer. HIT involved 10, 1-minute intervals at 80% peak power output (PPO) separated by 1-minute intervals at 10% PPO. END involved 30-50 minutes of continuous cycling at 55% PPO. Assessments were performed prior to starting (pre) and following 3-months of exercise training (post). Brachial artery diameters and velocities were collected using duplex B-mode and pulsed-wave Doppler ultrasound (12 and 4 MHz respectively) at baseline, and for 3-minutes following a 5-minute ischemic period. FMD is expressed in absolute (mm) and relative (%) terms. Results There was evidence of classical training adaptations, as fitness (relative peak oxygen consumption) was increased following HIT (21.3 ± 2.8 vs. 27.1 ± 4.3 ml·kg<sup>-1</sup>·min<sup>-1</sup>) and END (20.0 ± 7.0 vs. 23.7 ± 7.2 ml·kg<sup>-1</sup>·min<sup>-1</sup>). Brachial artery endothelial-dependent dilation was also improved following training. Absolute (HIT: 0.17 ± 0.12 vs. 0.24 ± 0.11 mm; END: 0.19 ± 0.13 vs. 0.27 ± 0.14 mm) and relative (HIT: 3.8 ± 2.5 vs. 5.3 ± 2.5 %; END: 4.2 ± 3.2 vs. 6.0 ± 3.4 %) increases in FMD were observed post-training (p≤0.001), with no differences between groups. Discussion FMD was improved following 3-months of HIT and END, despite the shorter training volume with the HIT program. Given that "lack of time" is the primary barrier to exercise adherence in cardiac rehabilitation programs, time-efficient and physiologically effective HIT may be an advantageous treatment strategy. References Hood et al. (2011). *Med Sci Sports Exerc*, 43, 1849-1856. Kaku et al. (1998). *Jpn Circ J*, 62, 425-430. Rakobowchuk et al. (2008). *Am J Physiol Regul Integr Comp Physiol*, 295, 236-242. Yeboah et al. (2007). *Circulation*, 115, 2390-2397.

##### INFLUENCE OF EXERCISE INTENSITY ON PULMONARY OXYGEN UPTAKE KINETICS IN YOUNG AND OLDER PEOPLE

McNarry, M.A., Kingsley, M., Lewis, M.J.

*University of Swansea*

Influence of exercise intensity on pulmonary oxygen uptake kinetics in young and older people M.A. McNarry<sup>1</sup>, M. Kingsley<sup>1,2</sup> and M.J. Lewis<sup>1</sup> 1College of Engineering, Swansea University, UK. 2Institute for Health and Social Science Research, CQ University, Australia Considerable controversy continues to surround the influence of exercise intensity on the time constant (τ) describing the primary component of pulmonary oxygen uptake (VO<sub>2</sub>) kinetics. Whilst some studies report no influence (1), others have found a lengthening of the τ during heavy intensity exercise (3), a finding interpreted to suggest reduced O<sub>2</sub> availability (2). Such a limitation may be attributable to the central circulatory response, which is partly mediated by vagal withdrawal. Few studies have sought to specifically address the influence of exercise intensity and the conclusions of those that have are largely limited by small sample sizes. Furthermore, inter-study comparisons are thwarted by the assortment of exercise intensities, modalities and modelling techniques used. Whether age further modulates the influence of exercise intensity remains to be elucidated. The purpose of this study was to determine the influence of exercise intensity on the VO<sub>2</sub> kinetics and, subsequently, the importance of age in modulating this effect. Fifty younger (24±4 yrs) and 15 older (54±3 yrs) healthy participants (34 male) completed repeated bouts of moderate (Mod; 70% gas exchange threshold, GET) and heavy intensity exercise (Hvy; 30% of the difference between the GET and peak VO<sub>2</sub>). ECG and pulmonary gas exchange variables were measured throughout and parameters describing the dynamic responses of O<sub>2</sub>, heart rate (RR) and vagal withdrawal (HF) were subsequently derived using a mono-exponential model, with (VO<sub>2</sub>) or without (RR and HF) a time delay. The VO<sub>2</sub> τ was significantly greater during heavy compared with moderate exercise in both younger (Mod: 22±9 vs. Hvy: 29±9 s; P<0.001) and older people (Mod: 22±9 vs. Hvy: 30±8 s; P<0.001), as were the time delay (Young; Mod: 8±6 vs. Hvy: 11±7; Older; Mod: 6±6 vs. Hvy: 12±6 s; P<0.01) and mean response time (Young; Mod: 28±9 vs. Hvy: 45±11; Older; Mod: 27±10 vs. Hvy: 45±13 s; P<0.01). The RR τ was similarly slowed during heavy exercise (Young; Mod: 26±16 vs. Hvy: 32±15; Older; Mod: 30±20 vs. Hvy: 36±18 s; P<0.01), as was the HF τ (Young; Mod: 63±27 vs. Hvy: 100±21; Older; Mod: 63±22 vs. Hvy: 101±30 s; P<0.01), irrespective of age. This study suggests that the temporal components of VO<sub>2</sub> kinetics are significantly slowed during heavy compared to moderate intensity exercise. The present results support the notion that this may be attributable to an oxygen availability limitation given the slower RR and vagal withdrawal kinetics also observed during heavy intensity

exercise. 1) Barstow T, Mole P. (1991). *J Appl Physiol*, 71, 2099-106. 2) Hughson R, Tschakovsky M, Houston M. (2001) *Exerc Sport Sci Rev*. 29, 129-33. 3) Paterson D, Whipp B. (1991) *J Physiol-London*, 443, 575-86.

### EXTREMELY SHORT DURATION HIGH INTENSITY TRAINING SIGNIFICANTLY IMPROVES ENDURANCE PERFORMANCE AND BLOOD LACTATE PROFILES IN TRIATHLETES

Jakeman, J.R.1, Adamson, S.2, Babraj, J.A.2

1. *Oxford Brookes University*; 2. *SPEC, University of Abertay, Dundee*

**Introduction** It has been demonstrated that high intensity training (HIT) involving 30 second sprints is an effective approach to improving aerobic performance (Burgomaster et al., 2005). The magnitude of this effect may be due to increased glycogen turnover (Babraj et al., 2007), and therefore, the same benefits should be achieved from shorter duration sprints. We investigated whether shorter duration HIT, involving 6 second sprints, improved aerobic performance. **Methods** Twelve competitive, male triathletes (35 ± 8 y, weight 82 ± 10 kg, BMI 26 ± 3 kg.m<sup>-2</sup>) participated in the study and were allocated to either a training group (n=6) performing two weeks of HIT, or a control group (n=6). The HIT intervention involved 10 x 6 sec sprints separated by 1 min rest, 3 x per week for 2 weeks (totalling 6 sessions, with a total exercise time of 6min). Before and after 2 weeks of HIT or normal activity (control), participants completed a self paced 10km time trial and a time to exhaustion (TTE) test on a cycle ergometer. Blood lactate concentration was taken throughout the TTE using finger prick blood samples. **Results** Two weeks of HIT resulted in an 11% decrease in self paced 10km time trial (p= 0.004) but no change in time to exhaustion. The time taken to reach onset of blood lactate accumulation (OBLA, defined as the point where blood lactate reaches 4mmol.l<sup>-1</sup>) was significantly increased following 2 weeks of HIT (p = 0.004). Total work done in a 10 x 6 second training session was 50 ± 9 kJ, in comparison with 64 ± 13 kJ for a 4 x 30 second training session (p = 0.05) **Discussion** In the present study we demonstrate for the first time that only 3 minutes of high intensity exercise per week over two weeks significantly improves aerobic performance with an attenuation of blood lactate accumulation normally seen following longer duration of sprints (Burgomaster et al., 2005). Though not quantified, all participants reported lower perceptions of exertion following sprints of 6 second than typically observed in our laboratory during 30 second sprints. The similarity of response between the 6 and 30 second sprint training regimens suggests that the performance adaptation to HIT is likely to be driven by glycogen depletion. **In conclusion**, lower duration sprints are a viable alternative to 30 second sprints for promoting improved aerobic performance in triathletes. **References:** 1. Burgomaster KA, Hughes SC, Heigenhauser GJ, et al. *J Appl Physiol* 2005; 98: 1985-1990. 2. Babraj JA, Vollaard NBJ, Keast C, et al. *BMC Endocrine Disorders* 2009; 9:3.

### NO EXCESS VO<sub>2</sub> DURING WHOLE-BODY HIGH INTENSITY EXERCISE IN WELL-TRAINED CROSS-COUNTRY SKIERS

Björklund, G.1, Stöggl, T.1,2, Holmberg, H.C.1,3

1. *Mid Sweden University (Östersund, Sweden)*, 2. *University of Salzburg, (Salzburg, Austria)*, 3. *Swedish Olympic Committee (Stockholm, Sweden)*

**Introduction** Cross-country skiing competitions are performed close to 90% of VO<sub>2</sub>max (Mygind, Andersen, & Rasmussen, 1994). At this intensity O<sub>2</sub> extraction is close to its maximum in both arms and legs (Björklund, Stöggl, & Holmberg, 2010). Consequently, there is a limited possibility to further increase VO<sub>2</sub> at such a strenuous workload. However, an increased VO<sub>2</sub> has been reported during constant running speeds above the lactate threshold (Jones, Carter, & Doust, 1999). The aim of this study was thus to investigate whether VO<sub>2</sub> tends to increase during high intensity exercise that uses a large muscle mass. **Methods** Eight XC skiers (age 22±3yr; VO<sub>2</sub>max 69±3 ml•kg<sup>-1</sup>•min<sup>-1</sup>, obtained during diagonal stride (DIA) on a treadmill) performed a continuous protocol, of 3-min at 90% of DIA1 VO<sub>2</sub>max, 3-min at 90% of double poling (DP) VO<sub>2</sub>peak and a 3-min bout at 90% of DIA2 VO<sub>2</sub>max. Cardio-respiratory data was obtained continuously and determination of blood gases and metabolites from a. femoralis, v. femoralis and v. subclavia. Pole and plantar forces measured (Pedar Mobile, 100Hz) and EMG data from six lower and upper body muscles (Noraxon, 3000 Hz). One and Two-Way ANOVA were used to analyze data between the three different workloads. Alpha was set a priori to 0.05. **Results** VO<sub>2</sub> for DIA1 90% VO<sub>2</sub>max, DP 90% VO<sub>2</sub>peak and DIA2 90% VO<sub>2</sub>max, were 4.89 ± 0.13, 4.36 ± 0.49 and 4.99 ± 0.11 respectively. Lactate increased between DIA1, DP, and DIA2 with a greater increase in the femoral artery and vein (P<0.05). O<sub>2</sub> extraction was attenuated during DP (P<0.05) but remained constant during DIA1 and DIA2 (P>0.05). Sum average EMG and RMS over all muscles was lower during DP compared with DIA, with no difference between DIA1 and DIA2 (P<0.05). Peak pole force and RMS during DP was higher when compared to DIA (P<0.05). **Discussion** VO<sub>2</sub> was lower during DP compared to DIA, with no difference in VO<sub>2</sub> between the DIA workloads although there was a great increase in venous blood lactate in arms and legs as well as arterial blood throughout the protocol. Therefore our results do not support increased VO<sub>2</sub> above the lactate threshold when using a large muscle mass at a high exercise intensity. Muscle activation remained constant, as indicated by the absence of change in biomechanical characteristics, i.e. EMG in the indicator muscles, foot or plantar forces. The unchanged muscle activation along with VO<sub>2</sub> suggests that the work economy remained constant. **In conclusion**, in well trained cross-country skiers, VO<sub>2</sub> does not increase over time when both arms and legs are highly activated. Björklund, G., Stöggl, T., & Holmberg, H. C. (2010). *Med Sci Sports Exerc*, 42(10), 1899-1908. Jones, A. M., Carter, H., & Doust, J. H. (1999). *Med Sci Sports Exerc*, 31(9), 1299-1306. Mygind, E., Andersen, L. B., & Rasmussen, B. (1994). *Scand J Med Sci Sports*, 4(4), 243-251.

### THE EFFECT OF CARBOHYDRATE AVAILABILITY ON HIGH-INTENSITY INTERVAL RUNNING-INDUCED ALTERATIONS IN METABOLIC GENE EXPRESSION IN HUMAN SKELETAL MUSCLE

Bartlett, J.1, Joo, C.H.1, Cochran, A.J.2, Gibala, M.J.2, Gregson, W.1, Close, G.L.1, Drust, B.1, Morton, J.P.1

1. *Liverpool John Moores University* 2. *McMaster University*

**Introduction** Acute high-intensity interval run training (HIT) activates skeletal muscle signaling pathways associated with mitochondrial biogenesis (Bartlett et al. 2012). Performing HIT with reduced endogenous and exogenous carbohydrate (CHO) availability enhances the training-induced increase in skeletal muscle oxidative capacity (Morton et al. 2009) though the mechanisms underpinning enhanced adaptation remain unclear. We tested the hypothesis that performing acute HIT with reduced CHO availability before, during and after exercise enhances acute signaling and metabolic gene expression compared with traditional nutritional strategies advising CHO provision before, during and after exercise. **Method** Muscle biopsies (vastus lateralis) were obtained from eight active men pre-, post- and 3 h post- completion of an acute bout of HIT performed with normal (NORM) or low CHO availability (LOW). In NORM, subjects consumed 8 g/kg CHO in the day before exercise and were fed CHO 2 h before (2g/kg), during (1g/min) and hourly after exercise (1.2 g/kg/h). In LOW, subjects consumed 3 g/kg CHO the day before HIT, performed glycogen depleting exercise in the evening prior to HIT and also withheld CHO intake prior to, during and for 3 h after completion of HIT. **Results** Resting muscle glycogen was higher in NORM vs. LOW (374 ± 53

vs.  $103 \pm 9$ ;  $p=0.002$ ). Total CHO utilization was greater in NORM vs. LOW ( $177 \pm 6$  vs.  $122 \pm 9$  g;  $p=0.001$ ) and fat utilization was lower in NORM vs. LOW ( $8 \pm 0.2$  vs.  $23 \pm 3$  g;  $p=0.004$ ). PGC-1 $\alpha$  mRNA increased similarly 3 h following HIT (NORM:  $3.5 \pm 1.0$ ; LOW:  $3.0 \pm 0.5$ ;  $p=0.06$ ) with no difference between conditions ( $p=0.58$ ). Resting PDK-4 mRNA increased 40-fold in LOW ( $p=0.03$ ), a difference which persisted after HIT ( $p=0.01$ ). There were no differences in GLUT-4, CPT-1 or SCO2 mRNA before or after exercise ( $p>0.05$ ). Discussion Reduced CHO availability does not regulate contractile-induced PGC-1 $\alpha$  expression, suggesting this transcriptional co-activator may not regulate the enhanced training adaptation observed following low glycogen training. Reduced CHO availability augments lipid oxidation which may be due to early regulation of the pyruvate dehydrogenase complex. Biopsy samples are currently being analyzed to examine for phosphorylation of AMPK, p38MAPK and p53. References Bartlett JD, Hwa Joo, C, Jeong, TS, Cochran, AJ, Gibala, MJ, Gregson, W, Close, GL, Drust, B, Morton, JP. (2012). *J Appl Physiol*. In Press Morton, JP, Croft, L., Bartlett, JD., Maclaren, DPM., Reilly, T., Evans, L., McArdle, A. & Drust, B. (2009). *J Appl Physiol*, 106, 1513-1521.

### **SIMILAR INCREASES IN SKELETAL MUSCLE OXIDATIVE CAPACITY AFTER LOW-VOLUME HIGH-INTENSITY INTERVAL TRAINING IN THE FED VS. FASTED STATE**

Gillen, J.B., Percival, M.E., Tarnopolsky, M.A., Gibala, M.J.

*McMaster University*

**SIMILAR INCREASES IN SKELETAL MUSCLE OXIDATIVE CAPACITY AFTER LOW-VOLUME HIGH-INTENSITY INTERVAL TRAINING IN THE FED VS. FASTED STATE** Gillen, JB.1, Percival, ME.1, Tarnopolsky, MA.1, Gibala, MJ.1 1: McMaster University, Ontario, Canada Introduction Low-volume high-intensity interval training (HIT) induces physiological adaptations typically associated with high-volume endurance training (END) despite a dramatically reduced time commitment (Burgomaster et al., 2008). END performed in the fasted state is reported to improve oxidative capacity to a greater extent than fed-state training in young healthy men (Van Proeyen et al., 2011). Fasted state low-volume HIT may thus represent a potent, time efficient exercise strategy to increase skeletal muscle mitochondrial content. We tested the hypothesis that 6 wk of low-volume HIT performed in the fasted state would enhance mitochondrial enzyme activity and protein content to a greater extent than training in the fed state in overweight women. Methods Sixteen overweight women (age:  $27 \pm 8$  yr, BMI:  $29 \pm 6$  kg/m<sup>2</sup>, VO<sub>2</sub>peak:  $28 \pm 3$  ml/kg/min) performed 18 sessions of HIT over 6 wk in either the fasted (FAST) or fed (FED) state ( $n=8$  each). Following an overnight fast, subjects consumed a standardized breakfast 60 min prior to exercise (FED) or 30-60 min following HIT (FAST). Each session consisted of 10 x 1 min cycling efforts at ~90% maximal heart rate ( $177 \pm 26$  W) interspersed with 1 min of rest. Skeletal muscle biopsies (vastus lateralis) were obtained at rest prior to training and again 72 hr following the final training bout. Results Citrate synthase maximal activity increased after training with no difference between groups (FAST:  $4.6 \pm 0.5$  vs.  $5.7 \pm 1.0$ ; FED:  $5.0 \pm 1.2$  vs.  $6.2 \pm 1.2$  mmol/kg protein/hr;  $p=0.01$ , main effect for time). Similarly, protein content of COXII and COXIV increased after training (21 and 26%, respectively) but there was no difference between FAST and FED ( $p=0.05$ , main effect for time). The capacity for lipid oxidation, as reflected by  $\beta$ -hydroxyacyl-CoA dehydrogenase maximal activity, tended to increase to a greater extent in FAST ( $2.1 \pm 0.5$  vs.  $2.6 \pm 0.7$  mmol/kg protein/hr) compared to FED ( $2.0 \pm 0.4$  vs.  $2.2 \pm 0.4$  mmol/kg protein/hr), but the difference was not significant ( $p=0.01$ , main effect for time). Discussion Contrary to what has been reported after END in young healthy men, fasted-state training did not enhance HIT-induced increases in mitochondrial capacity in overweight women. This could be attributable to the relatively short nature the exercise sessions performed, i.e., 10 min of intense exercise within a 20 min time commitment, and/or differences in substrate utilization pattern during HIT as compared to END. It is also possible that in our group of untrained, overweight women, the potency of the HIT stimulus may have overshadowed any potential effects associated with the nutritional intervention. Burgomaster, K et al. (2008). *J Physiol* 586:151-160 Van Proeyen, K et al. (2011). *J Appl Physiol*, 110:236-245.

**09:50 - 11:20**

## **Invited symposia**

### **IS-PM06 Nutritional Supplementation and Sports: Hopes and Disappointments**

#### **ERGOGENIC POTENTIAL OF BETA-ALANINE: AN UPDATE FROM THE 2011 GHENT CARNOSINE CONGRESS**

Derave, W.

*Ghent University*

Despite the large variety of so-called ergogenic supplements used by the sporting community, only few of them are effectively supported by scientific proof. One of the recent evidence-based supplements that entered the market is beta-alanine. Beta-alanine is the rate-limiting precursor for the synthesis of the dipeptide carnosine (beta-alanyl-L-histidine) in human muscle. The chronic daily ingestion of beta-alanine can markedly elevated muscle carnosine content, which results in improved exercise capacity, especially in sports that include high-intensity exercise episodes. The use of beta-alanine is exponentially growing in recent years. A dedicated international scientific congress on 'Carnosine in Exercise and Diseases' was organized at Ghent University (Belgium) in July 2011. The science behind the ergogenic potential of beta-alanine received a lot of attention on this meeting. This information, together with more recent insights and advances since the Ghent 2011 meeting, will be summarized and discussed in this lecture.

#### **SUPPLEMENTS IN THE TRENCHES: A BEHIND THE SCENES LOOK AT THE AIS SUPPLEMENTS PROGRAM**

Burke, L.

*Australian Institute of Sport*

The sports world is filled with products that claim to enhance performance. Unfortunately, sports science research is generally unable to keep pace with the number of new products that appear on the sports market. While some sports foods and supplements can provide true value in the nutrition program of the athlete, the majority of supplements and sports foods are either untested or have failed to live up to expectations in the studies that have been conducted. This provides a challenge for those working with elite athletes who eagerly seek products or strategies that might enhance their performance by even small margins. This session provides an overview of the Sports

Supplement Program of the Australian Institute of Sport (AIS), which was developed to educate athletes and coaches about supplements and manage the provision of supplements to AIS athletes and teams [www.ausport.gov.au/ais/nutrition/supplements](http://www.ausport.gov.au/ais/nutrition/supplements)

### SCIENCE IN PRACTICE: A SPORTS NUTRITION CASE-STUDY IN ELITE MARATHONERS

Stellingwerff, T.

*Canadian Sport Centre - Pacific*

One facet to marathon success is the role that fueling/hydration intake plays on marathon success, which is not a prerequisite for optimal endurance success over shorter racing distances (<90 min, including cycling and triathlon). Further to this, contemporary scientific studies have started to examine how a periodic lack of carbohydrate availability may further drive training adaptations, how the gastro-intestinal tract may also be adapted, how certain supplements may be utilized and how an individualized recovery strategy can all enhance training and competition effectiveness. Thus, the primary aim of this case-study is to characterize (via actual field data collection), several training and nutrition interventions leading to an individualized race-day fluid and fuel plan with three world-class male marathon runners.

**09:50 - 11:20**

## Oral presentations

### OP-BN03 Motor Learning

#### TASK-SPECIFIC EFFECTS OF TDCS ON MOTOR LEARNING

Zhang, X., Saucedo, C.M., Robijns, A., Zabrzaska, M., Wenderoth, N.

*KU Leuven*

**Introduction** Anodal transcranial Direct Current Stimulation (tDCS) applied to the human primary motor cortex (M1) facilitates motor skill learning in both healthy controls [1–2] and patients [3–4]. However, it remains unclear whether tDCS improves motor learning in a general manner or whether its effect is task-specific. In this study, we tested the effect of tDCS in two different motor tasks: (1) an explicit sequence learning task and (2) a visually guided force control task. We hypothesized that anodal tDCS would facilitate motor learning in both tasks, with the specific nature of the improvement dependent on task type. **Methods** Thirty-two healthy subjects participated in this double-blind, sham-controlled cross-over designed study. All subjects were randomly assigned to an anodal-tDCS group or sham-group. We applied tDCS over the primary motor cortex (M1) while subjects performed the motor task. Two different sessions (session interval > 1 month) were performed, with the task-order randomized across participants. Motor training of each task consisted of 20 min training for 3 continuous days. Retention tests were performed on the final training day and one week after the training. Results Learning scores were calculated and compared using a mixed model ANOVA analysis. The results showed that for both tDCS groups there was an overall improvement of scores across training (\*\*p < 0.001). Anodal tDCS showed more improvement compared to sham, in both motor tasks, but not to a significant level. In the explicit sequence task, a significant interaction between the TIME of stimulation (pre, training, post, RT) and TYPE of stimulation (anodal/sham) was found (p = 0.01), with the greatest improvement by anodal tDCS being at the 20 min retention test (p = 0.01). On the other hand, the visually guided control motor task showed the greatest improvement in the 1 week retention test (p = 0.03). **Conclusion** These findings suggest that anodal tDCS does lead to an increase in motor learning, most likely by improving consolidation. Further, the exact expression of this effect seems to be dependent on the motor task itself. **References** 1. Reis J, (2009), 'Noninvasive cortical stimulation enhances motor skill acquisition over multiple days through an effect on consolidation'. *Proc Natl Acad Sci*, 106:1590-1595 2. Boggio PS, (2006), 'Enhancement of non-dominant hand motor duction by anodal transcranial direct current stimulation'. *Neurosci Lett*, 404:232-236 3. Hummel F, (2005), 'Effects of non-invasive cortical stimulation on skilled motor function in chronic stroke', *Brain*, 128: 490-499 4. Boggio PS, (2007), 'Repeated sessions of noninvasive brain DC stimulation is associated with motor function improvement in stroke patients'. *Int J Neuropsychopharmacol*, 11:249-254

#### FUNDAMENTAL MOVEMENT SKILL PERFORMANCE IN RELATION TO FAMILY CHARACTERISTICS, PARENTAL BEHAVIOUR, PARENTAL BELIEFS AND ENVIRONMENTAL CHARACTERISTICS IN PRESCHOOL CHILDREN

Cools, W., De Martelaer, K., Andries, C., Vandaele, B.

*Vrije Universiteit Brussel*

Cools W. 1,3, De Martelaer K.1, Andries C.2, Vandaele B.1 1 VUB/LK (Brussels, Belgium), VUB/PE (Brussels, Belgium) 3 VUB/IDLO (Brussels, Belgium) **Introduction** As the development of fundamental movement skills plays an essential role in the development of a fit and healthy lifestyle, it is important to understand the factors related to this development. The purpose of this study was to investigate main effects of family socialization processes on movement skill competence of 4 to 6-year-old preschool children. This study also explored whether the relationship between movement skill performance and those processes was moderated by gender. **Methods** A sample of 846 preschool children (471 boys, 375 girls) between 4 and 6 years of age participated in this study. Movement skill performance was assessed with the Motoriktest für Vier- bis Sechsjährige Kinder (MOT4-6). Data on the children's family context (concerning family characteristics, parental behaviour, parental beliefs, and environmental characteristics) were collected using self-administered parental surveys. All data were analysed using a moderated multiple regression analysis. Results The models all showed significant main effects and explained between six and eight per cent of the variance. Significant variables showing a positive relationship with children FMS competence were: father's and mother's education (family characteristics); frequency of providing new equipment; father's PA, the use of active transport (parental behaviours); relative importance of motor development; parental value of the child's physical activities (parental beliefs) and population density (environmental characteristic). Parental rating the importance of a child's sleep as well as parental inquiry on children's motor development with the preschool teacher were inversely correlated with preschool children's movement skill performance. No moderating effect was found for gender. **Discussion** The study demonstrated that several factors relate to the complex development of fundamental movement skills in preschool children. The results also underline that relationships may differ according to specific per-



formance areas (locomotion, stability and object control) in preschool children. All different models showed agreement on the association between low FMS performance and lower educated parents. Therefore these children in particular should be focused for interventions and efforts to lower participation barriers in the current offer are recommended.

### HOW MOVEMENT SONIFICATION ENHANCES MOTOR PERCEPTION

Effenberg, A.O., Schmitz, G., Münte, T.

*University of Hanover, University of Hanover, University of Lübeck*

Introduction: Efficiency of additional movement sonification on motor perception and control is documented by a growing number of studies, but there is still sparse knowledge on the functional background of audiovisually integrated gross motor motion perception [1]. Here some data about perceptual effects of audiovisual motion perception are reported and supplemented by a related fMRI study indicating clear differences on the processing of audiovisually divergent vs. audiovisually convergent stimuli. Method: 72 students (35F, 37M, 24.8 ±3.8 years) should estimate velocity differences of a swimmer on two consecutive stimuli each trial (study 1). Visual stimulus component consisted of a volume model feeded with kinematic data of a world class athlete. Congruent auditory stimuli (AV\_con) consisted of a movement sonification based on two kinematic parameters (relative distance of wrist joints to pelvis, relative distance between ankle joints and pelvis). The divergent auditory stimuli (AV\_div) combined two chords of the same timbre and frequencies as AV\_con. Relative velocity of the audiovisual stimuli (100%) was varied fivefold (98%, 94%, 92%, 90%, 88%) to achieve subtle temporal variations of swimming frequency. Temporal variations were reduced to 98%, 94% and 92% in the scanner session (study 2) due to task requirements. Results: Two-way ANOVA reveals that different treatments effect significantly absolute error (AE), constant error (CE) and Variable error (VE) (AE:  $F(3,207)=21.17, p<0.001, \eta^2=0.23$ , CE:  $F(3,207)=29.18, p<0.001, \eta^2=0.30$ , VE:  $F(3,207)=32.82, p<0.001, \eta^2=0.32$ ), as well as the treatment\*group interactions (AE:  $F(6,207)=8.49, p<0.001, \eta^2=0.20$ , CE:  $F(6,207)=4.38, p<0.001, \eta^2=0.11$ , VE:  $F(6,207)=10.22, p<0.001, \eta^2=0.23$ ). Within-group comparisons reveal that variable errors were significantly lower in purely auditory and AV\_con treatments than in purely visual and AV\_div treatments (post hoc test of treatment: all  $p<0.001$ ) (study 1). Univariate analysis on our fMRI data revealed an increased activation for congruent relative to incongruent stimuli for superior and medial posterior temporal regions, for the insula bilaterally and for the right precentral gyrus (study 2). Discussion: Behavioral data again indicate that motion perception is enhanced by convergent multi-sensory information. Additional functional data confirm the behavioral findings: The superior temporal region is involved in multisensory integration which is usually correlated to enhanced perceptual performance. Further research is required to explore in detail neural mechanisms perceiving audiovisually gross motor motion. [1] Scheef, L. et al. (2009). Multimodal motion processing in area V5/MT: Evidence from an artificial class of audio-visual events. *Brain Research*, 1252, 94-104.

### SPORT-SPECIFIC VIDEO-BASED REACTIVE AGILITY TRAINING IN RUGBY UNION PLAYERS

Engelbrecht, L., Welman, K.E., Terblanche, E.

*Stellenbosch University, South Africa*

Introduction In rugby union, players are constantly faced with a dynamic environment. Hence successful play requires a quick and accurate interpretation and response to these changing situations. Evasive reactive agility (RA) manoeuvres could lead to successful tackle breaks and advancing beyond the advantage line. More so RA can distinguish between higher and lesser skilled athletes (Wheeler et al., 2010). Purpose The study set out to investigate the effectiveness of a sport-specific video-based RA training programme for rugby union players in comparison to a field-based training programme. Methods 26 male rugby union players (18-24 years) participated in the study and were randomly divided into video-training (VT), field-training (FT) or control (C) groups. VT sessions included viewing and physically reacting to rugby attacking scenarios displayed on a 2.0m x 1.5m screen. FT sessions consisted of drills that included decision-making scenarios and mini-games. The players completed a 6 week intervention programme of 2 sessions per week. Anthropometrical measurements (height, body mass, % body fat, % lean body mass), linear speed, change of direction speed and RA, were assessed pre and post intervention and after 6 weeks to assess retention. Results Both VT and FT improved RA compared to C, with differences in the training effect of 13% (+6) and 17% (+4), respectively ( $p<0.01$ ). FT is possibly better than VT to improve RA (3+4%). Both training interventions were able to maintain its improvements in RA following the retention period. Discussion VT and FT produced significant improvements in RA performance of rugby union players. These changes were also significantly greater than with rugby training alone (C), indicating that short-term exposure to RA training may lead to improved RA performance. The improvements seen in the VT group was in accordance to the results of Serpell et al. (2011). The inclusion of mini-games in the FT group may have exposed the players to more decision-making scenarios than in VT, which may explain the slightly greater gains in RA in the FT group. Gabbett (2006) also found that skill-based conditioning games significantly improved rugby league players' attacking ability, which may be due to increased ability to read patterns of play. Conclusion VT and FT are valid sport-specific methods for conditioning RA in rugby union players. VT can be used as an effective alternative conditioning method or add-on to improve RA in rugby union. References Gabbett, T.J. (2006). *Journal of Strength and Conditioning Research* 20(2), 309-315. Serpell, B.G., Young, W.B., Ford, M. (2011). *The Journal of Strength and Conditioning Research* 25(5), 1240-1248. Wheeler, K.W., Askew, C.D., Sayers, M.G. (2010). *European Journal of Sport Science* 10(4), 237-242.

### AUGMENT YOUR JUMPS WITH AUGMENTED FEEDBACK: SHORT- AND LONG-TERM EFFECTS

Keller, M., Lauber, B., Leukel, C., Gehring, D., Taube, W.

*University of Fribourg*

AUGMENT YOUR JUMPS WITH AUGMENTED FEEDBACK: SHORT- AND LONG-TERM EFFECTS Keller, M.1, Lauber, B.2, Leukel, C.1&2, Gehring, D.2, Taube, W.1 1: SMS (Fribourg, Switzerland), 2: IfSS (Freiburg, Germany) Introduction Augmented feedback (aF) is ever since accepted as a vital tool when learning or improving a motor skill. In long-term studies, subjects who received aF displayed greater increases in performance than controls. For example, service speed in tennis increased significantly more in a group that trained with aF (1). Furthermore, aF was shown to instantly influence motor performance so that subjects directly enhanced their force production in the presence of aF (2). As it seems unlikely that subjects have learnt to enhance force production within a few seconds, motivation seems to be influenced by aF. So far, all previous studies focused either on a short-term or a long-term effect. No previous study surveyed the influence of short-term and long-term effects in one study. The present study evaluates the interrelation of short-term (aF within one training session) and long-term effects (aF over 12 training sessions) of aF (jumping height) in drop jumps. Furthermore, to test whether the feedback frequency can potentially influence the training adaptation, three training groups with different frequencies of aF were tested. Methods and Results Subjects (n=36) were assigned to three training groups. One group received aF after every drop jump (100% group), a second group after

half of their jumps (50% group) and the 0% group trained without any aF. Short-term effects were analysed by comparing maximum drop jumps with and without aF from the pre-test (n=10). Significant differences were found for the jump height (JH; +4.6%;  $p < 0.01$ ) and the performance index (PI; +5.6%;  $p < 0.01$ ). Long-term adaptations were analysed by comparing pre to post data. Significant increases ( $p < 0.05$ ) as a function of aF frequency were found for JH (100% group: +18.1%; 50% group: +8.3%; 0% group: +4.7%) and PI (100% group: +22.5%; 50% group: +4.4%; 0% group: +5.3%). Discussion Short-term effects: Our data show that aF instantly enhances motor performance, i.e. from the first trial onwards. Thus, providing aF most likely motivated subjects to perform jumps with higher intensities. Long-term effects: The results show that a higher feedback frequency resulted in higher performance gains. It might be speculated that aF helped to differentiate better from worse trials and therefore guided learning. Alternatively, based on the short-term results it could be speculated that subjects were better motivated and thus, performed the drop jumps with higher intensity in trials with aF. This higher intensity may have augmented training outcome. Even though the exact mechanism(s) cannot be pointed out, the use of aF in the training of drop jumps effectively enhances performance gains. References (1) Moran K et al. (2011). *Med Sci Sports Exerc*, Epub. (2) Peacock B et al. (1981). *Ergonomics*, 24, 223-228

## EFFECT OF BALANCE TRAINING ON MUSCLE ACTIVITY AND JOINT MOMENTS DURING PERTURBED CUTTING MOVEMENTS

Oliveira, A., Silva, P.B., Farina, D., Kerting, U.G.

*Aalborg University*

Introduction: Many sports activities involve cutting movements which have been linked to injuries. The ankle and knee joints are particularly at risk when a sudden environmental change perturbs the planned movement. In order to reduce injury incidence, balance training has been used successfully in the past. However, the mechanisms that reduce the risk of injury at the moment of a threat are not completely understood. Therefore the aim of the present study was to verify the effects of balance training on postural reactions to sudden perturbations while cutting. Methods: Twenty-three subjects were randomly assigned to a control group (n=10) and a training group (n=13). The pre- and post-training measurements were based on electromyography (EMG), full-body kinematics and ground reaction force data collected during cutting movements. Subjects were asked to perform 10 cutting movements stepping with the right leg over a moveable force platform. Following these trials, the next trial was set for the force platform to elicit a unexpected rapid movement (10cm at 42cm/s) triggered by foot contact. Integraed EMG (iEMG) from vastus lateralis (VL), biceps femoris (BF), adductor longus (AD) and gluteus maximus (Gmax) as well as knee flexion moment (KFM) were calculated during the absorption period of stance phase (PRP). After pre-test the TG subjects performed six weeks of balance training (single standing on a soft mat/wobble board) for the right leg. Differences between groups and training (pre x post) were accessed by t-Student tests at a significance level of  $p < 0.05$ . Results: sudden perturbations do not alter VL iEMG before and after training for both TG and CG. Before training iEMG was significantly reduced during perturbations for BF (~22%), AD (~17%) and Gmax (~24%) for both TG and CG ( $p < 0.05$ ). After balance training, TG exhibited lower EMG reduction due to perturbations for BF (~6%,  $p = 0.2$ ), no changes for AD (~1%,  $p = 0.34$ ) and increased iEMG for Gmax (~9,  $p = 0.15$ ). In addition balance training induced KFM reduction (~20%,  $p < 0.05$ ) for both normal and perturbed cuttings. The CG showed a similar pattern as in the pre-test, with reduced EMG for BF (~16%,  $p < 0.05$ ), AD (~15%,  $p < 0.001$ ) and Gmax (~10,  $p = 0.11$ ), but no changes in KFM in the post-test. Discussion: This is the first study to indicate that balance training improves postural responses during perturbed cuttings. The substantial reductions on iEMG due to perturbations reveal that some presumably protective mechanisms [1] might not occur during a sudden slip, increasing injury risks especially for the knee. Balance training may have increased muscular coordination and facilitated neural drive, keeping muscular stabilization during the perturbation events. At the same time an improved landing strategies that reduce KFM. In conclusion, balance training is effective in improving muscular recruitment for hip and knee muscles, as well as reducing knee moments during sudden perturbations resembling slip episodes during cutting. [1] Zebis et al. (2009). *Am J Sports Med*, 37, 1967-1973.

09:50 - 11:20

## Oral presentations

### OP-PM09 Measurement and analysis techniques

## BREATH SOUND ANALYSIS AS A SURROGATE FOR GAS EXCHANGE MEASUREMENT OF VENTILATORY AND RESPIRATORY COMPENSATION THRESHOLDS

Foster, C.1, Yee, N.B.2, Stamatopolous, C.2, Nacy, G.3

*1University of Wisconsin-La Crosse, USA, 2 Breath Research, Inc, USA, 3 Cycling Fusions, Inc, USA*

Introduction The measurement of the ventilatory (VT) and respiratory compensation (RCT) thresholds using respiratory gas exchange is a standard diagnostic tool in exercise laboratories and is capable of defining important markers of sustainable exercise capacity, which may then be linked to the power output (PO) or heart rate (HR) response for training prescription. Measurement of respiratory gas exchange is cumbersome and expensive. However since it is grounded in the volume, rate and pattern of breathing, it is theoretically possible to use high quality microphones to listen to breath sounds at the mouth, and to derive estimates of VT and RCT. This study represents pilot data designed to test this concept. Methods Well-trained non-athletes (PPO=241+25W) performed incremental cycle ergometer exercise (3 min stages) with measurement of respiratory gas exchange to define VT and RCT. They also exercised with measurement of respiratory rate, audio intensity and inhalation-exhalation ratio captured by a microphone positioned 5 cm in front of the mouth. VT and RCT were estimated from the audio data using an algorithm that combined information from the audio recordings. Results There were no significant differences in the mean values for PO at VT and RCT for Gas Exchange vs Breath Sound Analysis (176+34 vs 191+49W and 222+42 vs 226+48W, for combined PO data the  $R^2 = 0.69$ ). Similarly, there were no significant differences in the mean values for HR at VT and RCT for Gas Exchange vs Breath Sound Analysis (151+13 vs 145+17bpm) and 167+11 vs 164+11bpm, for the combined HR data the  $R^2 = 0.63$ ). Discussion The present results provide the first evidence that a comparatively simple algorithm derived by analyzing breath sounds (respiratory rate, audio intensity and inhalation-exhalation ratio) can identify the VT and RCT during incremental exercise, without the necessity for the technically more demanding analysis of respiratory gas exchange.

### MONITORING BRAIN TEMPERATURE – A CRITICAL THRESHOLD THAT CONTROLS CENTRAL FATIGUE?

Stahn, A.1, Krell, J.2, Benzinger, S.2, Boes, K.1, Kupka, D.1, Opatz, O.1, Steinach, M.1, Werner, A.D.2, Sattler, F.3, Koch, J.3, Gunga, H.C.1

1: Center for Space Medicine, Charité (Berlin, Germany), 2: Karlsruhe Institute of Technology (Karlsruhe, Germany), 3: Draegerwerke (Luebeck, Germany)

**Introduction** Hyperthermia has been suggested to control central fatigue by a threshold temperature (critical limiting temperature, CLT) and/or selective brain cooling, having a neuroprotective effect against lethal heat stress. Recently, however, the role of these mechanisms has been questioned (Marino 2011). Previous studies in this field have been limited to small sample sizes due to technical difficulties and inconveniences associated with core body temperature measurements such as rectal or esophageal recordings. In addition, present temperature monitoring technologies might not accurately reflect brain temperature, and specifically temperature in the hypothalamus where the center of thermoregulation is located. We therefore introduced a new non-invasive heatflux technology for determining core body temperature at the forehead (Gunga et al. 2009; Stahn et al. 2011). The aim of the present study was therefore to investigate whether there is a consistent CLT determined close to the hypothalamus during intense exercise in a large sample of young men and women with varying degrees of maximal aerobic capacity. **Methods** A total of 64 young subjects (43 men, 21 women) completed a graded maximal exercise until volitional exhaustion on a bicycle ergometer. In addition to oxygen uptake (breath-by-breath) core body temperature was continuously determined using a new non-invasive heatflux sensor (Double Sensor) positioned at the forehead. Results Average CBT at the time of exhaustion was 40.2 °C with men displaying slightly, but significantly higher CBT than women (40.3 vs. 39.9 °C,  $P < 0.05$ ). ANCOVA revealed that this difference could be attributed to higher maximal aerobic capacity in men. Comparing high and low fit subjects irrespective of gender demonstrated that CBT was significantly higher at submaximal (60% and 80%  $\dot{V}O_{2max}$ ) and maximal exercise (40.6 vs. 39.7 °C,  $P < 0.001$ ). In addition, CBT demonstrated a linear increase as a function of maximal aerobic capacity ( $r = 0.53$ ;  $P < 0.001$ ). **Discussion** While volitional exhaustion was reached around 40 °C irrespective of initial CBT and its rate of increase, suggesting a consistent CLT there was considerable variation in CBT between subjects. In addition this variation was characterized by a positive linear relationship between CBT during maximal exercise and maximal aerobic capacity. These data suggest that either subjects may adapt to higher levels of heat stress by increasing CLT or that neuroprotection from heat stress might not be the primary cause per se for the discontinuation of vigorous physical activity (Marino 2011). **References** Gunga HC, Werner A, Stahn A, Steinach M, Schlabs T, Koralewski E, Kunz D, Belavy DL, Felsenberg D, Sattler F, and Koch J (2009). *Respir Physiol Neurobiol*, 169, S63-68. Marino FE (2011). *Int J Hyperthermia*, 27, 582-590. Stahn A, Mendt S, Steinach M, Opatz O, Werner A, Kunz D, Belavy DL, Felsenberg D, Sattler F, and Koch J. Proceedings of the 62nd International Astronautical Congress 2011.

### A PRACTICAL SUBMAXIMAL TEST TO PREDICT MAXIMAL RUNNING PERFORMANCE IN THE HEAT

Lambert, M.1, Mann, T.N.1, Marino, F.E.2

University of Cape Town

**Introduction** The aim was to predict running performance in the heat from changes in heart rate, rectal temperature and perceived exertion during submaximal running in cooler conditions. **Methods** Twelve highly trained male distance runners were recruited for the study ( $24.2 \pm 3.5$  yrs). Subjects were tested on 3 separate days with a 30 min submaximal test followed by a 5 min rest and then a maximal self-paced 8 km time trial. The tests were randomised in either cool (15°C), moderate (25°C) or hot (35°C) conditions. Results Heart rate (HR) at the end of the submaximal trial during 15°C ( $154 \pm 10$  b/min) was significantly less than HR at the end of 25°C ( $161 \pm 9$  b/min) and 35°C ( $176 \pm 13$  b/min) ( $p < 0.003$ ). Running performance was impaired by  $13 \pm 5$  % in the hot conditions (range 2–21%). The best predictor of the decrement in running speed in 35°C was the increase in HR during the submaximal test (25 vs. 35°C) ( $r = -0.91$ ; 95% CI: -0.98 to -0.62). **Conclusion** The subjects who had the greatest increase in HR during the submaximal test (25°C vs. 35°C) were more likely to have had the greatest decrement in performance when exercising at high intensity in the 35°C.

### APPLYING LACTATE ANALYSIS TO INTERVAL TRAINING IN CORONARY HEART DISEASE

Christle, J.W.1, Wisloff, U.2, Pressler, A.1, Halle, M.1

1: Technical University of Munich (TUM), 2: Norwegian University of Science and Technology

Christle, J.W.1; Wisloff, U.2, Pressler, A.1; Halle, M.1 1: Technical University of Munich (TUM), Preventive and Rehabilitative Sports Medicine (Munich, Germany), 2: Norwegian University of Science and Technology, Department of Circulation and Medical Imaging (Trondheim, Norway) **Introduction** Relatively high-intensity aerobic interval training (AIT) has been shown to be effective in coronary artery disease (CAD) therapy (Rognmo et al, 2004; Cornish et al, 2011). Methods used to prescribe and monitor training intensity during interval training, percent heart rate (%HR) and ratings of perceived exertion (RPE) from exercise testing (CPET) have some limitations. Therefore the potential of arterial lactate kinetics to aid in the prescription and monitoring of exercise intensity during AIT were investigated. **Methods** Thirty-five clinically stable CAD patients (age  $64 \pm 7$ , 66% male) performed symptom-limited CPET to volitional exhaustion. Heart rates at 50%-60% and 80%-90% of peak aerobic capacity ( $\dot{V}O_{2peak}$ ) were calculated and used to establish interval training intensities. Patients performed one bout of AIT, during which HR, RPE and arterial blood lactate data were collected in the last 10 seconds of every interval. The kinetics-curves for lactate concentrations were compared to HR, RPE as well as a 4.00 mmol/L lactate steady-state threshold (Heck et al, 1985)LSST). Results Heart rate and RPE intensity targets were reached in over 85% of all intervals. Mean lactate was substantially over the 4.00 mmol/L LSST in both moderate-intensity phases (4.14 mmol/L) and high-intensity phases (4.65 mmol/L), and increased throughout the training bouts. Data for HR and RPE correlated well to changes in load (watts) during exercise training ( $r_2 = 0.953$  and  $0.978$ , respectively;  $p < 0.01$ ), whereas arterial lactate concentrations showed very poor and insignificant correlations to intensity parameters (watts:  $r_2 = 0.280$ ,  $p = 0.466$ ; RPE:  $r_2 = 0.407$ ,  $p = 0.277$ ; HR:  $r_2 = 0.548$ ,  $p = 0.126$ ). **Discussion** During aerobic interval training, an accumulation of lactate in both the high and low interval-phases results in the majority of training being performed at above the lactate steady state threshold. Arterial blood lactate kinetics do not match HR or RPE during aerobic interval training. **References** Rognmo O, Hetland E, Helgerud J, Hoff J, Slordahl SA (2004). *EJCPR*, 11, 216-222. Cornish AK, Broadbent S, Cheema BS (2011). *Eur J Appl Physiol*, 111(4), 579-589. Heck H, Mader A, Hess G, Muecke S, Mueller R, Hollmann W (1985). *Int J Sports Med*, 6, 117-130.

## NEAR INFRARED SPECTROSCOPY FOR NONINVASIVE ASSESSMENT OF VASCULAR AND MICROVASCULAR DISORDERS IN TYPE 1 DIABETES

Tagougui, S., Leclair, E., Fontaine, P., Matran, R., Marais, G., Oussaidene, K., Rasohamanana, P., Vambergue, A., Heyman, E.

*university Lille2*

Near Infrared Spectroscopy for noninvasive assessment of vascular and microvascular disorders in type 1 diabetes Semah TAGOUGUI, Erwan LECLAIR, Pierre FONTAINE, Régis MATRAN, Gaëlle MARAIS, Kahina OUSSAIDENE, Patrick RASOHAMANANA, Anne VAMBERGUE, Elsa HEYMAN Univ Lille Nord de France, EA 4488: physical activity – muscle – health, Lille, FRANCE INTRODUCTION Recently the Near-infrared spectroscopy (NIRS) technique has been used to identify peripheral vascular disease (Hamoka et al. 2011). Diabetes is one major risk factor for development of vascular disorders (Akbari et al. 1999). Pichler et al. (2004) using NIRS during a localized exercise (handgrip) found that patients with Type 1 diabetes (T1D) had lower forearm blood flow (reflected by HbO<sub>2</sub>) than healthy controls. The aim of this study was to measure oxygenation near vastus lateralis during a bicycle maximal exercise involving a large muscle mass to detect any possible vascular alterations in T1D without any overt complications. METHODS Six T1D with adequate glycaemic control (T1D-A) (HbA<sub>1c</sub><6.8 %) and two T1D with an inadequate glycaemic control (T1D-I) (HbA<sub>1c</sub> >8.7%) were compared to seven healthy subjects matched on physical activity level (accelerometry, questionnaires) and body composition (DEXA). All subjects performed an incremental exercise test to exhaustion to determine maximal oxygen uptake (VO<sub>2</sub>max). The NIRS uses laser light to calculate relative concentration changes in oxy-haemoglobin (HbO<sub>2</sub>), deoxy-haemoglobin (HHb) and total haemoglobin (tHb) near the vastus lateralis muscle. RESULTS VO<sub>2</sub>max levels did not differ between T1D-A or T1D-I and healthy subjects. tHb and HbO<sub>2</sub> were comparable between T1D-A and healthy subjects, while they were reduced from beginning of exercise in T1D-I suggesting a problem of muscle perfusion. Moreover, the increase in HHb during exercise was considerably delayed in T1D-I (with high HbA<sub>1c</sub>) appearing after 40% of VO<sub>2</sub>max (vs. about 20% of VO<sub>2</sub>max in the T1D-A and healthy subjects). No inter-group differences in blood 2,3DPG or pH were detected. This supports the hypothesis that glycation of hemoglobin may reduce oxyhaemoglobin dissociation. DISCUSSION NIRS could be an interesting method to detect subclinical problems of muscle perfusion and oxygenation during exercise in T1D patients without overt micro or macrovascular complications. REFERENCES Akbari CM, LoGerfo FW. Diabetes and peripheral vascular disease. *J Vasc Surg* 30:373-84, 1999. Hamaoka T, McCully KK, Niwayama M, Chance B. The use of muscle near-infrared spectroscopy in sport, health and medical sciences: recent developments. *Philos Transact A Math Phys Eng Sci* 28: 4591-604, 2011. Pichler G, Urlesberger B, Jirak P, Zotter H, Reiterer E, Müller W, Borkenstein M. Reduced forearm blood flow in children and adolescents with type 1 diabetes (measured by near-infrared spectroscopy). *Diabetes Care* 27: 1942-6, 2004.

## EVALUATION OF A NEW APPROACH IN CYCLING POWER MEASUREMENT

Bruch, A., Bruch, H., Stapelfeldt, B.

*Albert-Ludwigs-Universität Freiburg*

Introduction: Traditionally power in cycling is measured at the crankset (SRM-system). Accuracy of the SRM system was tested in several studies (1). A new approach measures power output (PO) from technology attached to bike pedals. This Polar Look Keo Power system (Look Cycle International S.A., Never Cedex, France and Polar Electro Oy, Kempele, Finland) uses strain gauges on the pedal axis to measure the tangential pedal force. With known crank length and cadence power could be calculated. It is unknown, if this new principle is a valid and accurate method to measure cyclist's power. This study's aim is to compare a pedal based power-measuring system (PB) with a bottom bracket based measuring system (BBB) both in indoors and outdoors cycling. Methods: In an indoor lab-test a SRM cycle ergometer (SRM, Jülich, Germany) was equipped with a SRM-system and a Polar Look Keo Power system. 12 elite male cyclists (29,5 ± 4,7yrs; 77,1 ± 4,5kg) underwent a standardized incremental exercise test starting at 100W and increasing 20W every 3 minutes. Power was measured simultaneously with both systems throughout the complete test. The mean 60 sec value in the middle of each step was taken into results. In a second test conducted outdoors both systems were mounted on a race bike. Subjects performed a 2.9 km uphill time trial (TT). Mean PO data from 5 minutes at the beginning, middle and end of the TT was taken into consideration. Comparisons of PO were performed using Bland and Altman's 95% limits of agreement (2). Results: Maximum PO indoors was 420W and all subjects completed at least 300W. With an r-square of 0.997 a significant correlation between the two systems was revealed. The mean ± 2SD difference between PB and BBB was 8.0 ± 9.6 W (3.5 ± 4.2%). During the TT average PO of study group was 331W with mean ± 2SD power difference between PB and BBB of -7.4 ± 17.4W (-2.3 ± 5.5%). Conclusion: In the lab-test PB power method measured slightly higher values than BBB method and in the TT PB method measured less than BBB. The level of agreement in both conditions was sufficient based on previous studies suggesting that the difference in power measurements methods should be less than 5% (3). Therefore the pedal based power measurement system can be recommended as a method for monitoring performance in cycling. References: 1: Stapelfeldt et al. (2007). Development and evaluation of a new bicycle instrument for measurements of pedal forces and power output in cycling. *Int J Sports Med*, 28, 326-332. 2: Bland JM, Altman DG. (1986). Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*, 1: 307-310. 3: Van Praagh et al. (1992). A simple calibration method for mechanically braked cycle ergometers. *Int J Sports Med*, 13, 27-30.

09:50 - 11:20

## Oral presentations

### OP-PM10 Sports Medicine/Exercise Therapy

#### EFFECTS OF DIFFERENT TYPES OF ACUTE AND CHRONIC EXERCISE ON GLYCAEMIC CONTROL IN TYPE 1 DIABETES – A META-ANALYSIS.

Tonoli, C.1,2, Heyman, E.2, Roelands, B.1, Buyse, L.1, Cheung, S.3, Berthoin, S.2, Meeusen, R.1

*Vrije Universiteit Brussel. 1: VUB (Brussels, Belgium), 2: UL (Lille, France), 3: BU (Ontario, Canada).*

Introduction: Exercise has been accepted and generally recommended for the management of type 1 diabetes (T1D) and for improving the overall quality of life in affected individuals. In addition to increasing aerobic fitness, reducing cardiovascular risk factors, and reducing body weight and body fat, physical activity develops and maintains chronic glycaemic control. Exercise stimulates insulin sensitivity, muscle glucose uptake and improves insulin flexibility. This meta-analysis was conducted to determine the overall effects of exercise on acute and chronic glycaemic control and the conditions (frequency, intensity ...) which are required to obtain these effects in T1D patients. Methods PubMed, ISI Web of Knowledge and SPORTDiscus were consulted to identify studies on Type 1 Diabetes (T1D) and exercise. Cohen's d statistics were used for calculating effect sizes (ES), with effect sizes (d) defined as small = 0.3, medium = 0.5 and large = 0.8. Ninety-five percent confidence intervals (95% CIs) were used to establish the significance of our findings. Results From a total of 937 studies, 33 that met the inclusion criteria were selected. ES for exercise on acute glycaemic control were large, while they were small for chronic glycaemic control. Aerobic exercise, resistance exercise, mixed exercise (aerobic combined with resistance training) and high intensity exercise (HIE) decreased acute blood glucose levels. To prevent late onset hypoglycaemic episodes, the use of single bouts of sprints into an aerobic exercise can be recommended. This meta-analysis also showed that a regular exercise training program has a significant effect on acute and chronic glycaemic control, though, not all exercise forms showed significant results. Specifically, aerobic training is a favourable tool for decreasing chronic glycaemic control, while resistance training, mixed and HIE did not significantly decrease chronic glycaemic control. Conclusion. Aerobic training and strength training have different actions in the body and can therefore influence (acute and chronic) glycaemic control through different pathways. Based on this meta-analysis it is advised that regular aerobic exercise with the addition of bouts of HIE, strength exercise (or the combination of strength and aerobic exercise) will improve the glucose levels of T1D patients. Regular aerobic training will improve long term glycaetted haemoglobin.

#### EFFECTS OF HIGH INTENSITY TRAINING AND LONG SLOW DISTANCE TRAINING ON ENDOTHELIAL MICROPARTICLES AND ANGIOGENIC GROWTH FACTORS

Wahl, P.1, Achtzehn, S.1, Mester, J.1, Bloch, W.1, Werner, N.2

*German Sport University*

1: The German Research Centre of Elite Sport, German Sport University Cologne (Germany) 2: Department of Internal Medicine II, Cardiology, Pneumology and Angiology, Medical Faculty, University of Bonn (Germany). Introduction Endothelial microparticles (EMP) are complex vesicular structures shed from activated or apoptotic endothelial cells. They are considered to play a remarkable role in coagulation, inflammation, endothelial function, and angiogenesis. Besides their role as marker of cell damage, recent reports have underlined their role as signaling elements in cell-cell communication. It has been reported that profiles of EMP reflect endothelial status and that EMP are generated under certain blood flow conditions (shear stress). As endurance exercise alters the blood flow velocity and therefore shear stress at the vascular wall, the objective of the study was to examine changes in EMP following different endurance exercise protocols. Methods 12 subjects performed 3 different endurance exercise protocols: 1. LSD (120 min at 55% peak power output (PPO); 2. 4x4 min at 95% PPO; 3. 4x30 sec all out. For the determination of EMP, vascular endothelial growth factor (VEGF), migratory inhibiting factor (MIF) and hepatocyte growth factor (HGF) venous blood samples were taken pre, 0', 30', 60' and 180' after the interventions. EMPs were quantified (number/ $\mu$ l) using flow cytometry after staining platelet-poor-plasma with the cell surface markers CD31, CD42b and Annexin-V. Events positive for Annexin-V and CD31, and negative for CD42b, were classified as EMPs. Results All three interventions caused a significant decrease in EMP 60' and 180' post exercise compared to pre values. No differences between the interventions were observed. HGF significantly increased 180' after the 4x30 sec only. VEGF and MIF showed no significant changes. Discussion As exercise increases the blood flow/shear stress at the vascular wall, we expected EMP to be increased after endurance exercise, as increases in microparticles were described in diseases with altered shear forces in blood vessels. However EMP significantly decreased after exercise which might be due to an increased clearance from the circulation. Yet the mechanism of MP's clearance from the circulation is not known. It can be speculated that, EMP are taken up by active endocytosis in endothelial cells, as this process has already been described for platelet-derived microparticles modifying endothelial cell phenotype and function. Although a few other studies have investigated microparticles following exercise in humans, this has been the first to examine EMP, MIF and HGF after different endurance training regimes.

#### EXERCISE TRAINING IMPROVES CUTANEOUS MICROVASCULAR NITRIC OXIDE DYSFUNCTION IN PCOS WOMEN

Sprung, V.S., Cuthbertson, D.J., Pugh, C.J.A., Aziz, N., Kemp, G.J., Green, D.J., Cable, N.T., Jones, H.

*Liverpool John Moores University*

INTRODUCTION Polycystic ovarian syndrome (PCOS) is associated with a ~2 fold increased risk of coronary artery disease and a higher prevalence of hypertension in the post-menopausal period. Microvascular function contributes to hypertension by raising peripheral vascular resistance and arterial stiffness. However, the contribution of nitric oxide (NO) to cutaneous microvascular function in PCOS has not been previously explored. We hypothesised that PCOS women would exhibit impaired cutaneous microvascular NO function and that exercise training would induce an improvement. METHODS NO-mediated vasodilation in the cutaneous microvessels was examined in 11 PCOS women (29 $\pm$ 2yrs, 34 $\pm$ 2kg/m<sup>2</sup>) and 6 matched controls (29 $\pm$ 3yrs, 34 $\pm$ 2kg/m<sup>2</sup>) using laser Doppler flowmetry combined with intra-dermal microdialysis of L-NG-monomethyl arginine to assay the NO dilator system in response to incremental local heating of the forearm. Visceral and subcutaneous fat were quantified by whole body magnetic resonance imaging. Cardiorespiratory fitness, HOMA-IR and hormone profiles were also assessed. 6 PCOS women (30 $\pm$ 3yrs, 31 $\pm$ 2kg/m<sup>2</sup>) then undertook a 16-week exercise-training pro-

gramme. Upon completion, baseline measurements were repeated. Differences between PCOS and controls, and changes with exercise were analysed using t-tests. NO contribution to cutaneous blood flow in response to a heating stimulus was analysed using general linear modelling. Cutaneous blood flow data is presented as %CVCmax and all data are reported as mean $\pm$ SE. RESULTS PCOS and controls were matched for age, BMI, fat deposition and cardio-respiratory fitness ( $P>0.25$ ). NO contribution was attenuated in PCOS women at peak heating [42°C] ( $6.1\pm 4.3$  vs.  $16.4\pm 5.9\%$ CVCmax,  $P=0.06$ ) and during prolonged maximal heating [30 mins at 42°C] ( $1.4\pm 3.8$  vs.  $16.8\pm 5.8\%$ CVCmax,  $P=0.04$ ), compared with controls. Cardiorespiratory fitness improved by  $5\pm 1$  ml.kg $^{-1}$ .min $^{-1}$  following exercise training ( $P=0.03$ ). This was accompanied by increased NO contribution to cutaneous blood flow between 36.5-42°C ( $P<0.05$ ) and during prolonged maximal heating ( $1.4\pm 3.5$  vs.  $15.1\pm 6.6\%$ CVCmax,  $P=0.03$ ). DISCUSSION These novel findings indicate that cutaneous microvascular NO function is impaired in PCOS women compared with matched controls, and that exercise-training can up-regulate NO function in the cutaneous microcirculation in this population. Given that NO confers anti-atherogenic benefits, these data support the utilisation of exercise as a preventative strategy for microvascular dysfunction, and primary prevention for hypertension, in PCOS women.

## PHYSICAL TRAINING INFLUENCE THE SECRETION OF GASTRO-INTESTINAL HORMONES

Taudorf, L., Lund, M.T., Holst, J.J., Dela, F.

*University of Copenhagen*

**Introduction** There is an inverse relationship between insulin action and secretion. In athletes insulin sensitivity is higher compared with sedentary people, while the opposite is seen in glucose- and amino-acid induced insulin secretion. This is a remarkable adaptation of an endocrine gland to the level of fitness, and the mechanism behind is not fully known. With the discovery of the secretion of several new insulinotropic hormones from the gastro-intestinal (GI) tract the question: "Is there a global endocrine adaptation to physical training in the entire GI tract?", arise. **Methods** Ten trained (T) and ten untrained (UT) (max oxygen uptake:  $67\pm 2$  and  $42\pm 2$  ml $\cdot$ min $^{-1}$ kg $^{-1}$ , respectively) healthy men were included. Subjects, matched for age:  $25\pm 3$  and  $25\pm 3$  yrs and BMI:  $21\pm 2$  and  $22\pm 1$  kg $\cdot$ m $^{-2}$ , in T and UT respectively, reported to the lab after a 12h overnight fast. Here plasma concentrations of insulin, glucose, free fatty acids (FFA), glycerol, glucose-dependent insulinotropic peptide (GIP), glucagon-like-peptide-1 (GLP-1) and -2 (GLP-2), oxyntomodulin (OXM), obestatin (OBS), pancreatic polypeptide (PP), peptide YY (PYY) and total protein (PRO) were measured before and every 30 min for 180 min after ingestion of a liquid meal containing 1260 kJ (20g protein, 31g carbohydrates and 11g fat). **Results** There was no baseline difference in plasma concentration of insulin, glucose or GIP. Baseline GLP-1 ( $13.3\pm 1.1$  vs.  $10.2\pm 0.7$  pmol $\cdot$ l $^{-1}$ ) and OXM ( $1.2\pm 0.3$  vs.  $0.5\pm 0.1$  ng $\cdot$ ml $^{-1}$ ) plasma concentration were higher whereas GLP-2 ( $4.0\pm 0.2$  vs.  $4.5\pm 0.6$  ng $\cdot$ ml $^{-1}$ ), glycerol ( $56.3\pm 6.5$  vs.  $86.6\pm 11.4$   $\mu$ mol $\cdot$ l $^{-1}$ ) and FFA ( $371\pm 42$  vs.  $646\pm 79$   $\mu$ mol $\cdot$ l $^{-1}$ ) concentration were lower in T compared to UT. Insulin ( $11316\pm 800$  vs.  $18294\pm 1888$  a.u.), glucose ( $904\pm 31$  vs.  $988\pm 21$  a.u.) and GIP AUC ( $36212\pm 2543$  vs.  $52425\pm 3675$  a.u.) were significantly lower in T compared to UT. GLP-1, -2, OXM and Glycerol AUC defined as the increase measured from baseline (AUCinc) showed no difference between groups, but meal induced FFA suppression was lower (AUCinc:  $-39582\pm 6677$  vs.  $-70157\pm 9771$  a.u.) in T compared to UT. There was no difference in OBS, PP, PYY and PRO between groups. **Discussion** Here we confirm the well-established diminished insulin response in T vs. UT and the improved lipid tolerance in T. The GI hormones displayed a mixed response, with GLP-1 and OXM being higher at baseline in T, while the opposite was seen with GLP-2. GLP-1, -2 and OXM are all produced in the L-cell and interestingly none of the AUCinc differed between groups. Baseline GIP levels did not differ between groups, but AUC was higher in UT compared to T. Thus, it seems the L- and K-cells exhibit a difference response to training. In conclusion, we have demonstrated novel adaptations in the GI tract hormonal response to physical training.

## EXERCISE-INDUCED CHANGES IN PATELLA TENDON PROTEIN SYNTHESIS AND GENE EXPRESSION IN YOUNG ACL PATIENTS

Dideriksen, K.J., Sindby, A.K.R., Krogsgaard, M., Schjerling, P., Holm, L., Langberg, H.

*Institute of Sports Medicine Copenhagen*

**Introduction** Habitual loading can result in tendon hypertrophy (Couppé et al. 2008) and a single bout of strenuous kicking exercise has been shown to stimulate patella tendon collagen protein synthesis in young men (Miller et al. 2005). However, limited information exists regarding the underlying mechanisms that mediate this exercise-induced response. Recently, it was reported that the gene expression of growth factors and collagen in the tendon was unaffected by an identical kicking exercise bout (Heinemeier et al. 2011). Therefore, the effect of this kicking exercise bout on tendon gene expression alongside tendon collagen protein synthesis needs further investigation. **Methods** Twelve young ACL patients ( $31\pm 2$  yrs) were randomized to one of two groups: Control or Exercise (1-h unilateral knee-extension 67 % of maximal work (Wmax) 24 hours before operation). Two hours before operation a flooding-dose of L-[1-13C]proline was given. Patellar tendon tissue was obtained during surgery. Tendon collagen fractional synthetic rate (FSR) and mRNA abundances of TGF-beta-1, CTGF, and type I and III collagen were measured. **Results** CTGF and type I collagen expression were increased in Exercise compared to Control ( $p<0.05$ ). Type III collagen expression, TGF-beta-1 expression, and collagen FSR ( $p>0.05$ ) did not differ between groups. **Discussion** The knowledge about tendon responsiveness to exercise is blurred by contrasting findings. Here we demonstrate that despite no detectable changes on tendon protein synthesis rate, the expression of CTGF and collagen type I mRNA was elevated. This indicates that the tendon tissue is responsive to acute exercise and the elevated CTGF expression proposes the TGF-beta pathway should be involved. **References** Couppé, C. et al., 2008. Habitual loading results in tendon hypertrophy and increased stiffness of the human patellar tendon. *Journal of applied physiology*. pp.805-10. Heinemeier, K.M. et al., 2011. Expression of extracellular matrix components and related growth factors in human tendon and muscle after acute exercise. *Scandinavian journal of medicine & science in sports*, pp.1-12. Miller, B.F. et al., 2005. Coordinated collagen and muscle protein synthesis in human patella tendon and quadriceps muscle after exercise. *The Journal of physiology*, 567(Pt 3), pp.1021-33.

## EXERCISE OR MORE HABITUAL PHYSICAL ACTIVITY TO IMPROVE GLYCEMIC CONTROL IN PATIENTS WITH TYPE 2 DIABETES?

van Dijk, J., Venema, M., van Loon, L.

*Maastricht University Medical Centre+*

**Background:** Postprandial blood glucose excursions have been associated with the development of cardiovascular disease in patients with type 2 diabetes. Although exercise represents an excellent strategy to improve postprandial glycemia, many patients have difficulties adhering to strict exercise intervention programs. Besides exercise, also non-exercise associated physical activity has been related to improvements in glycemic control. In the present study we assessed the impact of a modest increase in habitual physical activity as

opposed to a single bout of exercise on postprandial blood glucose homeostasis in patients with type 2 diabetes. Methods: Thus far, 16 type 2 diabetic patients (age  $65 \pm 1$  y; BMI  $29 \pm 1$  kg/m<sup>2</sup>; HbA<sub>1c</sub>  $7.0 \pm 0.2\%$ ) participated in a randomized crossover study, consisting of 3 experimental periods separated by 1 week. During a 3-day experimental period, subjects were studied under sedentary control conditions (CON), under conditions where sedentary time was frequently interrupted by activities of daily living (ADL; totaling 45 min per day), and under conditions where prolonged sedentary time was preceded by a 45 min bout of moderate-intensity exercise (EXE). Subjects' diet was strictly standardized, with meals being provided at 8:30, 12:30 and 17:00 h. Blood glucose homeostasis was assessed by continuous glucose monitoring technique, whereas circulating insulin levels were assessed by frequent blood sampling. Treatment effects were assessed by repeated measures ANOVA. Results: Despite continued use of oral blood glucose lowering medication and an HbA<sub>1c</sub> level of  $7.0 \pm 0.2\%$ , type 2 diabetic patients experienced hyperglycemia (blood glucose  $>10$  mmol/L) for as much as  $7:14 \pm 1:14$  h:min throughout the day. The daily prevalence of hyperglycemia was strongly reduced during the EXE condition ( $-2:15 \pm 0:32$  h:min;  $P < 0.01$ ), but not during the ADL condition ( $-1:00 \pm 0:45$  h:min;  $P = 0.62$ ). Postprandial hyperglycemia, as assessed by the cumulative incremental AUC of breakfast, lunch and dinner, was  $19 \pm 6\%$  and  $38 \pm 6\%$  lower during the ADL and EXE condition, respectively, when compared with the CON condition ( $P < 0.05$  for both conditions). The postprandial insulin AUC was reduced by  $14 \pm 5\%$  and  $25 \pm 4\%$  during the ADL and EXE condition, respectively ( $P < 0.05$  only for EXE). The reduction in postprandial glucose and insulin levels was greater during the EXE condition when compared with the ADL condition ( $P < 0.05$ ). Conclusion: A single bout of exercise strongly reduces the daily prevalence of hyperglycemia and lowers postprandial insulin concentrations in patients with type 2 diabetes. Although a modest increase in habitual physical activity may slightly enhance postprandial glucose homeostasis, it cannot replace the benefits of exercise in the treatment of type 2 diabetes.

09:50 - 11:20

## Oral presentations

### OP-PM11 Nutrition 1

#### SHORT VERSUS LONG TERM GREEN TEA EXTRACT SUPPLEMENTATION ON FAT OXIDATION DURING EXERCISE.

Randell, R.K., Hodgson, A.B., Lotito, S.B., Jacobs, D.M., Boon, N., Jeukendrup, A.E.

*University of Birmingham*

Green tea consumption has been associated with protective effects against diseases such as cardiovascular disease, cancer and obesity. More specifically, the anti-obesity properties of green tea have been attributed to enhanced thermogenesis and increases in fat oxidation at rest and during exercise. Augmented fat oxidation, during exercise, is also beneficial for endurance-type athletes as the ability to oxidize fatty acids more efficiently has been linked to a muscle glycogen sparing effect and subsequent performance improvements. However, it remains unclear what supplementation strategy, of a green tea extract (GTE), is most effective in elevating fat oxidation during exercise. Therefore the aim of this study was to investigate the effects of short (1 day) and long term (7 days) GTE supplementation on fat oxidation during moderate intensity exercise. In a parallel, double-blind study design, 31 physically active male participants were recruited for the purposes of this study. Participants were randomly assigned to one of three supplementation conditions: 1) 7 days placebo (PLA); 2) 6 days of PLA followed by 1 day of GTE (GTE1); 3) 7 days GTE supplementation (GTE7). Prior to supplementation participants took part in a baseline experimental trial (Day 0) which consisted of a two hour rest period followed by a 60-min cycle exercise at 50% W<sub>max</sub> (55% VO<sub>2max</sub>). This experimental trial was repeated following the supplementation period (Day 8). To measure substrate metabolism respiratory breath samples were collected and analysed every 10 min during the exercise bout. Blood samples, to determine plasma glucose, glycerol and free fatty acids (FAs) were collected throughout rest and exercise. Short (GTE1) and long term (GTE7) GTE ingestion failed to increase whole body fat oxidation rates, compared to placebo, during the 60-min exercise bout ( $0.51 \pm 0.05$ ,  $0.50 \pm 0.05$ ,  $0.59 \pm 0.06$ g/min, respectively). Furthermore, respiratory exchange ratio (RER) did not differ between Day 0 and Day 8 in all three groups. Compared to baseline (Day 0), long term supplementation of GTE (GTE7) significantly increased plasma FAs and glycerol at rest and during exercise ( $P < 0.05$ ). There was no difference in plasma FAs and glycerol following short term GTE ingestion compared to Day 0. In conclusion, the present study showed no effect of 1 day GTE supplementation on lipolysis or fat oxidation during moderate-intensity exercise. Seven days of GTE supplementation increased lipolysis but this did not result in measurable changes in fat oxidation.

#### PROTEIN SUPPLEMENTATION AUGMENTS THE SKELETAL MUSCLE ADAPTIVE RESPONSE TO RESISTANCE-TYPE EXERCISE TRAINING

Cermak, N.M.1, Res, P.T.1, de Groot, C.P.G.M.2, van Loon, L.J.C.1

*1Maastricht University Medical Centre+, 2Wageningen University*

Introduction: Protein ingestion after a single bout of resistance-type exercise stimulates net muscle protein accretion during acute post-exercise recovery. Consequently, it is generally believed that protein supplementation is required to maximize the skeletal muscle adaptive response to prolonged resistance-type exercise training. However, there is much discrepancy in the literature on the proposed efficacy of dietary protein supplementation as a means to augment the skeletal muscle adaptive response to resistance-type exercise training. This meta-analysis addresses the issue of whether protein supplementation further augments the increase in muscle mass and strength following prolonged resistance-type exercise training in healthy young and older individuals. Methods: A systematic review of interventional evidence was performed through the use of a random effects meta-analysis model. Data from outcome parameters fat-free mass (FFM), type I and II muscle fiber cross-sectional area (CSA) and muscle strength (1-RM) were collected from randomized controlled trials (RCTs) investigating the impact of dietary protein supplementation during prolonged ( $>6$  wks) resistance-type exercise training. Results: Data from 24 RCTs (746 subjects) were included in May, 2011 and pooled for a random-effects meta-analysis. Protein supplementation demonstrated a positive effect for FFM (weighted mean difference (WMD): 0.75 kg, 95% confidence interval (CI) 0.53, 0.97 kg;  $P < 0.00001$ ) and 1-RM (WMD: 12.4 kg, 95% CI 6.4, 18.3 kg;  $P < 0.0001$ ) compared with a placebo during resistance-type exercise training in both young and older subjects. Protein supplementation further increased type I (WMD: 232  $\mu\text{m}^2$ ; 95% CI 128, 336  $\mu\text{m}^2$ ;  $P < 0.0001$ ) and type II muscle fiber CSA (417  $\mu\text{m}^2$ ; 95% CI 241, 593  $\mu\text{m}^2$ ;  $P < 0.00001$ ) following resistance-type exercise training in young subjects. Conclusion: Protein supplementation further improves the gains in fat-free mass and muscle strength during prolonged resistance-type exercise training. As

these effects are observed in both young and older subjects, it seems evident that protein supplementation represents an effective nutritional strategy to further improve the benefits of resistance-type exercise training to support healthy aging.

### EFFECTS OF CAFFEINE AND CARBOHYDRATE MOUTH RINSES ON REPEATED SPRINT PERFORMANCE

Beaven, C.

*Mid Sweden University*

EFFECTS OF CAFFEINE AND CARBOHYDRATE MOUTH RINSES ON REPEATED SPRINT PERFORMANCE Beaven, C.M.1,6, Cook, C.J.1,2,3, Maulder, P.4, Pooley, A.4, Kilduff, L.5 1: UK Sports Council (London, UK), 2: Imperial College (London, UK), 3: University of Bath (Bath, UK), 4: WINTEC (Hamilton, NZ), 5: Swansea University (Swansea, Wales), 6: Swedish Winter Sports Research Centre, Mid Sweden University (Östersund, Sweden) Introduction The beneficial effect of a carbohydrate mouth rinse (without ingestion) on exercise performance has been related to changes in brain activity (Chambers et al., 2009). Caffeine ingestion also demonstrates positive effects on exercise performance and antagonism of adenosine receptors has been identified as a possible mechanism of action (Davis & Green, 2009). However, neither the effects of carbohydrate nor caffeine mouth rinses on intermittent sprints have been examined previously. Methods Recreationally trained males (n = 12) performed 5 x 6 s sprints on a cycle ergometer interspersed by 24 s of active recovery. Twenty-five ml of either a non-caloric placebo, 6% carbohydrate (glucose), or 1.2% caffeine solution was rinsed in the mouth for 5 s prior to each sprint in a double-blinded and balanced, cross-over design. A second trial compared a combination of carbohydrate and caffeine with a carbohydrate only mouth rinse. Post-exercise maximal heart rate and perceived exertion were recorded along with power measures. Results Compared to the placebo, carbohydrate substantially increased initial peak power ( $22.1 \pm 19.5$  W; ES: 0.81) and both caffeine ( $26.9 \pm 26.9$  W; ES: 0.71) and carbohydrate ( $39.1 \pm 26.9$  W; ES: 1.08) improved initial mean power. Caffeine also enhanced initial peak power performance ( $103.8 \pm 116.5$  W; ES: 0.87) in a sub-group of responders (n = 6). Heart rate and rating of perceived exertion did not differ between the three trials (P > 0.05). The second trial confirmed that both carbohydrate alone and a combination of both caffeine and carbohydrate in a mouth rinse could improve initial power production in cycle sprints (ES range: 0.66 – 1.86) with the combination mouth rinse consistently out-performing the carbohydrate only condition in terms of peak (1.0 to 36.0 W) and mean power (1.0 to 35.4 W). Conclusion Carbohydrate and/or caffeine mouth rinses rapidly increased power production in a 6 s sprint which may have positive benefits for specific short sprint exercise performance. Improvements in maximal exercise performance in the absence of fatigue resulting from a mouth rinse suggests a central mechanism that is capable of enhancing the neural drive to the motor units and access the muscle recruitment reserve proposed by Gibson and colleagues (2001). References Chambers E, Bridge M, Jones D. (2009) *J Physiol*, 587. 1779-1794. Davis J, Green J. (2009) *Sports Med* 39. 813-832. Gibson A, Noakes T. (2004) *Br J Sports Med*, 38, 797-806.

### CARBOHYDRATES AND EXERCISE PERFORMANCE IN NON-FASTED ATHLETES: A SYSTEMATIC REVIEW OF STUDIES MIMICKING REAL LIFE SITUATIONS

Colombani, P.C.1, Mannhart, C.2, Mettler, S.1,3

*ETH Zurich*

1: ETH Zurich, Switzerland; 2: consulting mannhart, Wolfhausen, Switzerland; 3: Federal Office of Sports, Magglingen, Switzerland Introduction Carbohydrate intake in the proximity of or during a sports event is often considered to influence sports performance in a positive way and substantial research to investigate this has been carried out. However, in many studies standardized laboratory situations were applied that did not necessarily mimic the situation of a real competition. In this systematic review, we aimed at summarizing all studies in which a setting was used that mimicked the real life situation of a competition. Method The PubMed was screened for randomized, crossover, and placebo-controlled studies in which the subjects were in a postprandial state (2 to 4 h), between 18 and 40 years old (both genders allowed) and their reported VO<sub>2</sub>max was equal to or higher than 50 mL/kg body mass. The tested drink had to contain carbohydrates of any type and water. Electrolytes were allowed, but no further components (e.g. caffeine, choline, protein, amino acids, fatty acids). The tested drink had to be supplied immediately before and/or during the performance test that had to be of a time trial character (e.g. fixed distance, fixed time). Results 16'658 PubMed abstracts were manually screened, yielding 17 articles with 22 carbohydrate interventions that fulfilled the inclusion criteria. The interventions covered test durations from 26 to 241 min (mostly cycling). In four of five interventions with duration to 68 min and in seven of 17 interventions with durations between 70 and 241 min no significant performance improvement was observed with the carbohydrate intervention. The improvement in performance with the 11 studies, in which an ergogenic effect was reported, was between 1 and 13 %. Conclusion A significant ergogenic effect of providing carbohydrates in the proximity or during an exercise session lasting up to 70 min and simulating a real life situation does not seem to occur with trained athletes. For longer exercise durations it seems that the ergogenic effect is at least not as clear as usually discussed, but it also generally seems unlikely that carbohydrate provision as mentioned deteriorates exercise performance. Unfortunately, many articles had to be discarded from this review because relevant information enabling a comprehensive evaluation of the study was missing. Further well described studies with a real life setting and with well-trained athletes are needed to clarify the question about the magnitude of performance enhancement through carbohydrate provision immediately before/during an exercise bout simulating a competitive event. Acknowledgement The study was supported by a grant of the Federal Commission of Sports, Switzerland.

### THE EFFECT OF SODIUM PHOSPHATE SUPPLEMENTATION ON APPETITE AND ENERGY INTAKE IN TRAINED INDIVIDUALS

Guelfi, K.J., West, J.S., Ayton, T., Wallman, K.E.

*The University of Western Australia*

Introduction Ingestion of an acute dose of phosphate has been shown to attenuate energy intake in the subsequent meal (Obied et al., 2010). This raises the question of whether the practice of phosphate supplementation over a number of days by athletes to enhance performance also influences appetite and energy intake. The aim of this study was to investigate the effect of 6 days of phosphate supplementation on appetite and energy intake in trained individuals. This may have implications for athletes that frequently supplement with sodium phosphate to ensure that energy intake is sufficient to support optimal exercise performance. A secondary aim was to confirm the previously observed benefits of sodium phosphate supplementation for aerobic capacity. Methods Twenty moderately trained individuals participated in two, 6 day phases of supplementation with either sodium phosphate (50 mg/kg of fat free mass per day) or a placebo, in a double-blinded, counterbalanced design. To assess the effect of supplementation on energy intake, a laboratory breakfast meal was provided on days 1, 2 and 6 of supplementation from which ad libitum energy intake was determined. Energy intake



from all other food and drink intake during each supplementation period was determined from self-recorded food diaries. Following the 6 days of supplementation, peak aerobic capacity was assessed. A 2-3 week wash-out was imposed between supplementation phases. Results There was no significant effect of an acute dose of sodium phosphate on energy intake or perception of appetite (hunger, fullness, desire to eat or prospective food consumption) at the initial laboratory breakfast meal (i.e. day 1 of supplementation;  $p > 0.05$ ). Likewise, there was no effect of supplementation on energy intake or perception of appetite at the laboratory breakfast meal on day 2 or day 6 of supplementation ( $p > 0.05$ ). There was also no effect of supplementation on daily energy intake from the self-recorded food diaries ( $p > 0.05$ ). With respect to the effect of supplementation on peak aerobic capacity, there was no difference between trials ( $p > 0.05$ ). Discussion In summary, 6 days of sodium phosphate supplementation does not appear to influence energy intake. Therefore athletes supplementing with sodium phosphate can do so without hindering nutritional status. However, given that phosphate supplementation failed to improve aerobic capacity, the ergogenic benefit of this supplement remains questionable. References Obeid OA, Dimachkie S, Hlais S. (2010). *Int J Obes*, 34, 1446-1448.

### THE EFFECTS OF CREATINE SUPPLEMENTATION ON THE RELIABILITY OF BODY COMPOSITION AND BONE DENSITY MEASUREMENT USING DXA

Wallace, J.A.

*Aberystwyth University*

Introduction Increased cell hydration observed during periods of creatine loading (Powers et al. 2003), may affect the imaging quality of DXA scans. The extra cellular water may falsely elevate fat and muscle masses by adding artefacts to the scan analyses, resulting in erroneously low bone mineral density values, due to disruption of the x-ray beam attenuation (Horber et al. 1992). Studies investigating bone health or body composition without controlling for this nutritional supplement may have failed to address this issue, therefore reducing the accuracy, validity and legitimacy of their findings. Method Body composition (total mass, fat mass, lean mass, and percent body fat) and whole-body, proximal femur and lumbar spine bone mineral density (BMD), of 18 active subjects (Males:  $n=10$ ; Female:  $n=8$ )  $22.7 \pm 6.4$  years;  $70.1 \pm 9.3$  kg;  $1.72 \pm 0.09$  m, were measured using dual-energy X-ray absorptiometry (DXA). Measures were taken in a fasted state at baseline, following 1 week of supplementation and again 3 weeks post supplementation. Supplementation consisted of 20g creatine monohydrate (Creapure, Alzchem, Germany) with 30g dextrose, taken once a day for 7 days. Data were analysed using SPSS v19, by means of a 1-way within groups ANOVA. Results There were no significant changes in whole-body, total proximal femur or total lumbar spine BMD ( $P>0.05$ ). Whole-body mass significantly increased after supplementation and subsequently returned to baseline post washout ( $P>0.05$ :  $70.3 \pm 2.2$  kg;  $71.1 \pm 2.3$  kg and  $70.5 \pm 2.2$  kg). Lean tissue mass significantly increased by  $1.2 \pm 0.9$  kg after supplementation ( $p < 0.05$ ), yet failed to return to baseline post washout. Fat mass decreased after supplementation and again failed to return to baseline ( $p < 0.05$ :  $17.9 \pm 1.0$  kg;  $17.5 \pm 1.0$  kg and  $17.3 \pm 1.1$ kg). Discussion The gains in body mass and lean mass observed are likely due to water retention during supplementation. Creatine is an osmotically active substance. Thus, any increase in the body's creatine content should result in increased water retention and consequent gains in body mass, originating from the lean tissue. DXA is sensitive enough to detect changes in soft tissue mass related to fluid gain. Thus, body composition changes that are observed during periods of creatine loading, are possibly linked to an increase in total body water, rather than functional gains of a tissue type. Therefore, studies using DXA to measure or compare soft tissue components should consist of a washout period prior to scanning, or control for these fluid changes in their interpretation of data. Powers M, Arnold B, Weltman A, Perrin D, Mistry D, Kahler D, Kraemer W, Volek J. (2003) *J Athl Train*, 38, 44-50 Horber F, Thomi F, Casez J, Fonteille J. (1992) *Brit J Radiol*, 65, 895-900

09:50 - 11:20

### Invited symposia

#### IS-SH04 Martial Arts from a Multidisciplinary Perspective: Historical, Sociological and Psychological

##### LOOKING AT MARTIAL ARTS INVOLVEMENT AMONG YOUTH

Theeboom, M.

*Vrije Universiteit Brussel*

Youth participation in martial arts (e.g., judo, karate, taekwondo, kickboxing) has universal appeal. In several countries martial arts are listed in the ten most practiced sports among youth in general. Studies in Europe have also revealed that in several countries martial arts participation in a club-related context is very high and many members are under the age of 18 (van Bottenburg et al., 2005). This popularity has led to an increased interest in martial arts research over the past decade. However, despite the growing body of martial arts research, to date, many questions remain unanswered, specifically with regard to the meaning and impact of martial arts involvement to young participants. By and large, the relation between youngsters and martial arts is often viewed in controversial terms. On the one hand, youth participation has been associated with negative effects to personal and social well-being often emphasising the promotion of aggressive and violent behaviour of those involved. On the other hand however, there is also a belief that martial arts practice among children and adolescents can lead to positive socio-psychological outcomes and can be regarded as a means of education in general. Both perspectives have been supported by scientific research. It can however be argued that a 'good versus bad' point of view with regard to youth involvement in martial arts in general is questionable. By providing an overview of the most relevant research on martial arts and youth, as well as critically looking at a number of trends that can be detected in various parts of Europe, this paper will emphasise the need for a discerned view of the perceived or proclaimed outcomes of martial arts involvement among youth. Future research directions, as well as policy recommendations in relation to martial arts and youth will also be described. References Bottenburg, van M., Rijnen, B. and van Sterkenburg, J. (2005). Sports participation in the European Union. Trends and differences, W.J.H. Mulier Institute - Arko Sports Media, 's Hertogenbosch – Nieuwegein.

**THE CREATION AND TRANSFORMATION OF ASIAN MARTIAL ARTS IMAGINARY IN THE WEST**

Gutiérrez-García, C.

*University of León*

This presentation aims at analyzing the historical evolution of Asian Martial Arts (AMA) in the West from the perspective of their imaginary. Imaginary – or social imaginary – is considered here as cognitive schemas widely shared by ordinary people which legitimate and make possible common practices (Taylor, 2004). Although some Asian martial traditions were known many centuries ago in Western countries, modern AMA imaginary started to be created since the mid 19th century after the opening of Japan to the outside world. Japan became an internationally recognized military power in a few decades after defeating China (1894-95) and Russia (1904-95), thus rising the interest in the West about Japanese martial culture. Japanese MA – particularly jujutsu/judo – soon built a strong imaginary as ancient, bushido inspired, complex self-defense systems “that would allow a weak person to be capable of defeating a stronger opponent with minimal effort” (Gutiérrez et al., 2010: 26). Also, they were perceived as sports and physical and moral education means. This first, powerful imaginary, has irregularly evolved until present day. Foreign policies between Japan and Western countries, Japanese emigration, the inclusion of MA in military training, MA sportification processes or MA films have defined different historical and regional rhythms. Also, it is noteworthy that new MA imported in the West such as Karate or Taekwondo embraced this imaginary although trying to enhance their peculiarities (Green & Svinth, 2010). Since the middle of the 20th century, countercultural movements added a new set of images to AMA. Examples include New Age, Human Potential Movement or Holistic Health Movement (Campbell, 2007). AMA were seen as means for achieving holistic health and harmony with the self, nature and the universe. Many of these ideas came in fact from Asian religious-philosophical systems, but were soon westernized. While many AMA have usually incorporated countercultural imaginary to some degree, such as Zen meditation, some Chinese MA have adhered quite closely to this imaginary so that they are considered as countercultural typical practices. That is the case of the so-called “inner martial arts” such as Taijiquan (a.k.a. Tai Chi). Nowadays the social imaginary of AMA in the West is mainly refreshed by their practice as sports/health activities and by mass media, particularly films and TV series. This imaginary makes possible that AMA are so widely spread as social practice among population of different regions, ages and sex. REFERENCES Campbell C. 2007. *The Easternization of the West...* Boulder, CO: Paradigm Publishers. Green, T.A. & Svinth, J.R. (eds.). 2010. *Martial Arts of the World...* Santa Barbara, CA: ABC-CLIO. Gutiérrez C, Pérez M, Acevedo W, Cheung M (2010). IDO Ruch dla Kultury-Movement for Culture, X, 24-30. Taylor C (2004). *Modern Social Imaginaries*. Durham: Duke University Press.

**SPORT PSYCHOLOGY DELIVERY SERVICES TO OLYMPIC TAEKWONDO**

Sanchez, X.

*University of Groningen*

Taekwondo, an Olympic combat sport since Sydney 2000, is a discipline in which opponents are directly, deliberately and systematically confronted against each other in a dynamic environment (Pieter & Heijmans, 1997). Based on previous experience, the present communication illustrates how Taekwondo questions had been answered through sport psychology and how these answers had been applied in the sporting arena. We focus on the work we developed around the tactical component of competitive Taekwondo. We adopt Bishop's (2008) three-phase, eight-stage applied research model for the sport sciences (ARMSS) as a framework that is of particular interest when identifying performance predictors in such new disciplines. Sanchez and Wautier (2003) developed the Taekwondo Combat Assessment System (TCAS), a tool to study Taekwondo combatants' interactions during combats. By video-analysing the combats with TCAS, combatants' technical-tactical changes are detected and specific patterns of fighting are identified. First, by profiling the performance of the athletes, their temporal evolution in a competition is monitored (round by round, combat by combat) as well as their combat-learning development (throughout competitions). Second, by profiling the performance of the adversaries, the self-confidence of the athletes increases (self-reports), and the causal attributions of their performances become adaptive and modifiable (i.e. rather internal and controllable). In addition, by considering these causal attributions players and coaches provide to explain performance during a competition, the sport psychologist is able to assess the factors that are believed influence performance (Sanchez et al., 2003). Finally, athletes' emotional states are individually assessed to (1) build up 'optimal profiles' from which athletes have, in theory, the greatest chances to perform at their best, and (2) train those athletes how best manage these optimal levels. The presentation is supported with specific case-examples for both in-between-rounds, such as active recovering (rehydrating, attentional focus, effective communication) and in-between-combats, such as active recovering (skipping), competition modes (pre-, post-, no-fight), and optimal emotional-arousal regulation (use of music). REFERENCES: Bishop, D. (2008). An applied research model for the sport sciences. *Sports Medicine*, 38, 253-263. Pieter, W., & Heijmans, J. (1997). *Scientific Coaching for Olympic Taekwondo*. Meyer & Meyer Verlag: Aachen. Sanchez, X., et al. (2003). How do players and coaches account for their success and failure when competing in Taekwondo Olympic sparring matches? In: 2nd World Congress of Physical Activities and Sport Sciences (pp. 235-238). Granada, Spain. Sanchez, X., & Wautier, P. (2003). The Taekwondo Combat Assessment System-TCAS: A notational analysis tool. In: Proceedings of the XI FEPSAC European Congress of Sport and Exercise Psychology (p150). Copenhagen, Denmark.

**09:50 - 11:20****Invited symposia****IS-BN03 Neuroplasticity: From Basic Sciences to Sport Performance****BRAIN-DERIVED NEUROTROPHIC FACTOR AND EXERCISE, AN UPDATE**

Knaepen, K., Goekint, M., Meeusen, R.

*Vrije Universiteit Brussel*

Introduction: Neurotrophins are important regulators of neuronal survival, development, function, and plasticity. They are capable of signaling neurons to survive, differentiate or grow. Neurotrophic factors are also important in processes of central and peripheral energy metabolism. Their effect on synaptic plasticity in the central nervous system involves elements of cellular energy metabolism and in the periphery they take part in metabolic processes. Physical activity, and in particular, acute exercise and training play a key role in process-

es through which neurotrophins mediate energy metabolism and in turn neural plasticity. Brain-derived neurotrophic factor (BDNF) is the most susceptible to regulation by physical activity. Objectives: To give an update on the current research on peripheral BDNF following acute exercise or training interventions in healthy subjects and in people with a chronic disease or disability. Methods: Systematic literature review. Results: Most studies showed a transient increase in serum or plasma BDNF following acute exercise, both in healthy subjects and in people with a chronic disease or disability. Except for one study, strength and aerobic training interventions have no effect on BDNF concentrations. Discussion & Conclusion: Exercise temporarily elevates basal BDNF concentrations and possibly upregulates cellular processing of BDNF (i.e., synthesis, release, absorption and degradation). Acute exercise influences serum and plasma BDNF concentrations, although the affect is transient. No acute exercise or training protocol has a long lasting influence on peripheral BDNF concentrations in healthy subjects or people with a chronic disease or disability. Evidence of effects of acute exercise or training protocols on BDNF in people with a chronic disease or disability is inadequate to draw firm conclusions whether these effects differ from the effects in healthy subjects. Whether the use of acute exercise and training is viable in the treatment of neurodegenerative and metabolic diseases, seen from its effects on BDNF, still remains to be elucidated.

### **THE MUSICIAN'S BRAIN AS A MODEL OF BENEFICIAL AND MALADAPTIVE BRAIN PLASTICITY**

Altenmüller, E.

*HMTM-Hannover*

Performing music at a professional level is probably the most complex of human accomplishments. Music, as a sensory stimulus, is highly complex and structured along several dimensions. Moreover, making music requires the integration of multimodal sensory and motor information and precise monitoring of the performance via auditory feedback. In the context of classical music, musicians are forced to reproduce highly controlled movements almost perfectly with a high reliability. These specialized sensory-motor skills require extensive training periods over many years, starting in early infancy and passing through stages of increasing physical and strategic complexities. The superior skills of musicians are mirrored in plastic adaptations of the brain on different time. At one extreme, years of musical experience, especially in those musicians who begin training early in life, might lead to an increase in gray and white matter volume in several brain regions, including sensory-motor and auditory areas, the cerebellum and the anterior portion of the corpus callosum. These anatomical alterations appear to be confined to a critical period. The fact that in several of the studies a correlation was found between the extent of the anatomical differences and the age at which the musical training commenced strongly argues against the possibility that these differences are pre-existing and the cause for rather than the result of practicing music. There is a dark side to the increasing specialisation and prolonged training of modern musicians, namely loss of control and degradation of skilled hand movements, a disorder referred to as musicians' cramp or focal dystonia. The first historical record, from 1830, appears in the diaries of the ambitious pianist and composer Robert Schumann. As was probably the case for Schumann, prolonged practice and pain syndromes due to overuse can precipitate dystonia, which is developed by about 1% of professional musicians and usually ends their career. Neuroimaging studies point to dysfunctional (or maladaptive) neuroplasticity as its cause. Support for this theory comes from a functional brain imaging study performed in musicians with focal dystonia. Considering 1) the historical advent of the disorder in the nineteenth century with rapidly increasing technical demands imposed on musicians, 2) the epidemiological data with biomechanical load as a risk factor, and 3) neurobiological findings of the blurring of hand representations, one is tempted to state that focal dystonia finally marks the natural limits of a process of refinement of manual dexterity over a million years.

### **THE IMPORTANCE OF AUGMENTED FEEDBACK IN MOTOR LEARNING**

Leukel, C.

*University of Freiburg*

We are permanently informed by sensory feedback about the state of our own body and the state of the environment we are moving in. This is essential to adequately control motor task as well as to learn new and refine existing behaviour. Several types of feedback exist. For classification, feedback can simply be divided in intrinsic internal feedback, informing us about the state of our body, and intrinsic external feedback, informing about the state of our environment. A third type of feedback, called extrinsic or augmented feedback, provides explicit quantitative information about the performance of an accomplished motor task. This type of feedback has been shown to facilitate learning-related performance in many practical settings. In the first part of this talk, it is explained how augmented feedback may help to improve learning-related performance in different learning processes like error-based learning or reinforcement learning. As improvements in performance are based on neural plasticity within the central nervous system, the second part of the talk is concerned with the underlying neural changes when learning with augmented feedback. Finally, a specific subtype of augmented feedback is mentioned which may have great potential to modify behaviour. This subtype is subconscious (also termed subliminal) information, presented at stimulus intensities below conscious perception but strong enough to be processed within the central nervous system. Previous investigations show that motor performance can be improved by subconscious information. This finding may have practical implications when appropriately applied in specific settings.

09:50 - 11:20

## Oral presentations

### OP-BN04 Muscle/Tendon/Bone

#### BONE MICRO-ARCHITECTURE, ESTIMATED BONE STRENGTH, AND MUSCLE STRENGTH IN ELITE FEMALE ATHLETES: A HR-pQCT STUDY

Schipilow, J., Liphardt, A.M., Kan, M., Buie, H., Macdonald, H., Boyd, S.

*University of Calgary*

Bone micro-architecture, estimated bone strength, and muscle strength in elite female athletes: a HR-pQCT study Schipilow, J.1, Liphardt, A.M.1, Kan, M.1, Buie H.1, Macdonald H.2, Boyd, S.1 1: Schulich School of Engineering, University of Calgary, Canada 2: University of British Columbia, Canada Introduction Athletes participating in sports characterized by specific loading modalities show different levels of bone adaptation [1]. It is unclear how these loading environments affect bone macro- and micro-architecture and estimated bone strength, all contributors to bone quality. Furthermore, the relative role of impact versus muscle forces in determining bone quality remains a topic of debate [2]. The purpose of this study was to (1) investigate the differences in bone macro- and micro-architecture and estimated bone strength in elite female athletes; and (2) gain further insight into the muscle-bone relationship. Methods Elite female athletes (N=54) participating in high-impact (alpine skiing, n=10), moderate-impact (soccer, n=11), and non-impact sports (swimming, n=11), and 9 controls were measured at the dominant distal tibia using high-resolution peripheral quantitative computed tomography (HR-pQCT). Outcomes included total volumetric bone mineral density (vBMD), total area (Tt.Ar), and cortical area (Ct.Ar). Finite element analysis was used to estimate failure load (FL) of the bone. Muscle strength was assessed by measuring isokinetic knee extension torque (KET) with a Biodex dynamometer. Means were compared using a one-way ANOVA. Pearson correlations were used to identify any relationships between muscle strength and bone parameters. All reported differences and correlations are significant at  $p < 0.05$ . Results Swimmers exhibited a vBMD of  $281.0 \pm 41.4$  mg HA/cm<sup>3</sup> (mean  $\pm$  SD), which was 19%, 20%, and 15% lower than skiers, soccer players, and controls, respectively. Swimmers displayed a Tt.Ar of  $808.1 \pm 122.5$  mm<sup>2</sup>, which was 20% larger than controls; however, swimmer Ct.Ar ( $109.8 \pm 11.3$  mm<sup>2</sup>) was 17%, 18%, and 14% lower than skiers, soccer players, and controls, respectively. The FL calculated for swimmers ( $6.0 \pm 0.6$  kN) was 24% lower than skiers and 15% lower than soccer players. Skier KET ( $159.0 \pm 22.0$  Nm) was 24% higher than controls. After pooling the data, weak to moderate correlations were found between KET and vBMD ( $r=0.32$ ), Ct.Ar ( $r=0.42$ ), and FL ( $r=0.55$ ). Discussion Differences in bone parameters are shown between impact and non-impact sports, leading to the inference that impact loading is highly associated with bone quality. The results also show a relationship, albeit a weak to moderate one, between muscle strength and bone parameters. These data suggest that impact loading plays a larger role than muscle strength in determining bone quality; however, longitudinal prospective studies are required to support this. References [1] Nikander et al. (2006). Bone. 39(1), 886-894. [2] Robling, AG. (2009). Med Sci Sports Ex. 41(11), 2044-2049.

#### DEVELOPMENTAL DIFFERENCES IN DYNAMIC MUSCLE AND TENDON BEHAVIOUR: IMPLICATIONS FOR MOVEMENT EFFICIENCY

Waugh, C.M., Blazeovich, A.J., Korff, T.

*Brunel University*

Children perform cyclic motor tasks less efficiently than adults; however, the mechanisms underlying such differences are not fully understood. One mechanism that may contribute to age-related differences in task efficiency is the differential movement of muscles and tendons for a given muscle-tendon unit (MTU) length change. In adults, the majority of an MTU length change is performed by the tendon, which minimises energy expenditure by maximising elastic energy utilisation and enabling the muscle to operate near-isometrically. Previously observed age-related differences in tendon stiffness between children and adults may affect MTU dynamics and could influence movement efficiency. The aims of this study were to a) compare muscle and tendon length changes as a function of MTU length during two-legged hopping between children and adults and b) examine the relationship between such changes and tendon stiffness. 10 children ( $8.8 \pm 0.3$  years) and 10 adults ( $26.3 \pm 2.2$  years) performed 20-s of two-legged unshod hopping at a self-selected frequency. Gastrocnemius medialis (GM) muscle-tendon junction movement was imaged using ultrasonography whilst reflective markers placed on the hip, knee and foot provided sagittal movement kinematics. MTU length changes were estimated from anthropometric and kinematic data, and individual muscle and tendon length changes were derived using a combination of 3D-motion capture and ultrasonography. Length change profiles were averaged for the ground contact phase of 6 consecutive hops for each participant. Achilles tendon stiffness was calculated as the slope of the tendon force-elongation curve between 10-90% of maximum isometric plantarflexor force. The degree to which the tendon traced MTU movement was quantified as the difference between MTU and tendon length change at each participant's maximum MTU length change. Group means were examined using an independent t-test ( $p < 0.05$ ). The relationship between such changes and tendon stiffness was examined using a linear regression analysis. In relation to MTU movement, tendon length change was 30% lower in children compared to adults ( $p=0.021$ ). Moreover, the difference in MTU and tendon length changes were moderately correlated with tendon stiffness ( $r=0.64$ ). The present data demonstrate that the tendon component of the GM MTU lengthens to a lesser extent than that observed in adults during two-legged hopping. This difference is related to developmental differences in tendon stiffness, which lets us speculate that greater elastic energy utilisation and slower muscle shortening velocities contribute to age-related differences in cyclic task efficiency. These results have extensive implications for optimising sporting performance or improving movement disorders in children and should be the subject of future research.

## FOOT DEFORMATION INDUCED BY PASSIVE ANKLE MOTIONS IS DIFFERENT BETWEEN BOYS AND YOUNG ADULT MEN: IMPLICATIONS FOR THE JOINT ANGLE-MUSCLE-TENDON UNIT LENGTH RELATIONSHIP

Iwanuma, S.1, Hashizume, S.1, Kanehisa, H.2, Yanai, T.1, Kawakami, Y.1

*Waseda university*

[Introduction] The length of the muscle-tendon unit (MTU) is an important parameter that influences its mechanical functions. The foot deformation during ankle joint rotation affects the triceps surae MTU length-ankle joint angle relationship (Iwanuma et al., 2011). The foot deformation is associated with the elasticity of connective tissues within it (Ker et al., 1987). Since the connective tissues in children are more compliant than those in adults (e.g., O'Brien et al., 2010), we tested a hypothesis that the foot deformation for a given ankle dorsiflexion in boys is larger than that in young adult men, and it induces age-related difference in joint angle-MTU length relationship. [Methods] Thirteen boys (BOYS, 12 - 14 years) and 13 young adult men (ADULTS, 22 - 29 years) participated in this study. An MRI scanner was used to take a series of sagittal images of the foot at rest with four ankle positions of 10° dorsiflexion (DF10), neutral position, 10° and 20° plantar flexion (initial position). The MTU elongation was determined from the displacement of the calcaneal tuberosity, and it was normalized by lower leg length. The dorsiflexion angles of the anterior segment (the line connecting metatarsal to navicular bones,  $\theta_{ant}$ ) and posterior segment (the line connecting talus to calcaneus,  $\theta_{post}$ ) relative to the longitudinal direction of tibia were measured in each ankle position. In addition, the length of posterior segment ( $L_{post}$ ) and the displacement of the anterior vertex of talus ( $D_{tal-X}$  and  $D_{tal-Y}$ ) were measured. [Results and Discussion] The foot deformation at DF10 in BOYS ( $9 \pm 4^\circ$ ) was significantly larger than that in ADULTS ( $5 \pm 2^\circ$ ), which was caused by the difference in the  $\theta_{post}$  between BOYS ( $20 \pm 3^\circ$ ) and ADULTS ( $23 \pm 4^\circ$ ), and was independent of  $\theta_{ant}$ . The MTU elongation at DF10 in BOYS ( $15 \pm 3$  mm,  $4.1 \pm 0.9\%$ ) was significantly smaller than that in ADULTS ( $19 \pm 3$  mm,  $4.9 \pm 0.8\%$ ). The MTU elongation was more closely correlated to  $\theta_{post}$  (.82) than  $D_{tal-X}$  (-.26) and  $D_{tal-Y}$  (.32) as a result of partial correlation analysis, but it was not related to  $L_{post}$ . These results indicate that the foot is more flat during ankle dorsiflexion in BOYS than in ADULTS, and it induces an age-related difference in the MTU length change relative to a given ankle joint angle change. [References] Iwanuma S, Akagi R, Hashizume S, Kanehisa H, Yanai T, Kawakami Y. (2011). *J Biomech*, 44(14), 2579-2583. Ker RF, Bennett MB, Bibby SR, Kester RC, Alexander RM. (1987). *Nature*, 325(7000), 147-149. O'Brien TD, Reeves ND, Baltzopoulos V, Jones DA, Maganaris CN. (2010). *J Biomech*, 43(6), 1190-1205.

## NON-INVASIVE MEASUREMENTS OF THE TENSION DEVELOPED IN THE PATELLAR TENDON DURING SQUATTING - A CASE STUDY WITH A NOVEL SENSOR

Djordjevic, S.

*TMG-BMC d.o.o.*

Non-invasive measurements of the tension developed in the patellar tendon during squatting - a case study with a novel sensor Djordjevic, S. 1, Meglic, A. 1, Tomazic, S. 2, Morrissey, D. 3, Langberg, H. 4: 1: TMG-BMC, Ljubljana, Slovenia 2: Faculty of Electrical Engineering, University of Ljubljana, Slovenia 3: Queen Mary University of London, Centre for Sports and Exercise Medicine, UK 4: Institute of Sports Medicine, University of Copenhagen, Denmark Introduction The dynamic squat exercise is an integral part of strength and conditioning programs in many sports that require high levels of strength and power. The squat primarily strengthens hip, thigh, and calf musculature – all of which are key muscles for running, jumping and lifting. There are limited methods for characterization of dynamic muscle function and tendon force. Various methods do exist to measure muscle function however dynamic, non-invasive measurement of muscle or tendon tension is very challenging and, to our knowledge, no direct methods exist to quantify in vivo tendon and muscle forces that can be used on the field. In our study we aimed to measure quadriceps muscle and tendon forces during squatting using a novel force sensor in order to better understand dynamic tissue behavior during the squat movement. Methods To measure vastus medialis and lateralis muscle and tendon tension we used a new mechanical contraction (MC) sensor and data logger (TMG-BMC, Slovenia), adapted for muscle or tendon measurements (Djordjevic et al., 2011). Simultaneous EMG was measured using a 4-channel analog input device (National Instruments, USA) and knee angle with a 6D ACC-GYR (TMG-BMC, Slovenia). The subject performed 4 squatting movements, descending until the thighs were approximately parallel to the floor (thigh angle from perpendicular to app. parallel to the floor) without additional load. Results There was a significant correlation between the MC sensor data from the patellar tendon, knee joint torque and angle. MC measurement of tension recorded from vastus lateralis and medialis corresponded to the timeline of the EMG signal. The data also shows differences in amplitude of tension of vastus lateralis and medialis, potentially yielding insight into how both muscles mechanically contribute to the generation of tension in the patellar tendon. Discussion The new sensor shows potential utility for measurement of the dynamic properties of accessible tendons and muscles. There are strong correlations with generally accepted measurement tools e.g. EMG, revealing a proportional relationship to muscle force output and range of joint movement. Further reliability and validity studies are underway to reveal the full potential of these dynamic in-vivo perpendicular force sensors as a measure of contractile tissue and tendon function. References Djordjevic S, Stancin S, Meglic A, Milutinovic V, Tomazic S. (2011). *Sensors*, 11 (10), 9411-25.

## NONINVASIVE ESTIMATION OF MYOSIN HEAVY CHAIN COMPOSITION IN HUMAN SKELETAL MUSCLE

Simunic, B.1, Degens, H.2, Rittweger, J.3, Mekjavic, I.3, Pisot, R.1

*University of Primorska*

NONINVASIVE ESTIMATION OF MYOSIN HEAVY CHAIN COMPOSITION IN HUMAN SKELETAL MUSCLE Šimunič, B.1, Degens, H.2, Rittweger, J.3, Mekjavic, I.3, Pisot, R.1 1: UP (Koper, Slovenia), 2: MMU (Manchester, UK), 3: IJS (Ljubljana, Slovenia) Introduction Information on muscle fiber type composition is of great importance in muscle physiology and athletic performance. Because there are only a few techniques available that noninvasively and accurately provide an estimate of muscle fiber type composition, the development of additional and alternative approaches is required. Therefore, the aim of our study was to evaluate the correlation between radial twitch delay time (Td), contraction time (Tc) and half relaxation time (Tr) measured by Tensiomyography (TMG) and percentage of myosin heavy chain 1 (%MHC-I) in the human vastus lateralis muscle. Furthermore, we used a multiple regression analysis of %MHC-I versus Td, Tc, and Tr to establish noninvasive estimators of %MHC-I in human skeletal muscle. Methods Twenty-seven participants with an average age of 43 (18) years, height of 175 (7) cm, and mass of 74 (12) kg participated in the study. Td, Tc, and Tr were calculated from TMG radial twitch responses of the vastus lateralis muscle. Univariate and multiple linear regression analyses were used to correlate the proportion of %MHC-I in a biopsy obtained from the same muscle with a single and all three radial twitch parameters. Results Td, Tc, and Tr all correlated with %MHC-I ( $r = 0.612, 0.878, \text{ and } 0.669$ , respectively, at  $P < 0.001$ ). When all three parameters were included in a multiple linear regression, the correlation with the %MHC-I was even higher ( $R = 0.933, P < 0.001$ ). The result of multiple regression analysis is an equation: %MHC-I

$= 2.829Tc + 2.98Td + 0.127Tr - 121.023$ . Discussion TMG is a simple-to-use, reliable (Križaj et al., 2008), noninvasive, and selective method for the determination of skeletal muscle contractile parameters. The method could be easily applied in superficial human muscles. Our finding suggests that TMG method could be used for valid estimation of the %MHC-I in the human vastus lateralis muscle and most likely also in other human muscles. TMG upgrades other mechanomyographical methods for non-invasive and selective assessment of skeletal muscle contractile parameters (Valenčič and Knez, 1997). Several mechanomyographic methods have been proposed that are based on measuring lateral vibrations and thickening of the muscle during a contraction, for instance phono or soundmyography and vibromyography. Promising results have been obtained using mechanomyographic methods, but there are several difficulties: such as a low signal-to-noise ratio and consequently high variability, complex measuring setup and/or expensive hardware, and necessary postprocessing of the signals. References Valencic V., Knez N. (1997). *Artif Organs*, 21, 240–242. Križaj D., Simunic B., Zagar T. (2008). *J Electromyogr Kinesiol*, 18(4), 645–651.

### **AUTOGRAFT OR BIOIMPLANT WHEN REPAIRING TRAUMATIC CARTILAGE DEFECTS IN A RABBIT MODEL**

Intzoglou, K., Papaparaskeva, K., Koulalis, J.

*Athens University*

**Objectives:** We designed a laboratory study in order to analyze histologically and immunoistochemically the results of two wide spread one staged techniques, which are used for traumatic osteochondral repair: osteochondral autografting and biosynthetic osteochondral implantation. **Methods:** Thirty skeletally mature New Zealand White rabbits were used. With a hand drill, an osteochondral defect was created (4,5 mm diameter and 7mm depth) in the right knee of each rabbit. The defect was restored using osteochondral autograft (group A, ten rabbits), biosynthetic osteochondral graft (group B, ten rabbits) or was left untreated (group C, ten rabbits). The ICRS score was used to evaluate the restored tissue of the osteochondral defects 24 weeks post-op. **Results:** Statistical difference ( $p < 0,05$ ) was observed as far as the ICRS categories matrix, cell distribution, subchondral bone and cartilage mineralization are concerned. No statistical difference was noticed in the surface and cell viability category. Histochemical stains (Blue Toluidine and Van Giesson) and immunohistochemical results (antibody for collagen II) came in agreement with morphological results (ICRS score). **Conclusions:** Restoring osteochondral knee defects continues to challenge the present orthopaedician. Choosing the autograft looks like a better choice than the biosynthetic material, which in turn is a better choice than no treatment. The lack of statistical difference as far the surface category (macroscopic appearance) and the cell viability are concerned should be especially pointed out. As long as morbidity of the donor site is attached to the technique of autografting itself, combination of the two compared methods- autografting while restoring donor site with biosynthetic implant- constitutes a good surgical option today.

**09:50 - 11:20**

## **Oral presentations**

### **OP-PM12 Training & Tapering**

#### **AN OLD QUESTION REVISITED: IS MOVEMENT OR MUSCLE CODED IN THE MOTOR CORTEX? IMPLICATIONS FOR MOTOR REHABILITATION.**

Zijdewind, I., Ampomah, I., Bianchi, F.

*UMCG, University of Groningen*

**Introduction** At present motor imagery (MI) is advocated as a mean for motor rehabilitation. Stroke patients are encouraged to imagine goal-directed movements to help them relearn motor programs. Up to now, no attention has been paid to the importance of posture of the patient during motor imagery. In the present study we tested whether position is an important parameter that needs to be controlled during motor imagery. **Methods** Right-handed subjects (14, 10 females, age 20-31) were included. Subjects sat in a chair with their arms flexed (ca. 135°), their forearms resting on plateaus in front of them so that their hands were free. Subjects looked at a computer screen, which randomly showed alternating hand positions of the left and right hand (prone [P], halfway between prone and supine with thumbs up [HW], supine [S], and halfway between prone and supine with thumb down [HI]). Subjects placed their hands similarly to the hand positions on the screen. After a beep, they imagined moving their right index finger in the direction that was also shown on the screen (up, down, left, right); only imaginary abduction and flexion movements were used. A session consisted of 3 blocks of 32 imaginary contractions (5 s contractions, 15 s rest). During the imaginary contraction, the contralateral motor cortex was stimulated with transcranial magnetic stimulation. Motor evoked potentials (MEPs) were recorded in the right first dorsal interosseus (index finger abductor, FDI). Modulation of the MEPs was analysed with separate repeated measures ANOVA's 1) with movement (2), left (4) and right hand position (4) as within subjects factors and 2) with movement (2), direction (4) and left hand position (4) as within subjects factors. **Results** During the experiment the MEP amplitudes of the FDI were significantly modulated by movement ( $F(1,13)=16.806$ ,  $p=0.001$ ), right hand position ( $F(3,39)=4.370$ ,  $p=0.03$ ) and movement direction ( $F(3,39)=5.240$ ,  $p=0.004$ ). Post hoc analysis showed that imaginary performance of an abduction movement resulted in significantly larger MEPs than during flexion movements. Furthermore, larger MEPs were seen during right hand positions P and HI, than during S and H. For the movement direction, larger MEPs were mainly seen during downward movements. **Conclusions** The results show that corticospinal excitability is affected by different factors. The present data suggests that the coding of movements in the motor cortex depends on both the movement direction as well as on the involved muscles. We assume that a greater corticospinal activation would result in better training effect and thus these results data suggest that it is important to control the position of the patient during motor imagery.

**EFFECT OF REGULAR ENDURANCE TRAINING ON TELOMERE LENGTH IN HUMAN SKELETAL MUSCLE.**

Ponsot, E., Welin, L., Langberg, H., Kjaer, M., Kadi, F.

*University of Örebro*

**EFFECT OF REGULAR ENDURANCE TRAINING ON TELOMERE LENGTH IN HUMAN SKELETAL MUSCLE.** Ponsot E.1, Welin L.1, Langberg H.2, Kjaer M.2, Kadi F.1: 1: School of Health and Medical Sciences, Örebro University (Örebro, Sweden), 2: Institute of Sports Medicine - Copenhagen, Bispebjerg Hospital, (Copenhagen, Denmark). Introduction The length of telomeres is known to be an important indicator of the cell proliferative potential. It is likely that the regulation of telomeres in-vitro cannot fully mimic the behavior of telomeres in human tissues. The effect of regular training on in-vivo telomere length is poorly studied in human skeletal muscle. When satellite cells, the skeletal muscle stem cells, are heavily recruited for regenerative events as in skeletal muscle of athletes, telomere length has been found to be either dramatically shortened (overtrained athletes) or maintained compared to non-trained individuals (for review, see Kadi and Ponsot, 2010). The present study aims to address the question of whether the regular practice of endurance training is associated with alterations in telomere length in skeletal muscle of healthy athletes. Methods Skeletal muscle telomere lengths from a population of 12 healthy athletes regularly involved in endurance training (END) were compared to those of a population of 10 healthy, active individuals (CON). Mean and minimum telomere lengths were determined using southern blot. Results The mean telomere length in END ( $11.1 \pm 1.0$  kbp) did not differ significantly from the values collected in CON ( $10.5 \pm 0.5$  kbp). On the opposite, the minimum telomere length was significantly longer in END ( $5.5 \pm 0.4$  kbp) than in CON ( $4.7 \pm 0.3$  kbp,  $P < 0.001$ ). Discussion Our findings suggest that physical training, when not accompanied by excessive oxidative stress, is not harmful for telomeres and may positively influence telomere length regulation in skeletal muscle as previously suggested in skeletal muscle of strength-trained athletes (Kadi et al., 2008) and in leucocytes (Cherkas et al., 2008; Ludlow et al., 2008). This also suggests that telomeres can be regarded as dynamic structures under the influence of their environment and their length can be maintained as long as the environmental disturbances do not exceed the telomere regulatory capacities. The dynamic equilibrium can even be displaced towards longer telomeres in athletes compared to untrained individuals. The existence of such telomere regulatory mechanisms in well-trained skeletal muscle requires to be further investigated. References Cherkas L., Hunkin J., Kato B., Richards J., Gardner J., Surdulescu G., Kimura M., Lu X., Spector T., Aviv A. (2008). 168(2), 154-158. Kadi, F. and Ponsot E. (2010). *Scand J Med Sci Sports*, 20(1), 39-48. Kadi F., Ponsot E., Piehl-Aulin K., Mackey A., Kjaer, M., Oskarsson E., Holm L. (2008). *MSSE*, 40(1), 82-87. Ludlow A., Zimmerman J., Witkowski S., Hearn J., Hatfield B., Roth S. (2008), *MSSE*, 40(10), 1764-1771.

**COGNITIVE ENHANCEMENT IN RESPONSE TO CHRONIC PHYSICAL TRAINING ON A DOPAMINE-DEPLETION ANIMAL MODEL OF ADHD**

Felszeghy, K., Hart, N., Radák, Z., Nyakas, C.

*Semmelweis University, Faculty of Physical Education and Sport Sciences*

Introduction Attention deficit hyperactivity disorder (ADHD) is a heterogeneous, highly heritable, behavioural disorder that affects 5 to 10% of children worldwide. Basically two forms of the disorder are manifested: inattentive and hyperactive-impulsive forms. Methylphenidate is the preferred treatment for this disorder and has been used for long term management, although its adverse effects have been also detected. Since the brain dopaminergic system is highly involved in the development of ADHD, a neonatal dopamine (DA) depletion rat model has been extensively used for studying this disorder. Methods At neonatal age (postnatal day 4) animals were DA-depleted by intraventricular injection of  $20 \mu\text{g}$  6-hydroxydopamine. This intervention resulted in 70-90% decrement of extracellular DA content in dopaminergic brain areas. Control animals were sham operated. Adult rats at the age of 4 months were trained by daily 1 hour swimming 5 times per week for 10 weeks. On the 11th week animals were tested in a stress situation for hyperactivity and impulsivity in a conditioned fear test. Attention and memory function were assayed in spontaneous alternation and in novel object recognition paradigms. Results Dopamine-depletion resulted in hyperactivity in the conditioned fear stress situation, and a decrement in freezing behaviour, which indicates impulsive response to stress. Ten-week physical training, however, increased the measures of freezing behaviour towards control level. Depleted animals showed impaired attention and memory function during both in spontaneous alternation and novel object recognition. The swimming training significantly enhanced the number of correct alternation as compared to control animals in the spontaneous alternation test. In the novel object recognition test the recognition index of trained animals showed significant improvement in attention as compared to controls. Discussion Our results indicate that 10 weeks of regular swimming training decreased impulsivity of ADHD rats. Moreover, the regular exercise improved attention and memory function of DA-depleted animals comparing to those of untrained and DA-depleted rats. These results suggest that long-term and regular exercise may result in treatment effects in ADHD alone or in combination with the pharmacological intervention. It may be proposed that sport during early childhood development seems to be preventive against emotion driven hyperactivity and the consequent attention and learning problems even in cases of manifest diseases like ADHD. References Luthman J, Bassen M, Fredriksson A, Archer T. (1997). *Behav Brain Res*, 82, 213-221. Wappler EA, Szilágyi G, Gál A, Skopál J, Nyakas C, Nagy Z, Felszeghy K. (2009). *Physiol Behav*, 97, 107-114

**TWO WEEKS OF MUSCLE DISUSE INDUCES SPECIFIC TYPE II MUSCLE FIBRE ATROPHY WITHOUT A DECLINE IN SATELLITE CELL CONTENT**

Wall, B., Snijders, T., Verdijk, L., van Loon, L.

*Maastricht University*

Muscle disuse leads to a considerable loss of skeletal muscle mass and strength. At present, it is not clear whether this loss of muscle mass is attributed to type I or type II muscle fibre atrophy, or a combination of both. Furthermore, the underlying cellular mechanisms of muscle disuse atrophy remain to be elucidated. The present study assessed the impact of 2 weeks of muscle disuse on quadriceps muscle mass, leg strength, muscle fibre size and muscle fibre type specific satellite cell content. Nine healthy, young ( $23.8 \pm 1.0$  y) men were subjected to 2 weeks of one legged knee immobilization via a full leg cast. Three days before and immediately after the immobilization period, a single slice CT-scan of the immobilized leg was performed to assess quadriceps cross sectional area. In addition, muscle biopsies were obtained from the vastus lateralis to determine muscle fibre type characteristics via immunohistochemistry and fluorescence microscopy. Furthermore, 1-RM leg extension strength of the immobilized leg was determined 3 days prior to and 2 days after the immobilization period. Quadriceps cross sectional area of the immobilized leg declined from baseline by  $7.6 \pm 2.3$  % ( $P < 0.01$ ). In the immobilized leg, type I muscle fibre cross sectional area did not change significantly following immobilization whereas type II muscle fibre cross sectional area declined by  $14.9 \pm 4.3$  % ( $P < 0.05$ ) from baseline. Both type I and II muscle fibre satellite cell content (expressed as satellite cells per muscle fibre) remained unaffected following immobilization. In addition, the immobilization period had resulted in a

22.1±2.9 % decline in 1-RM leg extension strength of the immobilized leg ( $P<0.01$ ). We conclude that 2 weeks of muscle disuse leads to considerable loss of muscle mass and strength. The loss of muscle mass is mainly attributed to specific type II muscle fibre atrophy, and is not accompanied by a decline in satellite cell content.

### EFFECT OF REDUCED TRAINING FREQUENCY ON MUSCLE MASS AND SERUM TESTOSTERONE IN OLDER MEN

Matsutani, K., Sato, K., Takahashi, K., Tsujino, M., Kurihara, T., Iemitsu, M., Hamaoka, T., Fujita, S.

*Ritsumeikan University*

**Introduction** Age-associated loss of muscle mass and function (sarcopenia) leads to weakness of the lower extremities, slowing of gait speed, and increased risk of falls. Progressive resistance training (PRT) has been shown to counteract sarcopenia. Although the exercise guidelines have been proposed to induce muscular hypertrophy, minimum training volume and frequency of training to maintain the increased muscle mass induced by preceding training has not been clearly defined. Therefore, the purpose of the current study was to investigate the effect of PRT and reduced frequency of training on muscle mass and androgenic-anabolic hormone (testosterone) level in healthy older men. **Methods** Eleven healthy older men participated in a PRT program consisting of leg extension and flexion exercises (70% 1-RM, 10 reps  $\times$  3 sets), 3 times per week for 3 months. After the initial 3-month training period, subjects were divided into either control group (CON, N=4; without training) or reduced-training group (RT, N=7; trained once every two weeks) for 12 months. Blood samples were drawn after an overnight fast to assess serum testosterone (TST) levels. Lean mass of both legs (LLM) and muscle cross-sectional area (CSA) of mid-thigh were evaluated using DXA and MRI, respectively. All assessments were performed before the initial training (baseline), three months post-training (3M-post), 12 month after the second training period (1Y-post). **Results** After the initial training period, LLM and muscle CSA have increased by 4.8±0.8% and 7.3±1.1%, respectively. After the second training period, LLM and muscle CSA for CON group were decreased by 2.6±2.3% and 5.9±1.3%, respectively. Similarly, LLM and muscle CSA for RT group decreased almost to the baseline level by 1.1±1.0% and 3.6±0.8%, respectively. Serum TST at rest increased significantly at 3M-post (8.6±0.5 and 11.3±0.9 pg/ml for baseline and 3M-post, respectively;  $P<0.05$ ), but returned to baseline level at 1Y-post in both groups (8.6±0.6 and 8.6±1.6 pg/ml for RT and CON, respectively). No significant group difference in LLM, muscle CSA or serum TST was observed at 1Y-post. There was a significant correlation between %changes in muscle mass and resting TST concentrations after the initial training period ( $r=0.856$ ,  $P<0.001$ ) as well as the second training period ( $r=0.83$ ,  $P=0.002$ ). **Discussion** These results indicated that the training frequency of once every two weeks was not sufficient to maintain the increased muscle mass induced by preceding training in healthy older men. Furthermore, changes in resting serum TST concentrations had significant correlations with changes in muscle mass, suggesting an important association between serum TST level and muscle anabolism during PRT.

### EFFECTS OF THREE WEEKS OF INTENSIFIED TRAINING AND TWO WEEKS OF TAPER ON MITOCHONDRIAL RESPIRATION IN HUMANS

Granata, C.A.

*Victoria University*

**Effects of three weeks of intensified training and two weeks of taper on mitochondrial respiration in humans** Granata C.A. 1, Oliveira R.S.F. 1, Stepto N. 1, Renner-Sattler K. 2 and Bishop D.J. 1, 1 School of Sport and Exercise Science and Institute of Sport, Exercise and Active Living (ISEAL), Victoria University, Melbourne, Australia 2 Institut für Hämatologie und Onkologie Universitätsklinikum Regensburg, Deutschland **Introduction** Mitochondrial respiration has been reported to be an important determinant of endurance performance [1], and interval training (IT) has been shown to induce increases in maximal ADP-stimulated mitochondrial respiration [2]. Despite this, little is known about the effects of a period of intensified training on mitochondrial respiration. Furthermore, to our knowledge, the effects of reduced training workload (i.e., taper) on mitochondrial respiration have not been reported to date. Hence, the purpose of our study was to measure mitochondrial respiration following intensified training and taper, and to determine if changes were associated with changes in cycling performance (20-km time trial). **Methods** Ten active men ( $\text{VO}_2\text{Peak}= 47.0 \text{ mL}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}$ ) took part in an intensified cycling training program (INT), performing an IT protocol twice a day for twenty consecutive days, followed by a two-week exponential taper (TP) consisting of 6 training sessions. Carbohydrate supplementation was used in order to prevent overreaching during the INT phase [3]. Muscle biopsies were taken from the vastus lateralis muscle before the study and after the INT and TP phases. Maximal (5 mM ADP) ADP-stimulated mitochondrial respiration was determined on permeabilised muscle fibers. **Results** Maximal ADP-stimulated and non-coupled respiration simultaneously increased and decreased significantly during the INT and TP phase, respectively. Interestingly ADP sensitivity (0.25 and 0.5 mM ADP) showed no significant change during either phase. Finally complex IV reserve respiration increased significantly but to a lesser extent than maximal respiration during INT and dropped below initial levels after TP. The changes in maximal respiration tended to mirror performance changes. **Discussion** Our study demonstrates that three weeks of INT increased maximal and non-coupled mitochondrial respiration by 30 and 40% respectively, and this was associated with a 5% increase in 20-km TT performance. Surprisingly, the exponential TP resulted in a non-significant decrease in performance; this was accompanied by a marked decrease in maximal respiration (15%), underlining the remarkable plasticity of skeletal muscle oxidative capacity. **References** 1. Jacobs, R.A., et al., *Journal of Applied Physiology*, 2011. 111(5): p. 1422-1430. 2. Daussin, F.N., et al., *American Journal of Physiology - Regulatory Integrative and Comparative Physiology*, 2008. 295(1): p. R264-R272. 3. Halson, S.L., et al., *Journal of Applied Physiology*, 2004. 97(4): p. 1245-1253.



09:50 - 11:20

## Oral presentations

### OP-PM13 Pacing and Perception

#### EFFECTS OF COOLING DURING CYCLING ON PHYSIOLOGICAL AND COGNITIVE RESPONSES

Brandenburg, J.P., Gaetz, M.

*University of the Fraser Valley*

**Introduction** Cooling strategies applied during exercise often result in improved performance. The effect of these strategies on cognitive and brain function remains unclear. This study examined the effects of cooling on physiological and perceptual responses, cognitive function, and the electroencephalogram (EEG) during vigorous cycling. **Methods** Nine active males ( $21 \pm 3$  y;  $76.9 \pm 7.7$  kg;  $179.6 \pm 3.8$  cm) completed two trials in a randomized order: a control (CTL) and a cooling (COOL) trial. In each trial, subjects performed 30 min of cycling at a constant power output ( $2.4 \pm 0.2$  W•kg<sup>-1</sup>). During COOL, subjects wore a cooling vest, cooling collar, and received fan cooling while cycling. No cooling was provided in CTL. Heart rate (HR), core (TC) and tympanic (TTY) temperatures, thermal sensation (ThS), and RPE were measured throughout. Cognitive function was measured using the Stroop test and EEG. In both trials water was ingested at a rate to match sweat losses. Air temperature ( $\sim 23^\circ\text{C}$ ) and humidity ( $\sim 50\%$ ) were similar in both trials. **Results** The maximum attained HR was lower in CTL ( $166 \pm 15$  b•min<sup>-1</sup>) than in COOL ( $161 \pm 14$  b•min<sup>-1</sup>) ( $p=0.005$ ). TC rose by  $1.1 \pm 0.3^\circ\text{C}$  to a high of  $38.3 \pm 0.4^\circ\text{C}$  in CTL and by  $0.9 \pm 0.2^\circ\text{C}$  to peak at  $38.2 \pm 0.4^\circ\text{C}$  in COOL (no difference). The rise in TTY was larger in CTL ( $1.1 \pm 0.3^\circ\text{C}$ ) than in COOL ( $0.8 \pm 0.3^\circ\text{C}$ ) ( $p=0.018$ ). ThS was lower throughout COOL ( $p<0.001$ ) while there were no differences in RPE. No significant changes were observed for the Stroop reaction time and errors in the CTL and COOL trials. In CTL, but not COOL, the number of Stroop errors immediately post-cycling was significantly correlated with the rise in TTY ( $r=0.59$ ;  $p=0.025$ ) and the rise in TC ( $r=0.78$ ;  $p=0.004$ ). During cycling differences between CTL and COOL in EEG ratios of low/higher frequency EEG bandwidths emerged (e.g. Theta/Beta1 ratio,  $p=0.019$ ). Significant correlations were observed between EEG ratios and the number of Stroop errors (e.g. ratio of alpha/beta1 activity vs. Stroop errors;  $r=0.63$ ;  $p=0.01$ ). **Discussion** Cooling, during 30 minutes of cycling, moderated the cardiovascular, thermal, and perceptual responses, the increase in low/higher frequency EEG ratios, but did not produce differences in Stroop test variables. Generally, the increase in low/higher frequency ratios during cycling reflects a neural state that is sub-optimal for cognitive functioning (e.g. increased theta, decreased beta activity). The significant correlations between the low/higher frequency EEG ratios and number of Stroop errors support this interpretation. It may be the case that increases in body temperature, as seen with TC and TTY, lead to the changes in the EEG and cognitive functioning. The significant relationships between the number of Stroop errors and the increases in TTY and TC support this observation.

#### EFFECT OF WARM-UP AND PRECOOLING ON 15-KM CYCLING PERFORMANCE IN THE HEAT

Levels, K.1,2, Teunissen, L.P.J.1,2, de Haan, A.1,3, de Koning, J.J.1,4, van Os, J.A.1,2, Foster, C.1,4, Daanen, H.A.M.1,2

1: MOVE, VU University (Amsterdam, The Netherlands), 2: TNO (Soesterberg, The Netherlands), 3: MMU (Manchester, UK), 4: UWLAX (La Crosse, USA)

**Introduction:** Both warm-up and precooling have proved to be beneficial for exercise performance. However, it remains unclear which preparation regime is optimal for endurance exercise in conditions of high environmental heat stress. Especially the combination of internal and external cooling can have beneficial effects on performance by lowering body heat content and creating a sensation of coolness. Therefore, the aim of this study was to analyse the effect of different preparation regimes on pacing and performance during a 15-km cycling time trial in the heat. **Methods:** Ten male subjects ( $24 \pm 5$  yrs) completed four 15-km time trials ( $30^\circ\text{C}$ , 50% relative humidity), preceded by different preparation regimes: 10 min cycling at 2 W/kg BM (WARM/UP), 30 min scalp cooling of which 10 min cycling at 2 W/kg BM (WARM/UP+SC), 2g/kg BM ice slurry ingestion (COOL), and 2g/kg BM ice slurry ingestion + 30 min scalp cooling (COOL+SC). During the trials, power output (PO), rectal (Tre) and skin (Tsk) temperature, thermal sensation (TS), heart rate (HR) and RPE were measured. **Results:** Tre at the start of the time trial was lower ( $P<0.05$ ) for COOL+SC ( $36.7 \pm 0.2^\circ\text{C}$ ) and COOL ( $36.8 \pm 0.3^\circ\text{C}$ ) than for WARM/UP ( $37.2 \pm 0.3^\circ\text{C}$ ) and WARM/UP+SC ( $37.1 \pm 0.3^\circ\text{C}$ ). Tsk and TS were lower at the start for COOL+SC than for the other conditions (mean difference Tsk:  $0.7 \pm 0.4^\circ\text{C}$ ;  $P<0.05$ ). During the time trial, a main difference in Tre was found between WARM/UP+SC and both COOL and COOL+SC ( $P<0.05$ ). Tsk was lower for COOL+SC than for WARM/UP ( $P<0.05$ ). Differences in Tre and Tsk between precooling and warm-up were significant during the first part of the time trial. No differences were found in finish time ( $P=0.28$ ) and mean PO ( $P=0.32$ ), although PO was higher for COOL+SC during the final part of the time trial (km 13-14;  $P<0.05$ ). HR was significantly higher for WARM/UP ( $170 \pm 9$ ) than for WARM/UP+SC ( $165 \pm 10$ ;  $P=0.04$ ). No overall effect of RPE was observed ( $P=0.19$ ). **Discussion:** Main finding of this study is that precooling by ice slurry ingestion and scalp cooling before the start of a 15-km cycling time trial after is beneficial for performance in the latter stages of the trial, although physiological and perceptual changes have completely disappeared at that moment. This indicates that internal and external cooling before the start of endurance exercise in the heat should be preferred over warming-up, especially since a higher work rate near the finish may be of great benefit in practice, when inter-individual differences are small.

#### PHYSICAL PERCEIVED EXERTION AND MENTAL AWARENESS WHEN EXERCISING IN THE HOT CONDITIONS

Lamberts, R.P.1, Noakes, T.D.1

1: UCT/MRC Research Unit for Exercise Science and Sports Medicine, Department of Human Biology, University of Cape Town, South Africa.

**Introduction** In a recent publication Swart et al. differentiated between physical sensations and the psychic sensations generated during exercise, measured by an adapted RPE scale (P-RPE) and a Task Effort Awareness scale (TEA), respectively. During a self paced 100km time trial (100km TT) and a 100km TT test performed at 70% of this intensity, they found that TEA scores were attenuated in relation to P-RPE scores, indicating a lower awareness of task effort when exercising at a lower intensity. It is unknown however whether factors other than intensity can also influence this task effort sensation. Therefore, the aim of this study was to determine whether task effort awareness would change when performing a time trial in differing environmental conditions. **Methods** Ten experienced well-trained male cyclists between 18 and 45 years ( $393 \pm 23$  W) completed four 40km TT in 20, 25, 30 and  $35^\circ\text{C}$  in a randomized order. Rating of physical exer-

tion (P-RPE) and task effort awareness were recorded every 5 km. Subjects randomly assigned to different environmental conditions, while data was collected over a 2 week period. To minimize the effect of the season of the year, all data was collected within a 6 week testing period. Results Time to complete the 40km TT increased significantly with temperature ( $p < 0.001$ ) from  $3874 \pm 92$  s in 20 degrees Celsius to  $4199 \pm 99$  s in 35 degrees Celsius. Physical rating of perceived exertion (P-RPE) were similar during all 4 time trials in 20, 25, 30 and 35 °C, starting at approximately 16 and finishing at approximately 19 or 20. Task effort awareness levels (TEA) differed significantly between the four different temperatures, being higher in warmer environmental conditions. Differences in task effort awareness were seen from 5 km (ranging from  $7.5 \pm 0.4$  in 20 degrees Celsius to  $8.6 \pm 0.2$  in 35 degrees Celsius) and finished at a similar task effort awareness level of 9 to 9.5 in all the trials. Discussion Although that self paced time trial performance decreases with a rise in environmental temperature, physical ratings of perceived exertion (P-RPE) were similar during the all 4 trials, as reported before (Swart et al., 2009; Crewe et al., 2008). In contrast, levels of task effort awareness were higher when performing the time trials in warmer environmental conditions. This finding supports the capacity of the TEA scale to differentiate between physical and psychic sensation during exercise. We hypothesize that increased afferent feed-back when cycling in warmer conditions results in higher task effort awareness levels, as seen in this study and that rising task effort is responsible for the reduction in exercise intensity in an attempt to maintain the P-RPE within the constraints of the pre-determined P-RPE template. References Swart J, Lindsay TR, Lambert MI, Brown JC, Noakes TD. (2012). Br. J. Sports Med. 46,42-48 Swart J, Lamberts RP, Lambert MI, Lambert EV, Woolrich RW, Johnston S Noakes TD. (2009) Br. J. Sports Med. 43,775-781 Crew H, Tucker R, Noakes, TD. (2008) Eur J Appl Physiol 103, 569-577

## EVIDENCE OF PACING DURING REPEATED SHUTTLE SPRINTS

Christie, C., Armstrong, S.

*Rhodes University*

Introduction As there is limited data on pacing models in intermittent sports, the main purpose of this study was to establish how the knowledge of shuttle number would influence pacing during repeated sprints between the wickets while batting. Methods Ten batsmen performed three trials: Deceptive Trial (DT), Unknown Trial (UT), and Control Trial (CT). Each consisted of 14 shuttle runs although the information provided at the start of each differed. With the DT, players' were told they would be running 7 shuttles but, were doing 14. With the UT trial, players' were not told how many shuttles they would sprint but were stopped after 14. With the CT the players' were correctly informed of the fact that they would be doing 14 shuttles. Sprint times, surface EMG and perceptions of effort were the outcome measures. Results The non-significant trend was for faster shuttle times overall during the DT (6.96s) compared to the other two trials (7.01s and 7.11s for the CT and UT). There was evidence of an end spurt at the 7th and 14th shuttle in the DT. An end spurt was also evident at the end of the CT; this end spurt was not evident in the UT. Hamstring activation was lowest throughout the DT and there was a significant decrease in hamstring recruitment over time in all trials. Central RPE was similar in all trials while local RPE was lowest for the DT. All perceptions of effort increased significantly over time in all trials. Discussion It is highly plausible that during the DT there was a greater subconscious neural drive, resulting in the fastest times (Billaut et al., 2011). The more conservative approach during the UT is an indication that inhibition may have occurred (St Clair Gibson et al., 2006). The CT probably allowed speed to be predetermined using teleoanticipatory factors to affect performance (St Clair Gibson et al., 2006). There were indications of an 'end spurt' in the DT and CT suggesting reserve was available (Tucker, 2009). The drop in hamstring activation over time in all trials could be indicative of fatigue. This study suggests that pacing may occur in batting although more research is needed to validate this. References Billaut F, Bishop DJ, Schaerz S, Noakes TD. (2011). Influence of knowledge of sprint number on pacing during repeated-sprint exercise. Med Sci Sports & Ex, 43(4), 665-672. St Clair Gibson A, Lambert EV., Rauch, L.H.G., Tucker, R., Baden, D.A., Foster, C., and Noakes, T.D. (2006). The Role of Information Processing Between the Brain and Peripheral Physiological Systems in Pacing and Perception of Effort. J of Sports Med, 36(8): 705-722. Tucker, R. (2009). The anticipatory regulation of performance: the physiological basis for pacing strategies and the development of a perception-based model for exercise performance. British J of Sports Med, 43(1): 392-400.

## THE EFFECT OF MANIPULATING THE PRE-EXERCISE TEMPLATE ON TIME-TRIAL PERFORMANCE

Jaime, S., Nyberg, K., Condello, G., Casolino, E., Dodge, C., Marroyo-Rodriguez, J., Mikat, R., Porcari, J.P., Wright, G., Foster, C.

*University of Wisconsin-La Crosse*

Introduction Responsive control of power output (PO) is essential in order to achieve optimal performance with acceptable homeostatic disturbances. It is known that an athlete will decrease their PO following a decrease in arterial oxygen saturation (SaO<sub>2</sub>), and that during this decrease in PO, the athlete regulates the sense of perceived exertion (RPE) (Johnson et al., 2009; Joseph et al., 2008). The purpose of this study was to understand whether homeostatic disturbances prior to a time trial influence competitive exercise intensity would reset the pre-exercise template, reflected by the PO during the first 1 km of a 5 km time trial. Methods Seven well-trained subjects performed a VO<sub>2</sub> max test, two habituation trials, and four randomly ordered, single blinded 5 km cycle ergometer time trials with warm-up (WU) and time trial (TT) conditions. Including NN (normoxic WU/hypoxic TT), NH (normoxic WU/hypoxic TT), HH (hypoxic WU/hypoxic TT), or HN (hypoxic WU/normoxic TT) (hypoxic FIO<sub>2</sub> = 0.15, normoxic FIO<sub>2</sub> = 0.21). Results The hypoxic WU (HR: 163bpm, RPE: 5.9, HLa: 7.6 mmol/L, SaO<sub>2</sub>: 84%) was much more challenging than the normoxic WU (HR: 162bpm, RPE: 4.2, HLa: 5.2mmol/L, SaO<sub>2</sub>: 97%). Despite this, there was no significant difference ( $p > 0.05$ ) between the warm-up conditions in PO during the first 500m of the time trial (NN:  $272W \pm 76W$ , NH:  $283W \pm 67W$ , HH:  $270W \pm 54W$ , HN:  $284W \pm 79W$ ). During the second 500m, PO was decreased in the hypoxic racing conditions ( $264W \pm 46W$  vs  $244W \pm 49W$ ), without reference to hypoxia/normoxia during WU. The SaO<sub>2</sub> was significantly different ( $p < 0.00$ ) during normoxic ( $96\% \pm 0.59\%$ ) compared to hypoxic ( $83\% \pm 0.61\%$ ) at all time points. Discussion The central governor concept suggests that PO might be reduced following a more challenging WU (attributable to hypoxia) on the premise that the exerciser might expect a greater challenge to homeostasis. However, the results demonstrate that despite much more challenging conditions during the hypoxic WU, the PO during the opening part of the time trial was not affected, demonstrating the robustness of the pre-exercise template. References Johnson BD, Joseph T, Wright G, Battista RA, Dodge C, Balweg A, De Koning JJ, Foster C (2009). Eur J Appl Physiol, 106(4), 493-499. Joseph T, Johnson B, Battista RA, Wright G, Dodge C, Porcari JP, De Koning JJ, Foster C (2008). Med Sci Sports Exerc, 40(2), 381-386.

## RATE OF PERCEIVED EXERTION CHANGES NON-MONOTONICALLY IN CONSTANT-POWER EXERCISE UNTIL EXHAUSTION

Balagué, N.1, Aragonés, D.1, Hristovski, R.2, Tenenbaum, G.3, Garcia, S.1

1: INEFC (Barcelona, Spain), 2: Skopje Univ. (Rep. of Macedonia), 3: FSU (Florida, USA)

Introduction Rate of perceived exertion (RPE) increases linearly with workload in incremental exercises; however, RPE changes under constant workload are unclear. The aim of this study was to reveal and study the non-monotonic changes of RPE in constant-power exercise performed until volitional exhaustion. Methods A pilot study and a main experiment were carried out. The same cycling test (Sport Excalibur 925900) was performed in both cases. After a progressive warming-up, twenty seven participants pedaled at a constant-power (RPE= 15, 70 RPM) until volitional exhaustion. The pilot study compared the cardinal RPE dynamics during the exercise using three different measurement strategies: (1) CR10 scale sampling RPE every min (n = 9), (2) CR10 scale sampling every 15 sec (n = 8), and (3) RPE 6-20 scale sampling every 15 sec (n = 10). In the main experiment 13 participants reported their ordinal RPE non-monotonous changes (increases/decreases) when noticed during the same cycling exercise. The data series of the participants were divided into 10 non-overlapping temporal windows to obtain the RPE non-monotonic changes probabilities. Results In the pilot study, where 3 measurement strategies were used, 10%, 30% and 60% of the participants, respectively, presented non-monotonic changes in RPE. In the main experiment all participants showed such RPE non-monotonic changes, which were identified in three different time scales (15 sec, 30 sec, min). The 10 exertion time windows repeated-measures Friedman ANOVA (N = 13, df = 9) revealed a significant effect,  $\chi^2(13, 9) = 41.41$   $p < .0001$ , of exertion time on RPE non-monotonic changes probabilities. Three effort phases were distinguished: The beginning and ending were characterized by RPE monotonic changes and the mid phase by RPE non-monotonic changes. Discussion The findings, relevant for a nonlinear dynamic approach to exercise tolerance, reveal the existence of non-monotonic changes in RPE during constant-power exercise, highlight the interest of its evaluation for recognising non-invasively effort tolerance phases and provide information for clarifying the role assigned to perceived exertion in previous psychobiological models.

11:30 - 12:45

## Plenary sessions

### PS-PL02 Performance in the Heat: What Happens in your Head?

#### THE HOT BRAIN - CEREBRAL METABOLISM AND MOTOR PERFORMANCE DURING EXERCISE IN THE HEAT

Nybo, L.

University of Copenhagen

During prolonged exercise in the heat, the brain temperature may increase to well above 40°C as heat removal by the cerebral circulation becomes inadequate to match the cerebral metabolic heat production (Nybo et al., 2002). Heat is consequently stored in the brain and the mental effort associated with exercise increases in step with the rise in brain temperature (Nybo & Secher NH, 2004). Under such exercise conditions, intra nasal cooling, specific cooling of the neck or cooling of the face does not affect the average brain temperature (Nybo & Secher, 2011). Also, the cerebral metabolic rate for oxygen increases as consequence of the elevated temperature, but paradoxically the cerebral blood flow becomes reduced as hyperthermia-induced hyperventilation lowers the arterial carbon dioxide tension. Hence, the cerebral mitochondrial oxygen tension becomes reduced, but the reduction is modest and apparently not the main factor influencing the central fatigue that arises secondary to hyperthermia (Rasmussen et al., 2010). The present presentation provides an up-to-date overview of the cerebral changes occurring during prolonged exercise in the heat – with special reference to those of importance for fatigue and motor performance. References Nybo L & Secher NH (2004). Cerebral perturbations provoked by prolonged exercise. *Prog Neurobiol* 72, 223-261. Nybo L & Secher NH (2011). Last Word on Point:Counterpoint: Humans do/do not demonstrate selective brain cooling during hyperthermia. *J Appl Physiol* 110, 582. Nybo L, Secher NH, & Nielsen B (2002). Inadequate heat release from the human brain during prolonged exercise with hyperthermia. *J Physiol* 545, 697-704. Rasmussen P, Nybo L, Volianitis S, Moller K, Secher NH, & Gjedde A (2010). Cerebral oxygenation is reduced during hyperthermic exercise in humans. *Acta Physiol (Oxf)* 199, 63-70.

#### PLEASURE AND OPTIMIZATION OF MUSCULAR EXERCISE

Cabanac, M.

Laval University

The results of experiments with human subjects showed that pleasure was the optimizer of all decision making. In the case of muscular work, maximization of sensory pleasure optimized physiological functioning. What was most defended against the excess heat produced by muscular work was brain temperature.

13:45 - 14:45

## Poster presentations

## PP-BN01 Sport Biomechanics 1

**CHANGES IN EMG AND GAIT CHARACTERISTICS WHEN WALKING WITH THE REEBOK EASY TONE UNSTABLE SHOE CONSTRUCTION**

Horsak, B.1, Baca, A.2

1: University of Applied Sciences (St. Pölten, Austria), 2: University of Vienna (Vienna, Austria)

**Introduction** In the last few years, several authors have conducted research in the field of instable shoe constructions, especially focusing research on the effects of Masai barefoot technology and similar sole constructions. Recently, a relatively new instable sole construction was introduced by Reebok, the Easy Tone Technology (ET), which uses two built-in balance pods in the forefoot and heel areas, in order to create micro-instability during each step. Purpose of this study was to investigate the immediate effects of using ET footwear on kinetic, kinematic and muscle activation patterns during gait. **Methods** Five healthy female and seven healthy male subjects (N=12) volunteered to participate in this study (age: 25±4years, height: 172±11cm, mass: 67±11kg). 3D gait analyses were performed using a motion capture system (VICON) at 200Hz, the VICON Plug-In-Gait model, one force plate at 1000Hz (KISTLER) and surface EMG at 1000Hz (DELSYS) for assessing mean activities of Mm. gluteus maximus (GM), biceps femoris (BF), gastrocnemius medialis (GMM), vastus medialis (VM) and lateralis (VL), tibialis anterior (TA) and peroneus longus (PL). Six walking trials per subject were captured, time normalized over one gait cycle and averaged for walking with ET and normal footwear. **Results** Concerning time-distance parameters, walking with ET footwear slightly increased walking speed (3.2%, p=0.021) and stride-length (3.1%, p=0.009), whereas step time was somewhat reduced (-1.1%, p=0.028). Small but significant increase of hip flexion during initial contact (3.3%, p=0.031), decreases in maximum knee flexion (-4.5%, p=0.009), knee range of motion (-4%, p=0.027), ankle plantar-flexion (-21.6%, p=0.016) and ankle range of motion (-16%, p=0.009) in sagittal plane were found. Kinetics showed slightly increased maximum hip flexion moments (3.6%, p=0.013) and maximum ankle plantar-flexion moments (13.1%, p=0.036). Mean muscle activation showed some trends towards an increase especially for late stance phase of VM and TA (44.9% and 32.8%, p>0.05), whereas BF showed trends towards a reduction of up to 41.7% (p>0.05) during stance. GM showed a moderate increase of 4.6% (p>0.05) and PL of 12.4% (p>0.05) during initial contact. **Discussion** To the authors' knowledge, this study was the first investigating immediate effects of the recently proposed ET technology on gait characteristics. The unstable shoe produced some changes in kinematic, kinetic as well as trends in EMG characteristics. Trends especially for mean muscle activation suggest that walking with ET shoes can possibly increase muscle activation during late stance phase while slightly increasing external sagittal moments in hip and ankle joints. Results need to be validated through further studies.

**DEFINITION OF FOOTSTRIKE PATTERN DURING RUNNING BASED ON STRIKE INDEX**

Mann, R.1,2, Urhausen, A.1,3, Meijer, K.2, Statham, A.4, Brunner, R.1, Gette, P.1, Theisen, D.1

CRP-Santé

**Introduction** It has been suggested that running style, classified as rear-foot (RFS), mid-foot (MFS) or forefoot (FFS) strike, is closely related to the risk of running-related injury occurrence (1). Foot strike pattern during running is by definition determined by the initial foot contact angle (CA) with respect to the ground. It can also be assessed using strike index (SI), the initial point of contact on the foot sole with the ground (2). Previous definitions are arbitrary, with SI values up to 33% taken as a RFS, between 33 and 66% as a MFS and above 66% as a FFS (2). The aim of this study was to provide a clear definition of running style based on the relationship between SI and the initial foot contact angle (CA). **Methods** A pressure-sensitive insole, the Runalyser (by TNO Eindhoven, The Netherlands) was used to record pressure data (247 Hz) in 11 participants on a treadmill, each instructed to run in the following conditions: warm-up, FFS, MFS and RFS. SI was determined for each condition from 30-s Runalyser acquisitions and expressed as a percentage of total foot sole length. Active markers were placed at the heel and lateral metatarsophalangeal joint of the right shoe. A high-speed (200 Hz) motion analysis system (CODAmotion, Charnwood Dynamics, UK) was used to calculate the CA of the sole of the running shoe with the surface of the treadmill in the sagittal plane. Average SI and CA were calculated on >30 steps during each condition and analysed in a least squares linear regression with SI as the dependent variable. **Results** SI during warm-up varied between 22.5 and 32.3%. SI values across the different running styles ranged between 20.7 and 65.5%, while CA ranged between 32 and -23°. The two variables had a strong (R<sup>2</sup>=0.83) linear relationship: SI(%)=-0.8.CA(°)+43.2. The 95% confidence interval of the y-intercept was [40.7, 45.6]. **Discussion** This study provides a rationale for foot strike pattern definition based on the relationship between SI and CA. The 95% confidence interval of the y-intercept provides the boundaries to define MFS (0° CA), the SI values below and above defining RFS and FFS, respectively. This definition allows for the relationship between running style and injury occurrence to be studied in a large cohort using the Runalyser. **References** 1. Lieberman DE, Venkadesan M, Werbel WA, Daoud AI, D'Andrea S, Davis IS, et al. Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature*. 2010;463:531-6. 2. Cavanagh PR, LaFortune MA. Ground reaction forces in distance running. *J Biomech*. 1980;13:397-406.

**ESTIMATION OF FRONT-CRAWL VELOCITY BY INERTIAL SENSORS**

Dadashi, F.1, Crettenand, F.2, Millet, G.P.2, Aminian, K.1

1. Laboratory of Movement Analysis and Measurement, EPFL 2. ISSUL Institute of Sport Sciences, UNIL

**Introduction** Velocity is the main parameter of performance in swimming. To date, practical assessment of velocity is possible by using tethered apparatus that disturbs the swimmers' technique and measures the velocity only in one direction. Our study aimed to design a new system to measure the swimming velocity in front-crawl, using a single light waterproofed body-worn inertial sensor. **Methods** 10 well-trained swimmers (17.5±2.3 yr., 174.2±9.8 cm and 66.1±10.3 kg) performed 25-m front-crawl trials in four different speeds, equipped with one inertial sensor (Physilog®, 3D accelerometer, 3D gyroscope, 500Hz) worn on the sacrum. A tethered device (SpeedRT, APLab, Rome, 100Hz) was attached to the swimmers as reference. An accurate and drift-free integration of the acceleration measured by the inertial sensor was achieved by considering biomechanical constraints of front-crawl. First, sensor orientation was determined by strap-

down integration of gyroscope's data (Sabatini, 2005). The effect of drift was compensated by assuming that main angular velocity direction in body anatomical frame should be in sagittal plane of motion. Any deviation from this condition was considered to be the drift and removed. Finally the instantaneous velocity was calculated by integrating forward swimming acceleration. Results N=421 cycles were compared between the two systems and range of velocities was [0.91, 1.95] m/s. A significant correlation was observed between the two systems in measuring cycle average velocity (Spearman's  $\rho=0.94$ ,  $p<0.001$ ). The difference in cycle average velocity measured by the two systems was  $0.4\pm 6.9$  cm.s<sup>-1</sup>. Concurrent validity of our method, assessed by normalized pair wise variability index (nPVI) (Sandnes & Jian, 2004), was 4.3%. Discussion No significant difference between the two systems confirms the accuracy of our speed assessment method. The nPVI value shows that the two systems have in average 4.3% difference in detection of average cycle velocity variation. Most of the difference can originate from the elasticity of the nylon cord of the reference system, especially during high transient accelerations and decelerations. A technical problem that hinders the comparison of instantaneous velocity is the synchronization of the two systems, while for cycle average velocity comparison an ordinal association of cycles is needed. The accurate measurement of cycle average velocity allows the determination of the inter-cycle velocity variability that is a key determinant of swimming economy. Further step can be towards modification of proposed method to make it applicable for other swimming stroke techniques. References Sabatini, A. M.(2005). Medical and Biological Engineering and Computing, 43(1), 94-101. Sandnes, F. E., & Jian, H. L.(2004). Mobile Human-Computer Interaction 2004, 25-37.

## GENDER DIFFERENCES DURING CHANGES OF DIRECTION IN COLLEGE SOCCER PLAYERS

Condello, G., Kernozek, W.T., Suchomel, T., Tessitore, A., Foster, C.

*University of Rome Foro Italico*

**Introduction** Despite studies of the physical demands of the ability to change direction, a deep understanding of how soccer players exactly perform changes of direction is still unclear. The purpose of this study was to evaluate the differences between male and female soccer players for kinetic and kinematic parameters during a change of direction, using either the dominant and non-dominant leg. **Methods** Male and female college soccer players (NCAA Division III) (male: n=14, age  $19.6 \pm 1.5$  y, height  $179 \pm 5$  cm, weight  $73.1 \pm 7.2$  kg, experience in soccer  $13.7 \pm 2.6$  y; female: n=12, age  $21 \pm 2.7$  y, height  $167 \pm 4$  cm, weight  $61.9 \pm 6.2$  kg, experience in soccer  $15.1 \pm 2.6$  y) performed 10 trials (5 for each leg) of a 10m sprint with a 60° change of direction at 5m. A motion capture system and embedded force plate were used to assess vertical (VGRF), horizontal (HGRF) ground reaction force, contact time (CT), impulse (IMP), performance cutting angle (PERFANG - angle calculated using the pelvis markers during a window from 1.50m before force plate contact and from force plate contact to 1.50m), plate cutting angle (PLAANG - angle calculated using the pelvis markers during the contact time of the foot with the force plate), and minimal horizontal distance (DIST) of the pelvis markers from the foot contact point with the force plate (normalized by leg length). The dominant leg was defined as the athlete's preferred kicking leg. Associations between each kinetic and kinematic parameter, differences between dominant (DL) and non-dominant (NDL) leg and gender differences were assessed using the mean value of the 5 trials for each leg. Results Significant correlations were found between PERFANG and CT (DL:  $r = -0.62$  and NDL:  $r = -0.74$ ) and between DIST and HGRF (DL:  $r = -0.46$  and NDL:  $r = -0.39$ ). Significant differences were determined between male and female for DIST ( $p = 0.02$ ), PERFANG ( $p = 0.043$ ) and HGRF ( $p = 0.005$ ). Significant differences were evident between DL and NDL for DIST ( $p = 0.012$ ), PERFANG ( $p = 0.011$ ) and VGRF ( $p = 0.029$ ). No interaction between leg dominance and gender were found in these kinematic and kinetic parameters. **Discussion** The results of this study highlighted that the less acute PERFANG resulted in a higher CT needed to change direction. GRF was not well associated with the ability to perform a greater change of direction. Even though the male performers were able to generate a greater GRF, the females showed a greater ability to perform a sharper change of direction. The NDL showed a sharper change of direction than the DL across all players. This appears reasonable since the primary role of the NDL may be to perform changes of direction so that the DL can be used to perform skills with the ball.

## COMPARISONS BETWEEN HERRINGBONE AND DIAGONAL STRIDE TECHNIQUES IN CROSS-COUNTRY SKIING

Andersson, E.1, Pellegrini, B.2, Stöggl, T.1,3, Sandbakk, Ø.4, Holmberg, H.C.1

*(1) Swedish Winter Sports Research Centre, Mid Sweden University; (2) University of Verona, Italy; (3) University of Salzburg, Austria; (4) Norwegian University of Science and Technology*

**INTRODUCTION:** Diagonal stride (DS) is the commonly used technique for classical uphill skiing. Herringbone (HB) is a technique that generally resembles DS in arm and leg motion but in contrast to DS, HB is used mainly on steeper inclines. For HB, skis are laterally angled and slightly edged in order to maintain ski grip and propulsive forces without gliding. The present study was aimed to compare biomechanical differences between HB and DS. **METHOD:** Eight male elite cross-country skiers performed DS and HB skiing on a 7.5° uphill at a velocity of  $3.7 \pm 0.3$  m/s, equivalent to 65% of their previously measured maximal DS velocity. Pole and plantar forces (Pedar Mobile) were recorded and cycle characteristics were obtained from these data. A paired t-test was used to identify differences between DS and HB. Significance was set at  $\alpha<0.05$ . **RESULTS:** Cycle rate was 46% higher and cycle length 32% shorter in HB than DS (1.30 vs. 0.89 Hz and 2.8 vs. 4.1 m; both  $P<0.05$ ). In HB, skiers used a lateral ski angle of 17° in the absence of a gliding phase, whereas in DS a gliding phase of 0.42 s was used. The leg thrust durations (0.31 and 0.26 s) differed between HB and DS, respectively ( $P<0.05$ ), with a similar leg swing of 0.47 s. Relative phase durations for the leg actions were: 40% thrust and 60% swing in HB and 36% gliding, 23% thrust and 42% swing for DS (both  $P<0.05$ ). The peak leg force and the rate of force development (RFD) was 17% and 18% lower in HB vs. DS (both  $P<0.05$ ), with a similar time to peak force (~150 ms). For the arm action, poling times (0.31 and 0.43 s) and arm swing times (0.46 and 0.70 s) differed between the HB and DS, respectively (both  $P<0.05$ ), resulting in similar relative poling and arm swing phases of ~39% and ~61%. The peak pole forces were similar at ~101 N, with a 62% shorter time to peak and a 2.6 times higher RFD in HB vs. DS (both  $P<0.05$ ). The pole force impulse was 39% lower in HB, with similar leg thrust force impulses between the techniques resulting in pole to leg force impulse ratios of 5% in HB and 9% in DS ( $P<0.05$ ). **CONCLUSION:** The primary differences between HB and DS were: 1) a substantially higher cycle rate and shorter cycle length due to the absence of gliding and 2) longer absolute and relative leg thrusts. These results demonstrate that DS should be used on most uphill inclines to effectively glide and increase cycle length. Additionally, as the uphill becomes steeper, HB is likely to be more effective in order to maintain propulsion.

## NEUROMECHANICAL COUPLING BETWEEN THE TRUNK, HIP AND KNEE DURING LATERAL REACTIVE JUMPS

Weltin, E., Mornieux, G., Gollhofer, A.

*Albert-Ludwigs University Freiburg*

Neuromechanical coupling between the trunk, hip and knee during lateral reactive jumps Weltin E, Mornieux G, Gollhofer A Department of Sport and Sport Science, University of Freiburg (Germany) Introduction It is well documented that female athletes are at a 2- to 10-fold greater risk of anterior cruciate ligament (ACL) injury than male athletes. Video analysis revealed that lateral trunk motion might play a role in the mechanism of noncontact ACL injuries in female athletes (Hewett et al. 2009) and that possibly higher knee loads and motions result from reduced neuromuscular control of the trunk. Thus analysis of neuromuscular control of the trunk seems to be an interesting new perspective regarding ACL injury mechanisms. Therefore, the aim of the present study was to clarify if female athletes suffer from different neuromechanical coupling between the trunk, hip and knee during lateral reactive jump. Methods 3D whole body kinematics were recorded (Vicon) for 12 men and 12 women during lateral reactive jumps performed over a forceplate (AMTI). EMG data was collected for the following muscles: vastus lateralis (VL), vastus medialis (VM), biceps femoris (BF), semitendinosus (ST), and gluteus medius (GM). Trunk, hip and knee kinematics at the time of the maximal knee joint abduction moment as well as muscles onset and mean activation were compared between males and females by means of unpaired Student T-tests. Results Analysis of the EMG data revealed a later onset of GM (male  $127 \pm 41$  ms vs. female  $74.7 \pm 60$  ms,  $p=0.019$ ) and a trend towards greater VL activation for female athletes ( $p=0.053$ ). Female showed significantly lower trunk abduction angle ( $1.9 \pm 5^\circ$  vs.  $6.4 \pm 5.1^\circ$ ,  $p=0.026$ ), higher hip external rotation ( $-3 \pm 6.4^\circ$  vs.  $3.3 \pm 5^\circ$ ,  $p=0.008$ ) and higher knee valgus angle ( $-4.3 \pm 4.1^\circ$  vs.  $1.9 \pm 2.7^\circ$ ,  $p=0.001$ ) than male. No significant differences could be observed for knee joint abduction moment. Discussion Although no difference in knee joint abduction moment were found between males and females, the increased knee valgus and hip external rotation could be associated with higher knee injury risk (McLean et al., 2004). The later onset of GM observed by females could be associated with less hip control in the frontal plane and higher activation of lateral thigh muscles may explain the reported higher knee valgus angle since a balanced activation pattern is necessary to stabilize the knee joint. According to the present trunk abduction angle values, females did not present any deficit in the coupling between the trunk and pelvis segments. Different testing conditions focusing more on dynamic stabilization of the trunk (e.g. by application of perturbation upon initial contact) would further help to understand the influence of the trunk control during lateral movements. Hewett TE, Torg JS, Boden BP (2009). *Br J Sports Med* 43:417-422 McLean SG, Lipfert SW, van den Bogert AJ (2004). *Med Sci Sports Exerc* 36:1008-1016

## THE EFFECT OF INCREMENTAL TRAINING INTENSITIES ON JOINT DYNAMICS IN ELITE ROWERS

Buckeridge, E., Bull, A., McGregor, A.

*Imperial College London*

Introduction Rowers train at a range of work intensities in order to develop aerobic fitness as well as explosive leg power and strength. Changes in lumbo-pelvic (LP) kinematics have been noted when rowing at higher intensities (McGregor et al., 2004), however, little is known about the changes in joint loading patterns that occur at various work rates. Therefore the aim of this study was to quantify the effects of incremental work rates on lower limb and LP loading during ergometer rowing. Methods Twelve elite female rowers performed an incremental step test on a rowing ergometer. Each rowed for 3 minutes at the following strokes rates; 18, 24, 28 strokes per minute and free rate (i.e. maximum effort). A motion tracking system recorded 3D kinematic data of rowers' ankle, knee, hip and LP joints. External forces were measured by load cells incorporated at the handle, seat and foot stretchers. Intersegmental joint moments were calculated using inverse dynamics. Changes in joint loading and performance parameters, with respect to work rate, were examined using repeated measures ANOVA. Results No change in maximum handle force, vertical foot force or horizontal foot force were observed as work rate increased, whilst maximum seat force increased from 11.9 to 13.2 N/kg ( $p<0.05$ ). All joints exhibited significantly increased extension moments at the catch and increased peak flexion moments during the recovery phase. Peak ankle extension moments increased from 1.16 to 1.22 Nm/kg ( $p<0.05$ ). There was a small reduction in peak knee extension moment from 3.84 to 3.66 Nm/kg ( $p<0.05$ ), whilst peak hip extension moments were stable across all rates. Peak LP extension moments increased from 12.55 to 13.11 Nm/kg ( $p<0.05$ ) and this was coupled by proportional increases in LP flexion and pelvis range of motion ( $p<0.05$ ). Discussion Large LP extension moments were present during the rowing stroke and increased with respect to work rate. Flexion moments also increased during recovery, as higher stroke rates meant they had less time to slide naturally into the catch position. There was an increase in the ratio of peak hip to peak knee extension moments, which was due to reduced effort at the knee rather than increased effort at the hip. Consequently, the increase in LP loading at higher work rates is unlikely to be a measure of greater performance, as corresponding increases in handle and foot stretcher forces were not observed. Alternatively, it may be an indicator of technique decline at higher work rates, as larger peak LP extension moments occurred alongside increases in LP flexion and posterior hip range of motion. Reference McGregor A, Bull A, Byng-Maddick R. (2004). *Int J Sport Med*, 25,465-470.

## FOOT POSITIONING IN CYCLING: SELF SELECTION AND VARIABILITY

Disley, B.X., Li, F.X.

*University of Birmingham*

Introduction: Correct fit on a bicycle is essential for improved performance and comfort. At the pedal Q Factor (the horizontal distance between the cranks) and position of the cleats determine the location and range of movement of the foot. Commercial cleat and pedal systems limit the amount of rotation allowed at the foot ("float") without any supporting experimental data. As the pedalling action is constrained, increasing the degrees of freedom at the pedal should highlight inter-individual differences in pedalling mechanics. Previous research has shown that novice cyclists are more unstable and less proficient at executing a consistent movement pattern whilst cycling. There is no available data indicating if this difference remains when float is manipulated. Aims: The aims of this study were to a) examine whether commercial cleat and pedal systems provide the cyclist with sufficient freedom of movement during the pedal stroke, and b) whether stable and unstable cyclists respond differently to this increased freedom. It was hypothesised that individual differences in pedalling mechanics will result in situations where commercial systems limit freedom of movement, and that unstable cyclists will require a greater range of movement at the foot than stable cyclists. Methods: 29 male and female cyclists pedalled on an adjustable bicycle equipped with custom floating pedals. Pedals were able to move freely laterally towards and away from the bicycle (lateral and free conditions) and free to rotate (rotation and free conditions). 2 groups of 12 were selected based upon knee variability in the free condition: stable (ST) and unstable (UST). 3D kinematic data was taken in 4 conditions – fixed, lateral, rotation and free. Results: UST become 2.5mm more unstable (in terms of knee variability) as more degrees of freedom were introduced ( $p=.035$ ). Self selected Q Factor was lower in ST compared to UST in the free condition ( $p=.049$ ,  $ST=137.3 \pm 16.8$ mm,  $UST=152.6 \pm 18.9$ mm). ST trained for more hours than

UST ( $p=.008$ ,  $ST=8.8\pm 4.0$ hrs,  $UST=4.4\pm 3.3$ hrs), had less variability in float during the pedal stroke ( $p=.030$ ,  $ST=2.0$  deg,  $UST=2.6$  deg), and a lower maximum foot angle ( $p=.014$ ,  $ST=15.5$  deg,  $UST=19.6$  deg). There was no effect of gender on pedalling mechanics. Conclusions: Commercial cleat and crank systems present limitations for foot positioning in both stable and unstable cyclists. Pedal systems that provide more float than standard ( $\sim 15$ - $20$ deg vs.  $6$ deg) will not constrain the foot during the pedal stroke, which may affect power production and/or injury prevention. All cyclists exhibit different levels of variability that have an effect upon optimum foot positioning, and which must be taken into account during the selection and set up of equipment. Contact details: f.x.li@bham.ac.uk

## THE SHOULDER RANGE OF MOTION OF ALTERNATIVE SPIKE/SERVE TECHNIQUES AS A POTENTIAL INJURY PREDICTOR IN VOLLEYBALL

Seminati, E.

*Post Doc*

THE SHOULDER RANGE OF MOTION OF ALTERNATIVE SPIKE/SERVE TECHNIQUES AS A POTENTIAL INJURY PREDICTOR IN VOLLEYBALL. Seminati E.1, Marzari A.2, Vacondio O.3, Minetti A.E.1 1: Università degli Studi di Milano (Milano, Italy), 2: Niguarda Ca'Granda Hospital, (Milano, Italy), 3 Federazione Italiana Pallavolo (Milano, Italy) Introduction Volleyball is at the third place after Soccer and Basket within the sport activities causing injuries. Overuse and stresses during the traditional spike and serve movements, make the shoulder one of the most commonly exposed body part (Chan et al. 1993, Verhagen et al. 2004). Pain, reduced range of motion and mobility, bring often the athletes to prematurely interrupt their career. Different spike techniques are supposed to be associated to different risk damage of the shoulder joint. Here we compared two of them by also regarding the skills and fitness necessary for the athletes' performance. Methods 21 volleyball players, from high-level National categories, performed the spike movement using a traditional and an alternative technique, (TT and AT respectively), in 3 different conditions: without jumping, jumping with and without hitting the ball. Upper limb and trunk were modelled, as multilink segment structures (Murray, 1999). 3D positions of 16 reflective markers were recorded with a 6-camera optoelectronic system ( $f=250$ Hz). Glenohumeral centre was viewed as the centre of an imaginary sphere described by the distal end of the humerus, with a radius of 200 mm. The spatial relationships between humerus and trunk (considered as a relative system, to have data independently on the investigated condition) were described on this sphere in terms of an angle of azimuth (longitude on the sphere), elevation (latitude on the sphere) and axial rotation (intra-extra rotation) of the humerus about its longitudinal axis (An et al 1991). Ball speed was measured with a high-frequency camera (200Hz). Results Preliminary results showed that the two techniques (TT and AT) travel along two significantly different trajectories on the imaginary sphere. Maximal humerus elevation was reduced by the 15% in AT, while the azimuth angular amplitude was significantly higher for the AT, compared to the TT. Ball Speed, arm velocity and maximal arm height had higher values for the AT, in each of the three considered conditions. Discussion We performed a quantitative 3D comparison of two different spike techniques in the volleyball game. Our results suggest that the AT could be potentially a preventive solution to the shoulder chronic pathologies, while maintaining, or even enhancing, athletes' performance. References An KN, Browne AO, Korinek S, Tanaka S and Morrey BF. (1991). *J Orthopaed Res*, 9:143-149. Chan KM, Yuan Y, Li CK, Chied P and Tsang G. (1993). *Br J Sp Med*, 27 (4). Murray, IA. (1999). Ph. D. Thesis. University of Newcastle upon Tyne. Verhagen EALM, Van der Beek AJ, Bouter LM, Bahr RM and Van Mechelen W. (2004). *Br J Sports Med*, 38:477-481.

## INFLUENCE OF OPTIC FLOW STIMULI ON POSTURAL RESPONSES. I. ELECTROMYOGRAPHY

Piras, A., Persiani, M., Raffi, M., Squatrito, S.

*University of Bologna*

Introduction The direction of optic flow stimuli is an important cue for heading perception (Gibson, 1954). Several studies addressed the influence of visual stimuli on upright position, because vision provides the necessary information about the surrounding environment (Peterka & Benolken, 1995). However, little is known about the optic flow modulation on postural muscles. Aim of this study was to verify if the optic flow direction evokes different postural responses. We analyzed the bilateral muscular activation of two leg muscles, tibialis anterior and gastrocnemius medialis, during full field optic flow stimulation. Methods sEMG were recorded in 24 healthy right-handed volunteers (12 M and 12 F, mean age  $24.5\pm 2.9$ ). Experiments were performed in the dark. Stimuli were presented on a wide screen, placed 115 cm from the subjects' eyes, covering  $135 \times 107^\circ$  of visual field. Stimuli were two full screen optic flow, expansion and contraction, and random dots motion as control stimulus. sEMG data were acquired by a 16 channels Pocket EMG (BTS@ Bioengineering Inc.). Data acquisition included 5 trials per stimulus for about 30-s each. Results The muscle was considered significantly activated when its signal was greater than the baseline mean + 3SD (Hodges & Bui, 1996). Results showed that the great majority of the subjects had a different modulation on muscles activity depending on the type of optic flow stimulus. The right tibialis anterior was the most activated muscle. We also analyzed the highest amplitude values to evaluate if optic flow differently modulated the amplitude of the muscle responses. Results showed a significant effect ( $p<0.05$ ) of the stimulus in 14 subjects (58%). The stimulus effect on lower limb muscles was significantly different in 23 subjects (96%). We also found a strong effect of sex and muscle and interaction of sex by muscle upon the optic flow stimulus effect ( $p<0.05$ ). Discussion Visual input influences the neural control of body sway. One emerging interesting idea is that neural sensitivity to different afferent inputs in response to disturbances of the body balance, is highly dependent on the visual feedback. This theoretical framework may help us to understand fall prevention programs and to explain some of the mechanical and neural factors which contribute to the balance impairment. In these experiments subjects likely used an ankle strategy to maintain standing posture. Forward and backward sway may result in an increased compensatory muscular activity of the posterior and anterior lower extremity muscles respectively. References Gibson JJ (1954). *Psychol. Rev.*, 61, 304-314. Hodges PW & Bui BH (1996). *Electroencephalogr Clin Neurophysiol*, 101, 511-519. Peterka RJ & Benolken MS (1995). *Exp Brain Res*, 105, 101-110.

## INFLUENCE OF OPTIC FLOW STIMULI ON POSTURAL RESPONSES. II. STABILOMETRY

Persiani, M., Piras, A., Raffi, M., Squatrito, S.

*University of Bologna*

Introduction Several researches have been aimed at studying the balance control looking at the variation of the center of pressure (COP) trajectory induced by variation of the visual field (Collins & De Luca, 1995; Accornero, 1997). Indeed, presence of a visual stimulus produce less sway speed than the dark (Lee & Lishman, 1975). However, little is known about the modulation of optic flow stimuli on the body sway. Aim of this study was to verify how the direction of optic flow can affect the COP parameters like speed, trace length, equivalent area and equivalent radius. Methods Stabilometric data were recorded in 24 healthy right-handed volunteers (12 M and 12 F, mean age

24.5±2.9) who stood on two Kistler force platforms. Experiments were performed in the dark. Stimuli were presented on a wide screen, placed 115 cm from the subjects' eyes, covering 135 x 107° of visual field. Stimuli were two full screen optic flow, expansion and contraction, and random dots motion as control stimulus. Postural responses data were acquired by the SMART BTS® at 1000 Hz (BTS® Bioengineering Inc.). Data acquisition included 5 trials per stimulus for about 30-s each. Results We performed a repeated measure ANOVA on the 24 subjects for each COP parameter. Speed: we found significant differences across the optic flow stimuli ( $p=0.042$ ) and significant interaction between stimulus and sex ( $p=0.009$ ). Trace length: results showed significant interaction between stimulus and sex ( $p=0.001$ ). Equivalent area: we found significant interaction between stimulus and sex ( $p<0.001$ ). Equivalent radius: results showed significant interaction between stimulus and sex ( $p=0.002$ ). These results indicate that the direction of optic flow stimuli strongly modifies the upright posture. Male and female populations are differently affected by the optic flow direction. Discussion These experiments confirmed that the optic flow input modulates the neural control of body sway. Because the sensitivity to the body sway is greatly dependent on the visual feedback, results of this research may allow to lead rehabilitation programs in patients with visual deficits responsible of postural modification. Furthermore, the described changes in the sway parameters due to the optic flow stimulus direction could allow to develop specific sport visual training. References Accornero N, Capozza M, Rinalduzzi S, Manfredi GW (1997) Electroencephalogr Clin Neurophysiol 105:213-219. Collins JJ & De Luca CJ (1995) Exp Brain Res 103:151-163. Lee D & Lishman JR (1975) Journal of Human Movement Studies 1:87-95.

**13:45 - 14:45**

## Poster presentations

### PP-BN02 Motor Learning and Coaching 1

#### TIME MATTERS: CONTRALATERAL TRANSFER OF INTERFERENCE DEPENDS ON TRAINING DURATION

Lauber, B.1, Keller, M.2, Gollhofer, A.1, Lundbye-Jensen, J.3, Taube, W.2, Leukel, C.1,2

1 Department of Sport Science, University of Freiburg, Freiburg, Germany 2 Department of Medicine, Movement and Sports Science, University of Fribourg, Fribourg, Switzerland 3 Department of Neuroscie

Introduction It has long been known that practice of motor tasks with one limb improves not only the performance of the trained but also of the opposite untrained limb (e.g. Carrol et al. 2008). However, learning-related improvements in performance may also be hindered if we are engaged in subsequent learning of a different, interfering motor task. Specifically, the motor performance of a recently learned task A can be reduced if a second task B is learned shortly afterwards (Brashers-Krug et al. 1996, Lundbye-Jensen et al. 2010). So far, the interference effect was only demonstrated for the limb actively involved in the training and not for the contralateral untrained limb. Therefore, the aim of the present study was to test learning-related interference in the limb contralateral to the trained one. Methods In the present study, 46 subjects practiced ballistic isometric contractions with their index finger (task A). Subsequently, subjects were split into 4 groups practicing a visuomotor tracking (interference) task (task B) for either 6min (group A), 12min (group B), rested for 6min (group C) or 12min (group D), respectively. Results Ballistic training caused an improvement in performance of the trained hand of  $41.5 \pm 4.5\%$  ( $p < 0.001$ ) and in the untrained contralateral hand of  $23.8 \pm 3.8\%$  ( $p < 0.001$ ) in all subjects. Interference training of 6min (group A) caused a significant reduction of performance only for the trained hand ( $-22.7 \pm 4.3\%$ ;  $p < 0.001$ ) but not the untrained contralateral hand. The 12min visuomotor tracking (group B), however, showed a significantly reduced performance of the trained ( $-22.72 \pm 4.1\%$ ;  $p < 0.001$ ) and untrained contralateral hand ( $-19.1 \pm 4.8\%$ ;  $p < 0.001$ ). Groups C and D did not show significant interference effects. Discussion The results of the present study show for the first time that subsequent learning of an interfering motor task can not only cause reduced performance in the trained limb but also in the untrained contralateral limb. This interference effect was shown to depend on the training duration of the interference task. These findings might have important clinical implications for movement rehabilitation programs in patients suffering from hemiparesis, e.g. after stroke. Lit. Brashers-Krug T, Shadmehr R, Bizzi E. (1996). Nature 382: 252-255. Carrol TJ, Lee M, Hsu M, Sayde J. (2008). J Appl Physiol 104: 1656-1664. Lundbye-Jensen J, Petersen T H, Rothwell JC, Nielsen JB. (2010). PLoS One. 6(3):e17451.

#### THE EFFECT OF AGING ON MANUAL AIMING PERFORMANCE

Van Halewyck, F., Lavrysen, A., Levin, O., Helsen, W.F.

KU Leuven

The Effect of Aging on Manual Aiming Performance Van Halewyck, F., Lavrysen, A., Levin, O., Helsen, W.F. Movement Control and Neuroplasticity Research Group, KU Leuven (Belgium) Introduction Aging influences the ability to move. During manual aiming, for instance, older adults are thought to apply a 'play-it-safe' strategy to ensure endpoint accuracy. This strategy is characterised by a reduction of hand movement speed (Teeken et al., 1996) and a higher proportion of time spent after peak velocity, a period typically associated with corrective submovements based on visual and proprioceptive feedback (Elliott et al., 2010). However, due to the well-documented age-related decline in proprioception (Skinner et al., 1984), we hypothesised that older adults rely particularly more on visual information for online guidance of the hand. In the present study, we therefore examined the contribution of visual feedback during manual aiming in young and older physically active and non-active participants. It was also expected that older adults showed a disproportional drop of accuracy when vision was (partially) blocked. Methods Manual aiming performance of a group of young (aged 20-29yrs) and older (aged 60-69yrs) physically active and inactive adults was compared under different visual conditions. The synchronous registration of eye and hand movements allowed us to examine the eye-hand coupling and the underlying mechanisms of visual control during discrete and cyclical hand movements. In addition, levels of physical activity as well as cognitive abilities were determined using questionnaires. Results A significant age-related motor slowing was revealed during the execution of rapid discrete aiming. As predicted, older adults had longer movement times when vision was available and a lower accuracy rate when vision was (partially) blocked. Also in agreement with the proposed play-it-safe strategy, older adults generally undershot the targets while young adults ended more accurately. The tight eye-hand coupling and the greater number of corrective saccades in older adults confirmed our main hypothesis as well. Remarkably, there was an interaction between age and physical activity level, showing that physically inactive older adults were even more dependent on visual information. Discussion Compared to younger adults, older adults adopted a play-it-safe strategy characterised by more



time-consuming visual guidance. They were also more affected by the (partial) withdrawal of visual information. Interestingly, the notion of major differences in aiming strategy between physically active and inactive older adults highlights the importance of a physically active lifestyle. References Elliott D, Hansen S, Grierson LEM, Lyons J, Bennett SJ, Hayes SJ. (2010) *Psychol Bull* 136, 1023-1044. Skinner HB, Bar-rack RL, Cook SD. (1984) *Clin Orthop Relat R* 184, 208-211. Teeken JC, Adam JJ, Paas FGWC, van Boxtel MPJ, Houx PJ, Jolles J. (1996) *Psychol Aging* 11: 195-198.

### **FOCUS OF ATTENTION INFLUENCES QUIET-EYE BEHAVIOR AND MOVEMENT PATTERNS AT VARYING SKILL LEVELS IN FEMALE BASKETBALL PLAYERS**

Rienhoff, R., Strauss, B., Fischer, L., Baker, J., Schorer, J.

*Institute of Sport and Exercise Sciences*

**Introduction** Different foci of attention have varying influences on different expertise levels in motor control situations (Wulf, 2007). On another level, the quiet eye period also affects motor performance and seems to differentiate between expertise and performance levels (Vickers, 2007). This study investigated the possible association of focus of attention and quiet eye as well as their interacting effect on throwing performance. **Methods** Basketball experts, advanced players and novices (n = 9 per group) performed 40 free throws, subdivided in blocks of ten throws. The first block provided baseline data while in blocks two to four participants performed external focus, internal focus, and no-focus conditions in a counterbalanced order. Gaze behavior was captured by an eye tracking system. Throwing accuracy and quiet eye duration were measured. **Results** Clear difference between skill groups could be revealed for throwing performance during baseline,  $F(2,24) = 42.3$ ,  $p < .01$ ,  $f = 1.88$ . The analysis of the counterbalanced blocks showed differences between groups,  $F(2,24) = 44.0$ ,  $p < .01$ ,  $f = 1.91$ . Additionally the repeated measure instruction revealed significant differences,  $F(2,48) = 3.63$ ,  $p = .03$ ,  $f = .39$ , but not for the interaction,  $F(2,24) = .71$ ,  $p = .59$ ,  $f = .24$ ,  $1-\beta = .64$ . For quiet eye duration, analysis of variance showed no significant differences between groups,  $F(2,24) = .88$ ,  $p > .05$ ,  $f = .29$ ,  $1-\beta = .32$ , nor for the interaction (group x instruction)  $F(2,24) = .51$ ,  $p > .05$ ,  $f = .22$ ,  $1-\beta = .55$ , but significant differences for instructions as repeated measures,  $F(2,24) = 5.91$ ,  $p < .01$ ,  $f = .53$ . The post-hoc showed significant shorter quiet eye duration for external instruction in comparison to both other conditions. Furthermore significant differences in quiet eye duration can be revealed for hits vs. misses,  $F(1,15) = 3.72$ ,  $p = .04$ ,  $f = .50$ , and further the interaction of hits with skill groups,  $F(1,15) = 2.80$ ,  $p = .05$ ,  $f = .61$ . Hits are in total longer, caused by differences in advanced players. **Discussion** Our results show an influence of instruction on throwing performance, thus all skill levels performed worst under external instruction, what might be explained by personal preference (Weiss, Reber, & Owen, 2008). Furthermore the quiet eye period influences the throwing performance with longer quiet eye durations for hits in comparison to misses in the not yet automated advanced players. It seems that only in a specific skill level (advanced players) the interaction of quiet eye and focus of attention has influence on throwing performance. **References** Vickers, J. N. (2007). Perception, cognition and decision training: The quiet eye in action. Champaign, IL: Human Kinetics. Weiss, S., Reber, A. S., & Owen, D. R. (2008). The locus of focus: The effect of switching from a preferred to a non-preferred focus of attention. *Journal of sports sciences*, 26, 1049-1057. Wulf, G. (2007). Attention and motor skill learning. Champaign, IL: Human Kinetics.

### **QUIET-EYE IN OLDER SKILLED BASKETBALL PLAYERS AND ITS TRANSFERABILITY**

Fischer, L., Rienhoff, R., Strauss, B., Baker, J., Schorer, J.

*Institute for Sport and Exercise Sciences*

**Introduction** There is mounting research to suggest that cognitive and motor expertise are more resistant to age-related decline than more general capacities (Schorer & Baker, 2009). Two theoretical frameworks are commonly used to explain the maintenance of peak performance: compensation and selective-maintenance (Baker & Schorer, 2010). The primary aim of this study was to investigate the retention of quiet-eye skills in elderly experts with continued training at a lower league. We hypothesized that highly skilled older athletes would outperform novices and have little decrement in their perceptual processes in comparison to highly skilled younger athletes. Secondly, we wanted to explore the transferability of this skill to a different domain like dart. **Methods** The study investigated the retention and transfer of skill in skilled-older athletes (n=13) by comparing them with skilled-younger (n=13) and novice-younger participants (n=13). They performed basketball free throws and dart throws under standardized conditions. Motor performance (accuracy) and perceptual performance (quiet-eye) were examined across the three groups. **Results** There were significant differences between groups in throwing accuracy on both throwing tasks, basketball,  $F(2,37) = 45.35$ ,  $p < .01$ ,  $f = 1.56$ , and dart,  $F(2,37) = 6.90$ ,  $p < .01$ ,  $f = .61$ , with skilled groups outperforming novices but not differing from each other. There were medium sized, non-significant effects for quiet-eye, with skilled groups having longer quiet-eye durations than the novice group on the basketball tasks,  $F(2,35) = 1.23$ ,  $p = .30$ ,  $f = .27$ ,  $TP = .27$ , but younger groups having longer durations than the older group on the transfer task,  $F(2,35) = 2.50$ ,  $p = .10$ ,  $f = .38$ ,  $TP = .50$ . **Discussion** The results indicate expertise in a perceptual-motor task like basketball free throw can be retained in older athletes. But the perceptual skill was not transferred into dart throwing, although a better throwing accuracy was obtained. These results raise questions concerning current hypotheses of skill maintenance, which should be re-evaluated to consider the issue of transfer. **References** Baker, J., & Schorer, J. (2010). Maintenance of skilled performance with age: Lessons from the masters. In J. Baker, S. Horton & P. L. Weir (Eds.), *The master athlete. Understanding the role of sport and exercise in optimizing aging* (pp. 66-78). New York: Routledge. Schorer, J., & Baker, J. (2009). An exploratory study of aging and perceptual-motor expertise in handball goalkeepers. *Experimental Aging Research*, 35, 1-19. doi: 10.1080/03610730802544641

### **ANALYSIS THE TRACKING EYE OF ONE EXPERT SAILOR IN A VIRTUAL SIMULATOR.**

Manzanares Serrano, A., Menayo Antúnez, R., Segado Segado, F.

*Universidad Católica de San Antonio Murcia*

**Introduction** In a boat race, sailors are constantly receiving information about the environment thanks to the senses. The most determining sense in a sailor and other sports is his sight (Reina, Moreno & Sanz, 2007), since thanks to it, stimuli present in sailing environment are received, determining his response. The approach we have used aims to describing the visual conduct of an expert racer for the minute before the start signal. **Methods** The competitor in the current research was the first in Rankin of Optimist Class, in the Region of Murcia (Spain). Was used an automated system of measurement which integrates the following instruments: a) VSail-Trainer® sail simulator and b) Eye Tracking System®. Research variables were the number of fixations, the location of the fixations and the fixations time on each location made by the competitor. The event was made up by 2 starts of simulated race, with stable conditions of wind, competitor and sea. The simulated race reflected the same conditions as a real start. **Results** The total number of eye fixations performed in the first

start were 94, while in the second one were 86. In the first start, the greatest number of fixations, were located in tack of the sail, the remaining of the sail, sea, and rivals, while in the second start, the most frequent locations were, tack of the sail, the remaining of the sail, sea, rivals, and buoys of start. It is worth mentioning that eye fixations carried out during the second start were distributed in a more homogeneous way than in the first start. In the same way, the average fixations time is higher in the second start than in the first one. Discussion The results show that, in the second start the sailor performed a lower number of eye fixations, together with an increment of average fixations time, regarding the first start. As it is upheld by many authors, a visual search strategy is more effective when the number of fixations carried out is lower, as well as a greater length of the latest (Ávila & Moreno, 2003; Williams, Davids & Williams, 1999). Improvement in visual search strategy on the part of the sailor can be a consequence of his learning, due to the short period between the first and the second start and the resulting error assimilation. References Ávila, F. & Moreno, F.J. (2003). Visual search strategies elaborated by tennis coaches during execution error detection process. *Journal of Human Movement Studies*, 44, 209-224. Reina, R., Moreno, F. J., & Sanz, D. (2007). Visual behavior and motor responses of novice and experienced wheelchair tennis players relative to the service return. *Adapted Physical Activity Quarterly*, 24, 254-271. Williams, A.M., Davids, K. & Williams, J. G. (1999). Visual perception and action in sport. London: E & FN Spon.

### UN-LEARNING A MOTOR TASK: BRIEF REACTIVATION ALLOWS TO ERASE MOTOR MEMORIES

de Beukelaar, T., Alaerts, K., Woolley, D.G., Wenderoth, N.

*KU Leuven*

Learning new skills is inherent to many sports such as golf, playing tennis, but also sailing, mountain biking and many more. Much is known about how these motor skills are learned and consolidated in the human brain, but how can we un-learn movements, for example, when a wrong technique has been acquired? A decade ago, Walker et al. showed that a motor skill that has been stabilized and consolidated, can become fragile again after brief reactivation [1]. This fragile state renders it again vulnerable to interference from a competing motor task and allows the motor memory to be partly erased. Here we tested whether similar interference effects can be induced when movement observation instead of physical execution is used to reactivate the motor memory. Subjects were assigned to different experimental groups. All acquired a fixed 5-element sequence at day 1 by practicing the sequence for 12 blocks (30s each). At day 2 they briefly rehearsed the same sequence for 3 blocks either by physical execution or movement observation. Immediately after rehearsal, subjects performed an interfering motor task (learning a new sequence during 12 training blocks). At day 3, retention was tested for the sequence learned initially. Results show that reactivating the memory by mere observation followed by the interfering motor task, did not improve nor decrease performance. Also, the group that reactivated the motor memory physically was only minimally affected by the interfering task. However, we observed that 3 blocks of reactivation (approx. 75 trials) were sufficient to trigger a second phase of motor learning at day 2 in most of our subjects. Based on animal studies, showing that one-trial-reactivation is enough to render an acquired fear memory fragile and susceptible to interference [2], we designed a new experiment such that the sequence was reactivated only very shortly (performing it 5 times instead of approx. 75 times). When this brief reactivation was followed by the interfering motor task, we found a clear decrease in performance on day 3, indicating that we successfully destabilized and partly erased the motor memory of the initially acquired sequence. We conclude that if a motor memory is only briefly reactivated, not initiating new learning, stable motor memories are rendered fragile and susceptible to interference. This mechanism is highly relevant for athletes who want to un-learn wrong techniques. 1) Walker MP, Brakefield T, Hobson JA, Stickgold R (2003), *Nature*, 425, 616-620. 2) Nader K, Schafe GE, Le Doux JE (2000), *Nature*, 406, 722-726.

### FUNCTIONAL PROPERTIES OF MOTOR-RELATED CORTICAL OSCILLATIONS DURING A VISUOMOTOR TASK IN ATHLETES AND NON-ATHLETES

Hülsdünker, T., Mierau, A., Hannemann, M., Strüder, H.K.

*German Sport University Cologne*

Introduction Recent publications analyzed cortical processes in the Alpha and Beta frequency bands during visuomotor tasks related to the level of experience or quality of movement. The aim of the present study is to extend these findings by further considering higher frequency bands in the Gamma range from 30-40Hz which are thought to be involved in motor processes. Moreover, we modulate the sensory input to distinguish between sensory and motor-related cortical oscillations. Methods We compared 9 right-handed elite athletes to 7 right handed non-elite athletes in a visuomotor task. Each group performed 60 air pistol shots. The elite athletes additionally performed 30 blind shots with eyes closed 0.5s before the shot. Electroencephalographic (EEG) activity was recorded from four electrode positions (C3, Cz, C4, Fz) with FCz as reference. EEG data was re-referenced to the mean potential of C3, Cz, C4 and Fz. Alpha and Beta frequency bands were based on the individual Alpha peak frequency (IAF) and individual Beta peak frequency (IBF). Gamma1 and Gamma2 we defined as 30-35Hz and 35-40Hz, respectively. Absolute power values were log-transformed and calculated for a baseline level (BAS) and four time intervals in the last three seconds before the shot. We conducted two-way repeated measurement analysis of variance (Group\*Time; Condition\*Time) for the C3 electrode representing the contralateral motor cortex. Significance level was  $p < 0.05$  Results For the Group\*Time analysis we found a main effect for Time in the lower Alpha and upper Beta frequency bands showing significantly enhanced lower Alpha power as well as reduced Beta power. For Gamma1 and Gamma2 there were main effects for Group revealing higher power values for non-elite athletes. Additionally, we found a significant interaction of Group and Time in the Gamma2 frequency band. Non-elite athletes showed a decrease in power from BAS to the last 0.5s prior to the shot while no changes occurred in the elite athletes. Comparing conditions (eyes opened/eyes closed) we found increased power in both Beta frequency bands while Alpha and Gamma remained unchanged. Discussion Enhanced lower Alpha and reduced upper Beta power for the group comparison suggest a process of inhibition prior to the shot. Group effects in both Gamma frequency bands may indicate that reduced Gamma power represents the level of experience. Due to the absence of condition effects in both Gamma frequency bands, we propose a motor-related function of Gamma rhythms probably representing reduced movement activity of the arm before the shot being in line with the group effects showing elite athletes having lower Gamma power than non-elite athletes. Hence we further suggest that the differences between the groups primarily represent motor control and may be less due to cognitive processes. The sensitivity of the Beta rhythm to visual input can be interpreted as enhanced attentional demand compensating for the absence of visual information.

## GAIT VARIABILITY AS REPRESENTATION OF THE FUNCTIONALITY OF THE SENSORIMOTOR SYSTEM

Hamacher, D., Grabau, C., Singh, N.B., Schega, L., König, N., Taylor, W.R.

*Otto-von-Guericke-Universität Magdeburg*

Gait variability as representation of the functionality of the sensorimotor system Hamacher, D.1,2, Grabau, C.1,2, Singh, NB.1, Schega, L.2, König, N.1, Taylor, WR.1:1: JWU, Charité (Berlin, Germany), 2: OvGU (Magdeburg, Germany) Introduction Falls in the elderly constitute a high socio-economic burden. Effective methods for evaluating human sensorimotor system (HSMS) deficits are thought to aid in predicting fall risk in a geriatric population, where the assessment of task performance over longer durations contributes important information regarding the HSMS (Taga et al., 1991). Fall prone individuals also display higher levels of variability during dynamic activities such as walking compared to their healthy counterparts (Hamacher et al., 2011). However, the kinematic parameters that best represent optimal functioning of the HSMS remain unclear. The aim of this study was to evaluate the effectiveness of various gait parameters for distinguishing elderly fallers from non-fallers. Methods 3D kinematics of the right foot of 34 elderly female non-fallers (69.5±4.6 years) and 33 fallers (69.2±4.8 years) were captured with a marker based optical system while walking on a 10-meter walkway. A minimum of 6 walks were used to calculate the variability (coefficient of variance; CV) of 6 spatiotemporal parameters (stride time (StrT), double support time (DST), stance time (ST), stride length (SL), step width (SW) and minimum toe clearance (MTC)). To examine the magnitude of the difference between cohorts on CV of parameters, effect sizes (ES) were calculated using Cohen's d. Results Variations of all parameters except SL were larger in fallers than in non-fallers. Differences in CV between groups were moderate for DST (ES=0.41) and high for StrT, SW and ST (ES =0.64-0.65). The largest differences between fallers and non-fallers were found in CV of MTC variations (ES=0.99). Discussion The results confirm that variability of stride parameters is suitable in differentiating fallers from non-fallers. The variability of StrT and SW represent measures of rhythmicity (Hausdorff et al., 2007), while ST is a measure of balance (Gabell & Nayak, 1984). The HSMS is involved in control of rhythmicity during swing phases and balance during stance phases, which seem to be more variable in fallers, thus indicating diminished functionality of the HSMS. Variations in foot clearance seem to play a critical role in detecting deficits of HSMS, possibly due to the foot's extended distance from the body's core, where proprioceptive errors could be most apparent. Assessment of MTC variability in a clinical setting may aid in early identification of subjects at risk of falling. References Taga G, Yamaguchi Y, Shimizu H (1991). *Biol Cybern*, 65, 147-9. Hamacher D, Singh NB, van Dieën JH, Heller M, Taylor WR (2011). *J. R. Soc. Interface*, 8, 1682-98. Hausdorff JM, Lowenthal J, Herman T, Peretz C, Giladi N (2007). *Eur J Neurosci*, 26, 2369-75. Gabell A, Nayak U (1984). *J Gerontol*, 39, 662-6.

## EXERCISE PERFORMANCE DURING REPETITIVE SPRINTS IS CAREFULLY REGULATED BY THE CENTRAL MOTOR DRIVE TO LIMIT THE DEVELOPMENT OF PERIPHERAL FATIGUE UPON A CRITICAL THRESHOLD

Hureau, T.1, Olivier, N.1, Millet, G.Y.2, Meste, O.3, Blain, G.1

*1: UDSL2, EA 4488 (Lille, France), 2: UJM, EA 4338 (St Etienne, France), INSERM U1042 (Grenoble, France), 3: CNRS-UNS, I3S (Nice, France)*

Introduction Recently, Amann et al. (2009) demonstrated that somatosensory feedback from working muscle plays a metabo-meter role for the central nervous system so that the central motor drive is adapted to limit the peripheral fatigue development upon a critical threshold. Because during 5 km time trials voluntary muscle contractions are submaximal it is argued that the central motor command and power output are much more dependent upon a conscious self-paced cycling strategy rather than feedback from the contracting muscles (Marcora, 2010). We asked whether inputs from the fatiguing locomotor muscles reduce the maximal voluntary drive of central motor command, in order to tightly regulate the total degree of peripheral fatigue development during all-out sprints. Methods Twelve healthy subjects randomly performed, at least 72 h apart, two sets of 10 all-out 10 sec sprints intersped with 30 sec of passive recovery. One test was performed in the fresh state (control condition), the other with pre-induced quadriceps fatigue using neuromuscular electrical stimulation (NMES). NMES – and exercise – induced quadriceps fatigue was quantified via pre vs. post changes in potentiated quadriceps twitch force in response to supra-maximal femoral nerve stimulation (Qtw-pot) and in maximal isometric voluntary contraction (MVC). Central motor drive was estimated using the integral of each burst of the quadriceps EMG (iEMG). Mean power output was assessed for every sprint as an index of performance. Results NMES pre-induced quadriceps fatigue ( $\Delta Qs-pot = -28.9\% \pm 3.9$ ;  $\Delta MVC = -15.0\% \pm 3.1$ ) resulted in a significant reduction in central motor drive ( $-8.6\% \pm 2.5$ ) and performance ( $-3.2\% \pm 1.9$ ) compared to control, which was more pronounced during the first five sprints of the test. Despite these significant differences, the magnitude of locomotor muscle fatigue following sprints was not different between control and pre-fatigue conditions ( $\Delta Qs-pot = -50.6\% \pm 2.8$  vs.  $-50.6\% \pm 3.4$ ;  $\Delta MVC = -18.3\% \pm 3.4$  vs.  $-20.0\% \pm 4.2$ ). Discussion Our findings demonstrate that power output is tightly regulated during repetitive all-out sprints to avoid the development of peripheral muscle fatigue upon an individual critical level. We thus suggest that feedback from the fatiguing locomotor muscles exerts an inhibitory effect on the central motor drive and plays a key role in exercise performance. References Amann M, Proctor LT, Sebranek JJ, Pegelow DF, Dempsey JA. (2009). *J Physiol*, 587, 271-283. Marcora S. (2010). *J Appl Physiol*, 108, 454-456.

## THE EFFECT OF TIME OF DAY ON VESTIBULAR FUNCTION AND POSTURAL CONTROL

zouabi, a.

*University of Caen, Basse-Normandie*

Introduction During daytime activity, individuals must run their posture, their perception of verticality and orientation in space. Few studies (Avni et al., 2006; Forsman et al., 2007) examined the effect of time of day on postural control. These studies have found contradictory results. The vestibular system is continuously involved in equilibration reaction. Only one study has tried to identify the circadian rhythmicity of the vestibular system (Wolf et al., 1990) and showed a maximum amplitude of the vestibular nystagmus in the morning. The aim of our study was to evaluate the effect of time of day on vestibular function and postural control. Methods 16 male subjects of intermediate chronotype underwent a discontinuous circadian rhythm protocol: they had one session of test per week at 2:00, 6:00, 10:00, 14:00, 18:00, 22:00 and 2:00 h. Each session consisted of 2 tests (i) static and dynamic postural control using a force platform with eyes-open and eyes-closed. The coordinates of center of pressure (COP) was recorded using a platform Posturewin® (Technoconcept, France) (ii) vestibular-ocular exploration using a rotatory chair in darkness. The stimulation used, stimulates the vestibulo-ocular reflex (VOR) and induces a vestibular nystagmus. This nystagmus can be characterized by its initial velocity (Vi) and its time constant (TC). Eye movements were recorded using an infrared video camera system Chronos® (Skalar, Netherlands). Results (i) The results of our study show that the COP was not influenced by the time of day ( $F=0.69$ ,  $P=0.63$ ). (ii) Vi was not influenced by the time of day ( $F = 0.65$   $P = 0.66$ ). By contrast, the interaction of the time of day and TC was statistically significant ( $F=3.55$ ,  $P<0.005$ ), with a longer TC at 06:00 than 02:00h. Discussion The results of our study show that postural control in young adults is not influenced by the time of the day but that VOR duration varies

during 24 hours. It is interesting to note that even if vestibular responses fluctuate during the day, postural control has no daily fluctuations. These results suggest that the vestibular variations don't influence the postural control during the day. Compensatory mechanisms could be involved. References Wolf M., Ashkenazi IE, Leventon G. Circadian variation of nystagmus in healthy and sick subjects. *Arch Otolaryngol Head Neck Surg.* 1990 Feb;116(2):221-3. Forsman, P., Haeggstrom, E., Wallin, A., Toppila, E., and Pyykko, I. (2007). Daytime changes in postural stability and repeatability of posturographic measurements. *J Occup Environ Med*, 49(6), 591-6. Avni, N., Avni, I., Barenboim, E., Azaria, B., Zadok, D., Kohen-Raz, R. and Morad Y. (2006). Brief posturographic test as an indicator of fatigue. *Psychiatry Clin Neurosci*, 60(3), 340-6.

**13:45 - 14:45**

## Poster presentations

### PP-PM01 Sports Medicine 1

#### TRAINING LOAD AND LOW BACK PAIN IN GERMAN ELITE ROWERS

Winzen, M., Voigt, H.F., Hinrichs, T., Platen, P.

*Ruhr-University Bochum, Faculty of Sports Science*

**Introduction:** Training load and biomechanical impact on the musculoskeletal system in elite rowing on international level are considerable. On the middle and long term, they can lead to severe chronic disorders of the musculoskeletal system, and especially of the lower back. The aim of this study was to evaluate training load as well as prevalence and characteristics of lower back pain in German elite rowers during the Olympic year 2008. **Methods:** 29 female rowers aged 22.2±3.1 (18-30) years and 38 male rowers aged 22.3±3.1 (18-32) years of the German national team have been interviewed about their mean training volume and training content. Furthermore, they have been asked about pain at the lower back (LBP) at the time of the interview and over the past 12 months (self-administered questionnaire). Indicated percentages refer to the number of athletes who answered the respective question. **Results:** The rowers began their career at the age of 12.2±1.9 (8-17) years. Elite rowers trained on average 22.8±5.3 (11-38) hours in 16.0±4.6 (8-32) training sessions per week. They spent 10.3 hours (46.3% of the whole training volume) with rowing on the water, 4.7 hours (21.7%) with weight training and 2.8 hours (12.3%) with rowing on an ergometer. The training distance on the water was 3961±1062 (1500-6000) km. 18 rowers (27.3%) stated to suffer from LBP at the time of the interview. Within the past 12 months, another 14 rowers (21.9%) had suffered from LBP. 25 of the 32 rowers with LBP (78.1%) stated to have pain during rowing, 23 (71.9%) subsequent to rowing, and 20 (62.5%) at rest, independent from rowing (multiple answers permitted). 21 rowers (65.6%) with LBP stated that they had consulted a physician for that reason within the past 12 months. 12 rowers (37.5%) with LBP had to pause their training for that reason. The duration of the training break was 3.4±3.0 (0.5-10) weeks. According to the athlete's individual estimation, the most frequent reason for LBP was "overuse" (24 rowers; 75%); while "acute injury" was only named by 4 rowers (12.5%) (multiple answers permitted). **Conclusions:** The high prevalence of LBP in German elite rowers supports the demand for adequate preventive and therapeutic measures. Technically exact chains of movement and motion patterns of rowing and rowing specific weight training have to be learned at an early age and have to be regularly monitored later on to prevent overuse of specifically stressed structures. The knowledge on pathophysiology of LBP is essential for the education of trainers at all stages and especially for trainers who engage in the formation of children and junior elite rowers.

#### WHY HEART FAILURE PATIENTS DO NOT MEET CRITERIA OF DAILY PHYSICAL ACTIVITY GUIDELINES

Dontje, M.L., van der Wal, M.H.L., Stolk, R.P., Brügemann, J., Jaarmsa, T., Wijnvliet, P.E.J.P., van der Schans, C.P., de Greef, M.H.G.

*Hanze University of Applied Sciences*

**Background** Heart failure (HF) is one of the most prevalent cardiovascular diseases all over the world. Physical activity is the only non-pharmacological therapy which is proven to be effective in HF patients in reducing morbidity. Although physical activity consists of exercise and daily physical activity, most studies focus on exercise training. Little is known about daily physical activity of HF patients. Studies using self-report methods to assess daily physical activity, suggest that inactivity is common in HF patients, but data on objectively measured daily physical activity is scarce. Therefore, the purpose of this study was to examine performance-based daily physical activity in heart failure (HF) patients using physical activity guidelines (10000 steps/day and 30 minutes of activity/day) and to identify related factors. **Methods** Daily physical activity of 68 HF patients was measured using an accelerometer (SenseWear®) for 48 hours. Steps/day and time spent on physical activities at least at moderate intensity (≥3 METs) in minutes/day were the primary daily physical activity outcomes. Following the 10000 steps standard; <5000 steps/day was considered as a sedentary lifestyle, 5000-10000 steps/day as a moderate physically active lifestyle, and >10000 steps/day as a physically active lifestyle. Following the 30 minutes guideline; <30 minutes/day physical activity (≥3 METs) was considered as a sedentary lifestyle; and >30 minutes as a physically active lifestyle. Psychological characteristics (self-efficacy, motivation, and depression) were measured using questionnaires. **Results** Fifty percent took <5000 steps/day, 35% took 5000-10000 steps/day, and 15% took >10000 steps/day. Forty-four percent were active for <30 minutes/day; 56% were active for >30 minutes/day. A linear regression model using NYHA classification, age, and self-efficacy explained 42% of the variance in steps/day ( $F=11.86$ ;  $p<0.001$ ). **Conclusion** The prevalence of a sedentary or a physically active lifestyle in HF patients depends on which guideline—10000 steps/day versus 30 minutes of activity/day—is used. This illustrates the discrepancy between the guidelines and presents a major dilemma, since such mismatches cause difficulties in interpreting data and in drawing conclusions. When both guidelines are combined, 40% of patients can be classified as sedentary, 45% as semi-active and 15% as physically active. The large variance in daily physical activity can partly be explained by NYHA classification and self-efficacy.

## HIGH INTENSITY EXERCISE TRAINING IN PATIENTS WITH CHRONIC KIDNEY DISEASE

Weston, K.

*University of Queensland*

High intensity exercise training in patients with chronic kidney disease Weston Kassia S1, Howden Erin J1, Krishnasamy Rathika2, Isbel Nikky M2, Coombes Jeff S1 School of Human Movement Studies, University of Queensland, Australia 2School of Medicine, University of Queensland, Australia Introduction This aim of this study was to investigate the feasibility, efficacy and determinants of incorporating high intensity exercise in a 12 month exercise training intervention in patients with chronic kidney disease (CKD). It was hypothesised that high intensity exercise would be a feasible and effective option for patients with CKD. Furthermore, it was hypothesised that baseline exercise capacity and haemoglobin would predict participation in high intensity exercise. Methods This is an observational sub-study of a randomised controlled trial. 41 patients with stage 3 & 4 CKD (eGFR 25-60 mL/min/(1.73 m<sup>2</sup>)) were randomised to undertake a 12 month individualised aerobic and resistance training exercise intervention. The goal of the intervention was for all subjects to participate in high intensity interval training or vigorous exercise if capable. Pre and post intervention measurements included; Physical Activity Questionnaire, maximal treadmill test with VO<sub>2</sub>, blood analysis and arterial stiffness indices. Results Results from the 12 month Physical Activity Questionnaire allowed allocation of the following groups: meeting exercise guidelines but only completing moderate activity (150 mins/week) (n=9), not meeting guidelines (n=14), and meeting guidelines and including at least some high intensity activity (n=18). Patients who reported high intensity exercise had a higher exercise capacity both at baseline (9.3±3.8) and 12 months (11.6±3.6) measured in MET's than both patients reporting moderate exercise (6.3±2.1, 8.2±2.1) and those not meeting guidelines (5.8±2.5, 7.4±3.1). Patients reporting high intensity exercise also had significantly higher baseline haemoglobin levels (138.9±14.8 g/L) than patients reporting moderate (126.2±11.3 g/L) and not meeting guidelines (127.3±12.5 g/L). Independent correlates (p<0.05) of METs at 12 months included haemoglobin and pulse wave velocity and together they explained 51% of the variance (p<0.001). Discussion The study was successful in increasing high intensity physical activity in patients with CKD. Patients who reported high intensity exercise were more likely to have higher haemoglobin levels and exercise capacity at baseline. These findings suggest that in CKD patients haemoglobin levels are a strong predictor of exercise capacity at one-year and have a likely influence of fatigue on motivation.

## THE RE-AIM FRAMEWORK OF A JUMP LANDING TRAINING PROGRAM FOR THE PREVENTION OF LOWER EXTREMITY INJURIES IN BASKETBALL.

Aerts, I.

*SOMT - Stichting opleiding musculoskeletale therapie*

The RE-AIM framework of a jump landing training program for the prevention of lower extremity injuries in basketball. 1,2Aerts Inne, 2Cumps Elke, 1,3Verhagen Evert, 1Meeusen Romain. 1Vrije Universiteit Brussel, Faculty of Physical Education and Physical Therapy, Department of Human Physiology and Sports Medicine, Brussels, Belgium. 2SOMT Stichting Opleidingen Musculoskeletale Therapie, Department of the Master Sport Physical therapy, Amersfoort, Netherlands. 3EMGO Institute for Health and Care Research, Department of Public and Occupational Health. VU University Medical Center, Amsterdam, Netherlands. Introduction Jump-landing sports are often accompanied by a high rate of injuries (Dufek et al. 1991). To investigate the translatability and feasibility of a coach supervised injury prevention program, a randomized controlled trial was established during one season. Methods Exercises of the prevention program were chosen to ensure a progressive degree of difficulty. Particularly the lower extremity alignment was emphasized, while educating a proper jump-landing technique. Both the control (CG) and intervention group (IG) continued their normal training routine. The IG was asked to carry out the additional prevention program. Injuries and exposure hours were registered. The results of the prevention program were based on the five dimensions of the RE-AIM framework (Glasgow et al. 1999). Results The participation rate of the athletes was 62.5% (reach). Furthermore, the risk of lower extremity injuries was significantly lower in the IG compared to the CG (HR= 0.4 [95% CI: 0.16-0.99]) (effectiveness). Of the 12 teams in the IG, 10 teams (83%) agreed to participate in the study (adoption). Coaches and trainers (100%) stated that they had implemented the training sessions of the program as intended (implementation). All trainers, except one, intend to continue the prevention programme the following season (maintenance). Conclusion Overall, reach, adoption, implementation and maintenance of this coach supervised jump-landing prevention programme was high. Most trainers found the jump-landing programme to be easily compatible with their trainings. They indicated to make this programme part of regular routine. In addition, overall significant decreased injury risks were found for lower extremity injuries in the IG compared to the CG. These findings are promising for the achievement of injury prevention in jump-landing sports. References Dufek JS, Bates BT. Biomechanical factors associated with injury during landing in jump sports. *Sports Medicine*. 1991;12(5):326-37. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *American Journal of Public Health*. 1999;89(9):1322-1327.

## STRENUOUS RUNNING EXERCISE IS ASSOCIATED WITH ACTIVATION OF HEMOSTATIC PATHWAYS IN HUMANS

Eijvogels, T., Veltmeijer, M., van Geffen, M., Thijssen, D., van Heerde, L., Hopman, M.

*Radboud University Nijmegen Medical Centre*

BACKGROUND: Retrospective studies indicated that patients with heat stroke have a sustained activation of coagulation, fibrinolysis and platelets. However, little is known about the impact of exercise on haemostatic parameters in athletes without exertional heat stroke and whether possible (physiological) changes in haemostatic parameters relate to changes in core body temperature. Therefore, the aim of this study was to determine changes in thrombin and plasmin generation as well as core body temperature after running a 15-km race. METHODS: Core body temperature was measured before and at the finish line of a 15 km run in a large, heterogeneous group of moderate- to highly-trained athletes (n=63, 44±11 years). Venous blood samples were collected pre- and post-race. The Novel Haemostasis Assay was used to measure thrombin and plasmin generation simultaneously. This allows insight in the interaction between coagulation and fibrinolysis. RESULTS: Core body temperature increased from 37.7±0.5°C to 39.4±0.9°C. The time to thrombin peak decreased from 9.0±1.3 min to 8.0±0.9 min (p<0.001), while the thrombin peak height did not change (baseline: 207±29 nM, post-exercise: 208±25 nM). In contrast, plasmin peak-time was not different between baseline (36.6.4±9 min) and post-exercise (35.4±8.1 min), while the plasmin peak height decreased significantly from 19.1±12.2 nM to 9.9±8.9 nM (p<0.001). Thrombin and plasmin responses were not different between subjects with a low (<39°C, n=21), average (39-40°C) and high (>40°C) finish core body temperature. CONCLUSION: Our study revealed that a 15-km running race was associated with an activated coagulation pathway via a faster thrombin generation and a reduced plasmin capacity. These findings were independent of the increase in core body temperature, and may have important implications for the insight into the development of exertional heat stroke.

## LOCAL MUSCLE METABOLISM DURING WHOLE BODY VIBRATION

Friesenbichler, B.

*University of Calgary*

**LOCAL MUSCLE METABOLISM DURING WHOLE BODY VIBRATION** Friesenbichler, B.1, Nigg, B.M.1, Dunn, J.1 1: UofC (Calgary, Canada) Introduction Whole body vibration (WBV) platforms have become popular tools for fitness and health improvement. However, studies about the platforms' effectiveness are inconclusive (Rittweger, 2010). One reason for the inconsistent findings is that the proper platform settings, that are required to elicit the desired improvements of the musculoskeletal system, are yet to be determined. A clear understanding of the immediate and local energetic demand of muscle tissue, while being exposed to vibration, is needed as a foundation to recommend effective long-term vibration training protocols. Therefore, the aim of this study was to quantify the local metabolic cost and muscle activity during whole body vibration. Methods Sixteen healthy male subjects were instructed to stand on a Galileo® vibration platform, while being exposed to vibrations of 0, 10, 17 and 28 Hz at  $\pm 2.5$  mm amplitude for one minute in randomized order. Changes in oxygenized haemoglobin (O<sub>2</sub>Hb) and muscle activity (EMG<sub>rms</sub>) of the vastus lateralis (VL) and medial gastrocnemius (GM) muscles were quantified using near infrared spectroscopy (NIRO 200-NX®) and surface EMG electrodes (Norotrode ®), respectively. Results The rate of O<sub>2</sub>Hb desaturation in the VL was (mean $\pm$ SD)  $-1.2\pm 1.4$ ,  $-2.5\pm 2.0$ ,  $-3.0\pm 1.7$ , and  $-5.6\pm 3.0$   $\mu\text{mol}\cdot\text{cm}/(\text{l}\cdot\text{s})$ ; and in the GM was  $-1.1\pm 0.8$ ,  $-1.9\pm 1.5$ ,  $2.6\pm 1.6$ , and  $6.3\pm 2.7$   $\mu\text{mol}\cdot\text{cm}/(\text{l}\cdot\text{s})$  at 0, 10, 17 and 28 Hz, respectively. EMG<sub>rms</sub> of the VL was  $0.04\pm 0.05$ ,  $0.11\pm 0.08$ ,  $0.18\pm 0.15$ , and  $0.25\pm 0.12$  V and of the GM was  $0.01\pm 0.01$ ,  $0.05\pm 0.04$ ,  $0.09\pm 0.04$ , and  $0.20\pm 0.15$  V at 0, 10, 17 and 28 Hz, respectively. The correlation between normalized O<sub>2</sub>Hb and EMG<sub>rms</sub> for the VL was  $r^2 = 0.69$  and for the GM was  $r^2 = 0.82$ . Discussion It was previously shown that WBV increased respiratory oxygen uptake during WBV at 26 Hz and  $\pm 2.5$  mm amplitude about 2-fold compared to control (standing, no vibration) (Rittweger et al., 2002). On the local level of individual muscles, the current study showed that relative metabolic cost during vibration exposure at similar platform settings increased roughly 4.5-fold (VL) and 5.5-fold (GM) relative to control. This means that although the entire body's energy expenditure only doubles during WBV compared to normal standing, the local oxygen demand can be considerably higher. The strong correlation of muscle activity and local metabolic cost ( $r^2 = 0.82$  for GM) may be used to estimate muscle metabolism of individual muscles during WBV. Vibration parameters can then be tuned properly to enhance the effectiveness of vibration training. References Rittweger J. (2010). Eur J Appl Physiol, 108, 877-904. Rittweger J, Ehrig J, Just K, Mutschelknauss M, Kirsch KA, Felsenberg, D. (2002). Int J Sports Med, 23, 428-432.

## MUSCLE FATIGUE AFFECTS DUAL TASK PERFORMANCE IN PATIENTS WITH MULTIPLE SCLEROSIS

Wolkorte, R.1, Kaspar, M.1, Heersema, D.J.2, Zijdwind, I.1

*University Medical Center Groningen*

**Introduction** Multiple sclerosis patients suffer from symptoms of fatigue and reduced information processing speed. Several experiments have been performed that investigated these symptoms. However, studies that investigate the relation between these symptoms are scarce. **Methods** MS patients (relapsing remitting; EDSS range 0-3; mean age 42) and age, sex and education matched controls participated in experiments performed on three occasions separated by a week. Experiment one was a practice session. In experiment two and three subjects performed a cognitive task concurrently with either a fatiguing or a non-fatiguing motor task. The motor task consisted of a contraction of a hand muscle (FDI, abduction of the index finger). The cognitive task consisted of an auditory choice-reaction-time task (CRT) in which subjects had to respond to two different tones with either their left index- or middle finger. Each session consisted of: 1) practice of the cognitive task. 2) Assessment of the maximal voluntary force (MVC). 3) A single cognitive task (auditory CRT task), followed by 4) a fatiguing or less-fatiguing dual task. The dual task consisted of the cognitive task combined with a muscle contraction at 30% MVC (fatiguing dual task) or 10% MVC (less-fatiguing dual task). Finally, 5) repetition of the single cognitive task. Task performance was measured as percentage of correct responses, and reaction times. **Results** Preliminary analysis (10 MS patients, 5 females; 6 controls, 3 females) with repeated measures ANOVA showed that the dual task was more difficult than a single task (main effect of task for MS-patients on number of errors,  $p=0.024$ , on reaction time,  $p=0.014$ , for controls on reaction time,  $p=0.036$ ). Furthermore, performance during the fatiguing dual task was more affected than during the less-fatiguing dual task (interaction effect of task\*fatigue on number of errors for MS patients,  $p=0.021$ , on reaction time,  $p=0.039$ , for controls on reaction time,  $p=0.049$ ). **Conclusions** The concurrent execution of a motor task decreases performance on a simple cognitive task; this effect is more pronounced in MS patients than in controls. During muscle fatigue, cognitive performance in MS patients deteriorates even more. It is known that during muscle fatigue, supraspinal motor centres increase their activity (Steens et al 2012), presumably to compensate for fatigue downstream of the motor cortex. This increased activation of motor areas could be responsible for a deterioration of cognitive task performance. Since MS patients show a lower capacity to compensate for fatigue-related changes (Steens et al 2012) a larger decline in cognitive performance is expected. **References** Steens et al. (2012). Neuroimage 59, 3110-3118

## WHAT ARE THE BENEFITS OF PHYSICAL EXERCISE IN PEOPLE WITH HIV INFECTION?

Bonato, M., La Torre, A., Bossolasco, S., Pavei, G., Merati, G., Galli, L., Cinque, P.

*Università degli Studi di Milano*

**Introduction** Since the introduction of Highly Active Antiretroviral Therapy (HAART), the number of patients dying from AIDS has fallen by more than two thirds. However, treatment causes a number of side effects, especially metabolic problems. Aim of this study was to evaluate fitness and health benefits of fitwalking, as moderate aerobic exercise, with or without strength exercise, in people with HIV infection receiving HAART. **Methods** Twenty HIV-infected, HAART-treated, sedentary male subjects performed an outdoor 12-week protocol consisting of 60 min of fitwalking at 65-75% of HR<sub>max</sub>, 3 sessions a week. Eight subjects also performed, at each session, 30 min circuit training at 65% of 1RM. Subjects were tested at baseline (BL) and 12 weeks (W12) by: 6 Min Walking Test (6MWT); maximal number of crunches in 30 sec; 1 RM test (lat machine, chest press, leg extension, sitting calf, leg press); general and morphometric examination (heart rate, blood pressure, BMI, waist, hip and leg circumference); blood examination (cytometry, fasting total, HDL and LDL cholesterol, tryglicerides, glucose, insulin; AST/ALT, ALP, gGT, creatinine, CPK, HbA1c; CD4+ lymphocytes and plasma HIV-RNA level). Differences between groups were tested by the Mann-Whitney test and differences over time by the Wilcoxon-signed rank test. BL differences between groups; results are expressed as [median (Q1-Q3)]. **Results** Out of 20 subjects, 18 [49.45 (43.75-54.33) yrs; BMI 24.95 (21.35-26.18) kg/m<sup>2</sup>] completed the 12-week training protocol and 9 (50%) attended  $\geq 65\%$  of the training sessions. In the whole group, 6MWT distance improved significantly at W12 compared to BL [722.5 (695-830) vs. 675 (627.5-691) m,  $p=0.002$ ]. At W12 a significant reduction was observed in BMI [24.95 (21.35-26.18) vs. 25.20 (22.71-26.87) kg/m<sup>2</sup>,  $p=0.009$ ], waist circumference [92.00 (85.75-96.00) vs. 93.00 (86.25-97.25) cm,  $p=0.03$ ] and LDL cholesterol [121 (102-135.5) vs. 131 (115-154) mg/dL,  $p=0.035$ ]. The 8 subjects of the fit-strength group showed

a significant increase of strength performance at W12. W12 changes of distance at 6MWT, waist and LDL level did not differ significantly between these subjects and those performing fitwalking only; BMI reduction was more marked in the latter subjects [23.95 (21.08-26.95) vs. 23.89 (21.53-27.13) kg/m<sup>2</sup>, p=0.054]. Discussion Fitwalking, with or without strength exercise, improved the aerobic fitness, morphometric variables and LDL cholesterol level in HIV-infected treated subjects. It can be offered to these patients to control the side effects of HAART. References Hand GA et al. *Am J Lifestyle Med.* 2009;3:489-99

### HEALTH-RELATED QUALITY OF LIFE: COMPARISON BETWEEN TRANSPLANTED AND HEALTHY MASTER ATHLETES

Totti, V.1,2, Roi, G.S.1, Coustere, O.3, Nanni Costa, A.4

*Isokinetic Medical Group*

1. Isokinetic Medical Group (Bologna, Italy), 2. Foundation for the Increase of Organ and Tissue Transplanted (Padova, Italy) 3. World Transplant Games Federation (Paris, France) 4. Italian National Transplant Centre (Rome, Italy) Introduction Health-related quality of life (HRQL) is an important marker in many chronic diseases. It allows the quantification of the patient's subjective perception and enables comprehension to their physical, emotional and social needs (1). The aim of this preliminary study was to compare the level of HRQL between a group of transplant athletes (TA) who participated in the World Transplant Games 2011 (WTG) and a group of healthy athletes who participated in master competitions through administration of the SF-36 questionnaire. Methods The SF-36 questionnaire was filled by 39 males (46±15 yrs; 75±13 kg; 177±0 cm; 24.0±3.2 kg/m<sup>2</sup>) TA (heart n=6; liver n=7; kidney n=25; bone marrow n=1) participating in cycling (n=3), swimming (n=16), track and field (n=14), tennis (n=4) and golf (n=2) competitions of WTG, and by 20 males healthy master athletes (MA) (36±11 yrs; 74±10 kg; 176±0 cm; 23.7±2.4 kg/m<sup>2</sup>) participating in national master swimming (n=17) and cycling (n=3) competitions. Results TA participated in sports competitions from 8±9 years, training 4±1 times/week for an average of 1±1 hour per session, while MA from 13±9 years and they trained 4±1 times/week for an average of 1±1 hours for each training session. The two groups achieved similar scores in the scales of general health (75±20 TA vs 75±11 MA), vitality (67±17 TA vs 69±12 MA), social functioning (85±18 TA vs 84±16 MA) and mental health (76±18 TA vs 75±14 MA). TA showed significant difference in scales of physical functioning (81±29 vs. 99±2 MA, t=3.858, P<0.01), role limitations due to physical problems (83±31 vs 96±12 MA, t=2.304, P<0.05), body pain (79±19 vs 88±18 MA, t=1.784, P<0.05) and role limitations due to emotional problems (84±28 vs 98±8 MA, t=2.324, P<0.05) compared to healthy athletes. Conclusions In a selected group of transplanted patients practicing sports, the physical component and a part of the mental component (role limitations due to emotional problems) were worse than that of healthy athletes, while the other scales of the general health were similar to that of healthy athletes. In particular vitality and general health scales that are part of both the physical and mental components, are similar to MA. Despite TA is not representative of the general transplant population, the data suggests that near-normal level of health-related quality of life is possible after transplantation in TA. Reference Rodrigues Fructuoso M, Castro R, Oliveira I, Prata C, Morgado T. Quality of life in chronic kidney disease. *Nefrologia* 2011; 31(1): 91-96

### LACK OF ENDOGENOUS PAIN INHIBITION DURING EXERCISE IN PEOPLE WITH CHRONIC WHIPLASH: AN EXPERIMENTAL STUDY

Van Oosterwijck, J.1,2,3, Nijs, J.1,2,3, Meeus, M.1,2, Van Loo, M.4, Paul, L.5

1: *Vrije Universiteit Brussel (Belgium)*, 2: *Artesis University College Antwerp (Belgium)*, 3: *University Hospital Brussels (Belgium)*, 4: *Red Cross Flanders (Belgium)*, 5: *University of Glasgow (UK)*

INTRODUCTION: Evidence for altered central pain processing and hypersensitivity of the central nervous system, i.e. central sensitization, in chronic whiplash associated disorders (CWAD) is accumulating. Dysfunctional descending inhibitory action is one of the major characteristics of central sensitization and has been studied during exercise in some chronic pain conditions, but no data regarding the response of people with CWAD to exercise are available. Therefore the purpose of this study was to examine the efficacy of the endogenous pain inhibitory systems during exercise, and exercise response in CWAD patients during two different types of acute exercise. METHODS: Twenty-two women with CWAD and 22 healthy sedentary controls performed a submaximal and a self-paced, physiologically limited exercise test on a cycle ergometer on two separate occasions. The exercise tests were undertaken with cardiorespiratory monitoring. Before and after the exercise bouts, subjects filled out questionnaires to assess health status, and underwent pain pressure threshold (PPT) measurements. Throughout the study, subjects' activity levels were assessed using accelerometry in order to monitor potential influences of daily activity levels. Possible changes in any of the outcome measures in response to exercise were compared between the two groups, and between the two types of exercise, using repeated measures ANOVA. RESULTS: In CWAD PPTs decreased following submaximal exercise, whereas they increased in healthy subjects (between group difference p-value between .021 and .044). The same effect was established in response to the self-paced, physiologically limited exercise, with exception of the PPTs measured at the calf which increased (p=.291). A worsening of the CWAD symptom complex was reported post-exercise (p<.05). Fewer symptoms were reported in response to the self-paced, physiologically limited exercise. In addition, no differences in submaximal exercise capacity or daily physical activity were observed between people with CWAD and controls (p>.05). DISCUSSION: The present study is the first to examine and suggest an impaired descending endogenous pain inhibition during exercise in CWAD patients, and hence provides additional evidence for the presence of central sensitization in CWAD. Submaximal exercise triggers post-exertional malaise, while a self-paced and physiologically limited exercise will trigger less 'severe' symptoms, and therefore seems more appropriate for CWAD patients. These finding highlights the fact that one should be cautious when evaluating and recommending exercise in people with chronic WAD, and that the use of more individual, targeted exercise therapies is recommended.

### HIGHER HABITUAL PHYSICAL ACTIVITY LEVELS ARE PROTECTIVE OF FUNCTIONAL CAPACITY AND QUALITY OF LIFE IN FEMALE PATIENTS WITH RHEUMATOID ARTHRITIS REGARDLESS OF DISEASE ACTIVITY

Prioreschi, A.

*University of the Witwatersrand*

Rheumatoid Arthritis (RA) is a chronic condition resulting in persistent pain, limiting the ability of patients to function normally and therefore decreasing their physical activity levels. Physical activity is difficult to assess, as subjective measures are often inaccurate. Actical accelerometers have been developed to objectively assess physical activity levels. Our study therefore aimed to use accelerometry to objectively assess habitual physical activity levels in a group of patients with RA, and to compare these measures to quality of life and disease activity indices. Seventy-two black, female participants with a mean age of 47±12 years were recruited, 50 of which were patients from a local hospital confirmed as having RA, that were divided into a physically active group (n=25) and a physically inactive group (n=25)

according to their average activity counts recorded on the accelerometer over a two week period. The remaining 22 participants were healthy age and socioeconomically matched controls. All participants wore an Actical on their right hip for two weeks during the day. Participants with RA completed the Short Form-36 (SF-36) and Health Assessment Questionnaires (HAQ-DI), and were assessed for disease activity using the Simplified Disease Activity Index (SDAI). All Acticals were calibrated before the data were analysed. The physically inactive group spent significantly more time in sedentary activities than did the physically active group ( $p=0.003$ ) or the control group ( $p<0.0001$ ), and significantly less time in light and moderate activities than both the physically active group and the control group. HAQ-DI was significantly greater in the physically inactive group than in the physically active group ( $p<0.0001$ ), indicating a greater degree of functional impairment. There were no differences between the two groups for SDAI, yet the physically active group scored better than the physically inactive group on every component of the SF-36, and significantly better for vitality ( $p=0.039$ ), overall mental health ( $p=0.049$ ), overall physical health ( $p=0.049$ ), and total SF-36 score ( $p=0.026$ ). Accelerometry is able to detect habitual physical activity in patients with RA, and indeed confirmed that they lead a significantly more sedentary lifestyle than healthy controls. Higher levels of physical activity were not associated with disease activity, but were protective of functional capacity and highly associated with improved quality of life in RA patients.

### REVASCULARISATION IN PERIPHERAL ARTERIAL DISEASE : EFFECT ON LEG BLOOD FLOW, WALKING TOLERANCE AND CALF MUSCLE FUNCTION.

Stefanovic, B., Russell, F.D., Walker, P.J., Green, S., Askew, C.D.

*University of the Sunshine Coast*

REVASCULARISATION IN PERIPHERAL ARTERIAL DISEASE (PAD): EFFECT ON LEG BLOOD FLOW, WALKING TOLERANCE AND CALF MUSCLE FUNCTION. Stefanovic, B. 1, Russell, F.D. 1, Walker, P.J. 2, Green, S. 3, Askew, C.D. 4. 1: University of the Sunshine Coast, 2: School of Medicine, Discipline of Surgery and Centre for Clinical Research, University of Queensland, 3: University of Western Sydney, 4: Institute of Health and Biomedical Innovation, Queensland University of Technology (Australia). Introduction Haemodynamic and non-haemodynamic factors are believed to contribute to walking intolerance in patients with PAD. Whilst revascularisation leads to improvements in walking tolerance, the mechanisms of improvement and its influence on calf muscle function are not clear. This study aimed to determine the effect of revascularisation on walking tolerance, calf muscle function and leg blood flow in PAD. Methods 12 men and 3 women (age  $63 \pm 8$  y) with PAD scheduled to undergo revascularisation were included. Resting ankle to brachial index (ABI) of the limb to be revascularised (VASC) was  $0.72 \pm 0.11$  compared to  $0.95 \pm 0.19$  for the non revascularised limb (NON-VASC). Before and 2-4 weeks after revascularisation, six minute walking distance (6MWD) was assessed, as was calf muscle strength, endurance, and fatigue using an isometric plantar flexion dynamometer in both VASC and NON-VASC limbs. Leg blood flow was measured during calf exercise using strain gauge plethysmography. The biphasic responses of the muscle blood flow and fatigue responses were quantified by fitting distinct equations to these data. Results Revascularisation lead to a non-significant increase in 6MWD (pre  $352 \pm 90$ ; post  $408 \pm 77$  m,  $p = 0.07$ ). There was an increase in ABI for VASC (pre  $0.72 \pm 0.11$ ; post  $1.05 \pm 0.22$ ) compared with NON-VASC limbs (pre  $0.96 \pm 0.17$ ; post  $1.00 \pm 0.21$ ). Exercise blood flow magnitude increased (pre  $26.2 \pm 11.7$ ; post  $38.1 \pm 13.9$  ml.100ml<sup>-1</sup>.min<sup>-1</sup>) in the VASC limbs, and there was an increased amplitude for both the early and late phases of the exercise blood flow response. The time delay preceding the late blood flow phase decreased in the VASC (pre  $22.4 \pm 13.3$ ; post  $15.4 \pm 6.2$  s) compared with the NON-VASC limbs (pre  $14.4 \pm 6.5$ ; post  $17.4 \pm 8.5$  s). Muscle endurance, but not strength, was increased in VASC (pre  $259 \pm 160$ ; post  $525 \pm 382$  s) but not the NON-VASC limbs (pre  $516 \pm 373$ ; post  $586 \pm 316$  s). There were no significant changes in muscle fatigue, although there tended to be an increase in the time delay prior to the late fatigue phase for the revascularised limbs (VASC: pre  $152 \pm 77$ ; post  $202 \pm 115$ . NON-VASC: pre  $221 \pm 129$ ; post  $207 \pm 139$  s,  $p = 0.09$ ). Discussion Revascularisation resulted in a significant improvement in exercise blood flow and plantar flexion endurance. These data support the notion that exercise blood flow is an important determinant of exercise capacity in PAD.

**13:45 - 14:45**

## Poster presentations

### PP-PM02 Nutrition 1

#### BETA-ALANINE SUPPLEMENTATION FOR 10 WEEKS WAS UNABLE TO IMPROVE TRAINING AND COMPETITION PERFORMANCE IN ELITE SWIMMERS

Chung, W.1, Shaw, G.1, Anderson, M.2, Pyne, D.B.1, Saunders, P.U.1, Bishop, D.J.3, Burke, L.M.1

1: Australian Institute of Sport (Canberra, Australia), 2: Queensland Academy of Sport (Queensland, Australia), 3: Victoria University (Melbourne, Australia)

Introduction Although some laboratory-based studies show an ergogenic effect with beta-alanine supplementation, there is a lack of field-based research in training and competition settings. This study investigated the effects of beta-alanine supplementation on training and competition performance in international level swimmers. Methods Elite swimmers ( $n = 27$  males and 21 females, age =  $21.7 \pm 3.1$  yr; mean  $\pm$  SD) were supplemented with either beta-alanine (BA; 4 week loading phase of  $4.8$  g.day<sup>-1</sup> with a maintenance dose of  $3.2$  g.day<sup>-1</sup> thereafter) or placebo (PLA) for 10 weeks. Competition performance was evaluated before (National Championships; CPRE) and after (World Championships or national selection meet; CPOST) supplementation using IPS points. Swimmers also completed three standardised sessions (sprinters  $4 \times 50$  m, 100 m; middle-distance  $6 \times 50$  m, 200 m; distance  $8 \times 50$  m, 200 m) in training at baseline (TPRE), 4 weeks (TMID) and 10 weeks (TPOST) of supplementation. Capillary blood was analysed for pH, bicarbonate and lactate concentration in both competition and training. We employed a contemporary analytical approach involving magnitude-based inferences to detect small effects of practical importance in an elite athlete group. Precision of estimation expressed as 90% confidence limits (CL) to evaluate differences within and between groups. Results There was a trivial effect ( $-1.2 \pm 2.3\%$ ; mean  $\pm$  90% confidence limits) of BA on race performance compared with PLA and no meaningful effect on blood measures (post race pH ( $0.2 \pm 0.8\%$ ); post race bicarbonate ( $-6.7 \pm 22.6\%$ )). For training performance with all three groups combined, there was no substantial effect of BA at TMID and TPOST ( $-0.1 \pm 1.2\%$ ;  $-0.1 \pm 1.4\%$ ). There were also no meaningful effects on post training blood pH at TMID and TPOST ( $-0.1 \pm 0.7\%$ ;  $0.2 \pm 0.7\%$ ) or bicar-



bonate ( $3.6 \pm 13.5\%$ ;  $2.7 \pm 16.4\%$ ). However, post-training blood lactate concentration at TPOST was reduced by  $-11.0 \pm 9.9\%$ . Discussion We were unable to demonstrate an ergogenic effect of beta alanine supplementation in elite level swimmers due to the trivial or unclear results in our study. More work is required to clarify how the results of laboratory-based studies showing positive effects of beta alanine can be transferred effectively into improved real world training and competitive performance.

### **METABOLIC RESPONSE TO GREEN TEA EXTRACT DURING REST AND MODERATE INTENSITY EXERCISE**

Hodgson, A.B.1, Randell, R.K.1, Boon, N.2, Garczarek, U.2, Mela, D.J.2, Jeukendrup, A.E.1, Jacobs, D.M.2

1. *University of Birmingham (Birmingham, UK)* 2. *Unilever R&D (Vlaardingen, The Netherlands)*

**Introduction** Green tea catechins have been hypothesized to increase energy expenditure and fat oxidation by inhibiting catechol-O-methyltransferase (COMT) and thus promoting more sustained adrenergic stimulation. Metabolomics may help to clarify the mechanisms underlying their putative physiological effects. The study investigated the effects of seven days ingestion of green tea extract (GTE) on the plasma metabolite profile at rest and during exercise. **Methods** In a placebo-controlled, double-blind, randomized, parallel study, 27 healthy physically active males consumed either GTE ( $n=13$ , 1200mg catechins, 240mg caffeine / day) or placebo ( $n=14$ , PLA) drinks for seven days. After consuming a final drink (day 8) they rested for two hours and then completed 60 minutes moderate intensity cycling exercise ( $56 \pm 4\%$  VO<sub>2</sub>max). Blood samples were collected before and during exercise. Plasma was analyzed using untargeted 4-phase metabolite profiling and targeted profiling of catecholamines. **Results** Using the metabolomic approach we observed that GTE did not enhance adrenergic stimulation (adrenaline and noradrenaline) during rest or exercise. At rest, GTE led to changes in metabolite concentrations related to fat metabolism (3- $\beta$ -hydroxybutyrate), lipolysis (glycerol) and TCA cycle intermediates (citrate) when compared to PLA. GTE during exercise caused reduced 3- $\beta$ -hydroxybutyrate concentrations as well as large increases in lactate and Cori cycle metabolite concentrations (alanine) when compared to PLA. **Discussion** GTE supplementation resulted in marked metabolic differences during rest and exercise. Yet these metabolic differences were not related to the adrenergic system, which questions the in vivo relevance of the COMT inhibition mechanism of action for GTE.

### **HYDRATION ASSESSMENT OF BASKETBALL PLAYERS DURING FIBA EUROPE U20 EUROPEAN CHAMPIONSHIP**

Andjelkovic, M.1, Vukasinovic-Vesic, M.1, Dikic, N.1,2, Radivojevic, N.1, Curcic, D.J.1, Antic, T.1, Barlic, I.1, Turner, R.2, Stokes, R.2, Gunter, H.2

*Sports Medicine Association of Serbia, FIBA Europe2*

**Introduction** Hydration is the condition of having adequate fluid in the body tissues. Field research suggests that approximately 50% of individual and team athletes are hypohydrated. Thus, the aim of this study was to analyze the hydration status of male basketball players. **Method** Ninety-six basketball players of eight national teams were assessed during the official FIBA Europe U20 Championship Men 2011 - Division B held in Sarajevo in July 2011. In order to estimate hydration we collected three morning urines of each player on consecutive days and once after the game, then we measured body mass of all players before and after one game, the quantity of consumed fluid and urine output during the game, as well as temperature and humidity in the sports hall. Hydration assessments were evaluated by urine specific gravity (Usg), urine color (Ucol), urine osmolality (Uosmol), sweat rate (SR), fluid intake (FI) and urine output (UO). **Results** Players age was  $19 \pm 0.79$  years. After the game body mass loss was  $0.9 \pm 0.7$  kg, percentage of dehydration  $0.99 \pm 0.7\%$ , total fluid intake  $1868 \pm 816$  ml (range 435 – 3987) and sweat rate  $2.7 \pm 0.9$  L/h (range 1.16 – 5.54). Urine output during the game was  $55 \pm 61$  ml. Mean morning Usg was  $1024 \pm 6$  and after the game  $1026 \pm 6$ , mean morning urine color was  $5.67 \pm 1.12$  and after the game  $5.97 \pm 1.37$ , mean morning urine osmolality was  $883 \pm 229$  osmol/L and after the game  $852 \pm 228$  osmol/L. Ambient temperature was  $30 \pm 2^\circ\text{C}$  and humidity  $55 \pm 4\%$  on average. We found statistically significant correlation between sweat rate with Usg ( $p < 0.05$ ), Uosmol ( $p < 0.01$ ), body mass loss ( $p < 0.01$ ), FI ( $p < 0.01$ ), BSA ( $p < 0.01$ ) and percentage of dehydration ( $p < 0.01$ ). **Discussion** Most athletes did not intake enough fluids to match sweat losses during the game and they were significantly dehydrated which was proven by measuring Usg and Uosmol, as well as by body mass loss and percentage of dehydration. Even more players begin the day in a hypohydrated state which is indicated by morning Usg, Uosmol, Ucol. Finally we might conclude that players were chronically dehydrated. The results of this study support idea that trainers and team doctors should be educated to help athletes to be properly hydrated. It seems that only a proactive role and awareness of all participants in basketball could contribute to a better hydration and sports performance. Players should receive encouragement and educational information about suitable hydration strategies. **References** Maughan R.J., Shirreffs S.M. Development of hydration strategies to optimize performance for athletes in high-intensity sports and in sports with repeated intense efforts. *Scand J Med Sci Sports*. 2010.

### **ENERGY BALANCE AND FOOD SOURCES DURING AN ULTRA ENDURANCE CYCLING EVENT**

Geesmann, B.1, Kramer, F.1, Koehler, K.1,2, Mester, J.1,2

1. *German Sport University (Cologne, Germany)* 2. *German Research Centre of Elite Sport (Cologne, Germany)*

**Introduction** Ultra endurance events are among the largest physiological challenges on the human body. One of the biggest tasks is the sufficient energy supply from solid and liquid foods and a successful completion is only possible with adequate dietary strategies. Most scientific reports describing the energetic demands of such events are single case studies (Knechtle et al., 2005) or studies with a small amount of subjects (Hulten et al., 2010), so that only little is known about the inter-individual variance in energetic demands and eating habits of such events. In the present study the cycle marathon Paris-Brest-Paris (PBP) which leads over 1.200 km was analyzed from an energetic point of view. Hence, the aim was to assess the energy balance of a whole team participating in this event and to analyze the energy intake (EI) under terms of nutritional composition and energy supply. **Methods** Fourteen well-trained male athletes ( $74.1 \pm 6.8$  kg,  $43.6 \pm 7.8$  y) participated in this study and finished PBP in 54 hours with a mean cycling time of 42h 48min. In the preparation period, the cyclists performed an incremental test on a cycle ergometer to determine the ratio between power output (PO) and energy expenditure (EE) individually. EE was measured by indirect calorimetry. All riders were equipped with an SRM system to assess PO continuously, which was later converted into EE using the previously determined individual regression. Diet was continuously recorded by trained staff. The nutrient content was obtained from the Federal German Nutrient Database or the manufacture. Immediately before and after the event body weight, body fat and skin fold thickness were measured. **Results** The total EE was  $25303 \pm 2436$  kcal ( $11245 \pm 1083$  kcal/24h). EI was  $19749 \pm 4502$  kcal ( $8777 \pm 2001$  kcal/24h). This resulted in an average energy deficit of  $5554 \pm 4567$  kcal. Of the total EI,  $15634 \pm 4310$  kcal ( $6948 \pm 1916$  kcal/24h) derived from solid food and  $4115 \pm 1850$  kcal ( $1829 \pm 822$  kcal/24h) from liquid nutrition. Analyzing the macronutrient content revealed that 57% were taken up from carbohydrates, 30% from fat and 13% from proteins. Total carbohydrate intake was  $3011 \pm 525$ g ( $40.6 \pm 7.1$  g/kg BW). The loss of body weight in pre-post comparison was  $0.1 \pm 1.4$  kg. Total body fat was reduced by  $0.9 \pm 0.5$

kg, skinfold thickness by  $9.8 \pm 4.6$  mm. Discussion In relation to other ultra endurance events the energy deficit was rather low, which verifies a successful realization of the individual dietary strategies. The nutritional composition can be used for further events with similar energetic and physiological challenges. References Hulton A.T., Lahart I., Williams K.L., et al. (2010). *Int J Sports Med*, 31, 463-467. Knechtle B., Enggist A., Jehle T. (2005). *Int J Sports Med*, 26, 499-503.

### EFFECTS OF SHORT-TERM ENERGY RESTRICTION WITH AND WITHOUT TRAINING ON PHYSIOLOGICAL AND PSYCHOLOGICAL MEASURES OF PERFORMANCE

Koehler, K., Pilger, N., Zinner, C., Braun, H., Kleinert, J., Mester, J., Schaenzer, W.

*German Sport University*

Introduction Apart from potential long-term effects on body mass and composition, a restriction of the dietary energy intake leads to acute changes in metabolic and hormonal profiles, which indicate a catabolic state (Loucks, 2004). These acute effects of low energy availability have primarily been reported in moderately trained females, but data on the effects in trained male athletes is lacking. Furthermore, little is known about the acute effects of energy restriction on performance capacity. Hence, the purpose of our study was to characterise the effects of a short-term energy restriction on physiological and psychological performance measures. Methods In a preliminary study, four male athletes ( $26 \pm 3$  y,  $79 \pm 8$  kg) underwent four interventions in a randomized, cross-over-design. Dietary energy intake (EI) and exercise energy expenditure (ExEE) were predefined to regular energy availability (EA; 40 kcal/kg FFM) or reduced EA (15 kcal/kg FFM). In two of the four study arms, the athletes underwent a daily training program with an ExEE of 15 kcal/kg FFM, which was compensated for by raising EI by 15 kcal/kg FFM. EA was controlled for 4 consecutive days and pre and post measures included assessment of body weight and composition, strength tests, submaximal and maximal performance tests on a cycle ergometer, and questionnaires to assess the perceived physical and psychological state. Results Regardless of exercise, energy restriction caused a reduction in body mass by  $2.3 \pm 0.7$  kg ( $p < 0.001$ ). There was a trend towards greater fat mass losses and smaller fat-free mass losses when the subjects exercised during energy restriction. Peak power in bench press, leg curl and leg extension and peak power output during a 30-sec all-out cycle ergometer test were not significantly affected by energy restriction with or without exercise. During the submaximal cycling test, heart rate was elevated during energy restriction ( $p < 0.05$ ) but ratings of perceived exertion were only slightly higher. Energy restriction caused a significant reduction in subjective scores of the perceived physical and motivational state, but training significantly reduced the negative effects of energy restriction on perceived physical fitness, social acceptance and positive mood. Discussion The present data show that dietary energy restriction for four days with or without exercise leads to massive changes in body mass and has negative effects on submaximal but not on peak performance. Energy restriction also caused changes in psychological measures, but for several items, the combination of energy restriction and exercise blunted the negative effects. References Loucks AB. (2004). *J Sports Sci*, 22, 1-14.

### OPTIMISING AN ORAL INSULINOTROPIC FORMULATION FOR L-CARNITINE FEEDING IN HUMANS

Shannon, C.E., Greenhaff, P.L., Stephens, F.B.

*University of Nottingham*

Aims Carnitine facilitates the mitochondrial entry of long-chain fatty acids and also buffers pyruvate-derived acetyl group accumulation during intense exercise in humans. Increasing skeletal muscle carnitine content alters fuel metabolism but requires prolonged (>24 wks), daily feeding of L-carnitine in a carbohydrate beverage (Wall et al., 2011) to raise serum insulin to a concentration sufficient (>50 mU/L) to augment muscle carnitine retention (Stephens et al., 2006). In an attempt to improve the efficacy of muscle carnitine loading, this study used oral insulinotropic beverages to extend the time period during which serum insulin concentration was >50 mU/L in the presence of elevated plasma carnitine. Methods On four randomised 6-hour visits following an overnight fast, seven healthy males (age  $23 \pm 4$  yr, BMI  $24 \pm 2$  kg/m<sup>2</sup>) ingested 4.5g L-carnitine-tartrate in 200ml water (0 h) followed by 3x700ml beverages containing either flavoured water (CON), 80g carbohydrate (CHO), 40g carbohydrate + 40g whey protein (PRO), or 30g carbohydrate + 14g whey protein + 7g leucine + 7g phenylalanine (AA) at 1, 2.5 and 4 h. Blood was sampled every 20 min for the determination of serum insulin and plasma total carnitine (TC) concentration. Six-hour area under the concentration x time curve (AUC) and peak concentration values were compared using ANOVA. Results Serum insulin concentration AUC >50 mU/L during CHO ( $3.3 \pm 1.3$  U/L·min) was 265% greater than AA ( $0.9 \pm 0.4$  U/L·min;  $P < 0.05$ ) and tended to be 211% greater than PRO ( $1.1 \pm 0.6$  U/L·min;  $P = 0.07$ ). Peak insulin concentration after the first drink was similar between CHO, PRO and AA ( $86 \pm 16$ ,  $91 \pm 23$  and  $80 \pm 18$  mU/L, respectively), but was greater after the second and third drinks in CHO ( $98 \pm 15$  and  $80 \pm 9$  mU/L, respectively) than PRO ( $52 \pm 6$  and  $46 \pm 9$  mU/L, respectively; both  $P < 0.01$ ) and AA ( $49 \pm 5$  and  $53 \pm 11$  mU/L, respectively; both  $P < 0.05$ ). Plasma TC AUC during PRO ( $7.6 \pm 0.9$  mmol/L·min) was 32% ( $P < 0.01$ ) and 25% ( $P < 0.05$ ) greater than AA and CON ( $5.7 \pm 0.6$  and  $6.0 \pm 0.8$  mmol/L·min, respectively) and tended to be 16% greater than CHO ( $6.5 \pm 0.7$  mmol/L·min;  $P = 0.08$ ). Conclusions Serum insulin concentration was >50 mU/L for longer in CHO. Furthermore, the blunted insulin response to repeated ingestion of PRO and AA may abate the stimulation of muscle carnitine uptake relative to CHO. This study affirms a high-carbohydrate beverage as a potent insulinotropic option for carnitine loading. The greater plasma TC AUC during PRO may improve temporal matching between peak concentrations of TC and insulin. References Wall BT, Stephens FB, Constantin-Teodosiu D, Marimuthu K, Macdonald IA, Greenhaff PL. (2011). *J Physiol*, 589, 963-973. Stephens FB, Constantin-Teodosiu D, Laithwaite D, Simpson EJ, Greenhaff PL. (2006). *Am J Physiol Endocrinol Metab*, 292, E637-E641.

### PROTEIN SUPPLEMENTATION DOES NOT FURTHER AUGMENT THE BENEFITS OF PROLONGED RESISTANCE TYPE EXERCISE TRAINING IN HEALTHY ELDERLY MEN AND WOMEN

Leenders, M., Verdijk, L.B., van der Hoeven, L., van Kranenburg, J., Nilwik, R., van Loon, L.J.C.

*Maastricht University Medical Centre+*

Background: Resistance type exercise training has been well established as an effective intervention strategy to increase skeletal muscle mass and strength in the elderly. Objective: To assess whether dietary protein supplementation can further augment the adaptive response to prolonged resistance type exercise training in healthy, elderly men and women. Design: Healthy, elderly men ( $n=31$ ;  $70 \pm 1$ y) and women ( $n=29$ ;  $70 \pm 1$ y) were randomly assigned to a 24-wk, progressive resistance type exercise training program with (protein group) or without (placebo group) additional protein supplementation (15 g/day). Strength was assessed regularly by one-repetition maximum (1RM) testing. Muscle hypertrophy was assessed at whole-body (DXA), muscle (CT) and muscle fiber (biopsy) level. Functional performance was assessed with a sit-to-stand test. Blood glucose and lipid profiles were assessed as markers for metabolic health.

Results: 1RM strength increased by  $45 \pm 6$  vs  $40 \pm 3\%$  (women) and  $41 \pm 4$  vs  $44 \pm 3\%$  (men) in the placebo vs protein supplemented group, respectively ( $P < 0.001$ ), with no differences between groups. Muscle mass increased similarly in the placebo and protein groups, both at whole-body ( $2 \pm 1\%$ ) and muscle level ( $9 \pm 1\%$ ). In agreement, type II muscle fiber size increased significantly in both placebo and protein groups ( $25 \pm 13$  vs  $30 \pm 9$  and  $23 \pm 12$  vs  $22 \pm 10\%$  in the women and men, respectively), with no changes in type I muscle fiber size. Sit-to-stand time improved by  $18 \pm 2$  and  $19 \pm 2\%$  in the women and men, respectively ( $P < 0.001$ ) with no differences between groups. Glucose homeostasis as measured by HbA1c, OGIS, and ISI improved in all groups. Furthermore, significant decreases in plasma LDL and total cholesterol concentrations were observed in both placebo and protein group. Conclusion: Prolonged resistance type exercise training muscle mass and strength, augments functional capacity, and improves glycemia and lipidemia in healthy elderly men and women. Additional protein supplementation (15 g/d) does not further increase muscle mass, strength, and/or functional capacity in healthy elderly men and women.

### THE EFFECT OF HIGH DOSE VITAMIN C AND E SUPPLEMENTATION ON VO<sub>2</sub>MAX, HEMOGLOBIN MASS AND ENDURANCE PERFORMANCE IN WELL TRAINED SUBJECTS

Holden, G., Landgraff, H., Raastad, T., Hallén, J., Paulsen, G.

*Norwegian School of Sport Sciences, Oslo, Norway*

The effect of high dose vitamin C and E supplementation on VO<sub>2</sub>max, hemoglobin mass, and endurance performance in well trained subjects Holden, Geir., Landgraff, Hege., Raastad, Truls., Hallén Jostein., and Paulsen, Gøran. Norwegian School of Sport Sciences, Oslo, Norway Introduction There is a widespread use of antioxidant supplementation in general population and among athletes. A growing body of evidence indicates detrimental effects of high-dose antioxidant supplementation on health and performance benefits of training (Gomez-Cabrera et al., 2008). The aim of this study was to investigate the effects of high-dose of antioxidant supplementation (vitamin C and E) during an 11 week endurance training regiment on maximal oxygen consumption (VO<sub>2</sub>max), running performance (beep-test; 20m shuttle run), blood volume (BV) and total hemoglobin mass (HbM), as well as oxygen consumption (VO<sub>2</sub>), heart rate (HR) and blood lactate concentration (La) on submaximal performance on motorized treadmill. Methods Seventeen endurance trained subjects (12 females and 5 males; age:  $24.4 \pm 2.9$  yrs, VO<sub>2</sub>max  $55.0 \pm 7.9$  (ml.kg<sup>-1</sup>.min<sup>-1</sup>) were recruited and randomized in an antioxidant group (AG) and a placebo group (PG). The AG (n=8) received 1000 mg vitamin C and 235 mg vitamin E daily, while the PG (n=9) received placebo pills. The study was a double blinded design. The training protocol consisted of 3-4 endurance training sessions every week for 11 weeks, combining interval (4 x 4 up to 6 x 6min; > 90% HRmax) and continuous running sessions (30 and 60 min; ~85% HRmax and ~75% HRmax), respectively. The subjects were tested before and after 5 and 11 weeks of training and supplementation. Results VO<sub>2</sub>max increased by  $8.9 \pm 2.9\%$  in AG and by  $7.8 \pm 4.0\%$  in PG ( $p < 0.01$ ). PG significantly reduced HR at a workload corresponding to 60% of initial VO<sub>2</sub>max test by  $4.4 \pm 4.6\%$  ( $p = 0.02$ ), while AG had a small increase in HR by  $1.3 \pm 3.1\%$  ( $p = 0.3$ ). At a workload of 85% of initial VO<sub>2</sub>max, PG significantly reduced HR by  $4.7 \pm 5.0\%$  ( $p = 0.02$ ), with AG increasing HR by  $1.6 \pm 3.1\%$  ( $p = 0.3$  within and  $p = 0.01$  between groups). There were no significant changes in blood (La) at the submaximal workloads for either group. Performance in the beep-test did not change significantly in AG  $3.4 \pm 8.2\%$  ( $p = 0.3$ ), but improved distance in PG by  $14.3 \pm 14.1\%$  ( $p = 0.02$ ). No significant changes were observed for BV or HbM in the two groups. Discussion The 11 week endurance training program increased VO<sub>2</sub>max in both AG and PG, with no changes in BV or HbM. Supplementation with large doses of vitamin C and E hindered the training induced reduction in HR at submaximal workloads. Even though there were no group differences in performance changes in the beep-test, only the PG increased significantly their performance. Our results suggest that antioxidant supplementation may hamper endurance training induced adaptations related to performance. References Gomez-Cabrera, M. et al. (2008) *Am J Clin Nutr*, 87(1), 142-149.

### THE FATE OF CHRONICALLY INGESTED BETA-ALANINE RETENTION IN HUMANS.

Everaert, I., Blancquaert, L., Derave, W.

*Ghent University*

Introduction: Beta-alanine is a popular nutritional supplement, which enhances muscle carnosine synthesis and likely high-intensity exercise performance. Urinary retention of beta-alanine after acute ingestion is very high, namely 96.3% for pure beta-alanine and 98.9% for slow-release (1). The retention of both creatine (from 60 to 32% (2)) and carnitine (from 97.8 to 90% (3)) decreases after 3 days supplementation but can be enhanced by co-ingestion of carbohydrates and proteins, as insulin stimulates the muscular accumulation of these compounds. Therefore, the aim of this study was to investigate the effect of 5 weeks beta-alanine supplementation on whole body beta-alanine retention and whether this could be enhanced by co-ingestion of carbohydrates and proteins. Methods: 7 young healthy male subjects were supplemented for 5 weeks with slow-release beta-alanine (3 x 1.6g/day (Powerbar)). Beta-alanine retention was measured weekly, by ingestion of 1.6g slow-release beta-alanine in fasted subjects and collection of urine up to 6h post-ingestion. From week 2, subjects performed the retention test twice on consecutive days: 1/ control as described above, 2/ with intake of 2 energy bars (10min post beta-alanine intake: Power C2max (= 39.1g CHO + 5.8g protein) and 55min post beta-alanine intake: Protein Plus (= 22.2g CHO + 16.6g protein), Powerbar). Results: The mean ( $\pm$  SD) urinary beta-alanine excretion before supplementation was  $25.63 \pm 22.53$  mg, which corresponds with a beta-alanine retention of  $98.40 \pm 1.41\%$ . Long-term supplementation with beta-alanine did not affect beta-alanine retention (week 1 - 5:  $97.98 \pm 1.45\%$ ,  $98.45 \pm 1.20\%$ ,  $98.05 \pm 0.85\%$ ,  $98.53 \pm 0.66\%$ ,  $98.79 \pm 0.59\%$ , respectively,  $p > 0.05$ ). Logically, co-ingestion of beta-alanine with carbohydrates and proteins did not enhance beta-alanine retention (week 2:  $98.37 \pm 0.92\%$ , week 3:  $98.71 \pm 0.83\%$ , week 4:  $98.54 \pm 0.98\%$ , week 5:  $97.56 \pm 1.74\%$ ,  $p > 0.05$ ). Discussion: During chronic beta-alanine supplementation, only ~ 2-3% of ingested beta-alanine was excreted in urine and only ~ 5-6% of ingested beta-alanine is converted into muscle carnosine (calculated from Stellingwerff et al.(4) ), demonstrating that the long-term supplementation of 100g (= 1.12mol) beta-alanine results in an increase of muscle carnosine of 2 mmol/kg muscle mass). Thus, a large amount of ingested beta-alanine is currently not accounted for muscle carnosine, and is probably metabolized. Further research on the effect of insulin on muscle carnosine loading is necessary. References: 1. Decombaz et al. *Amino Acids*, 2011. 2. Harris et al. *Clin Sci (Lond)*, 83(3):367-74, 1992. 3. Stephens et al. *J Appl Physiol*, 102:1065-1070, 2007. 4. Stellingwerff et al. *Amino Acids*, 2011.

**EFFECT OF BETA-ALANINE SUPPLEMENTATION ON 2000 M ROWING ERGOMETER PERFORMANCE**

Ducker, K., Dawson, B., Wallman, K.E.

*The University of Western Australia*

**Introduction** Beta-alanine has been shown to potentially improve exercise performance in short-term, high intensity efforts. However, limited research has reported whether serial supplementation with beta-alanine is ergogenic to many actual sporting events. Therefore, the aim of the current study was to assess if beta-alanine supplementation could improve race simulation 2000 m rowing ergometer performance in well trained male rowers. **Methods** Sixteen competitive male rowers were recruited to participate in the study (mean  $\pm$  SD; age  $26 \pm 9$  y, body-mass  $83.4 \pm 8.3$  kg; height  $186.9 \pm 4.7$  cm; lightweight  $n = 4$ ; heavyweight  $n = 12$ ). Participants completed duplicate trials (2 x pre-supplementation and 2 x post-supplementation) of a 2000 m rowing ergometer race, separated by 28 days of either beta-alanine ( $n = 7$ ;  $80 \text{ mg} \cdot \text{kg}^{-1} \text{BM} \cdot \text{day}^{-1}$ ) or placebo ( $n = 9$ ; glucose) supplementation. **Results** Race times for the beta-alanine group (pooled data) improved by  $2.9 \pm 4.1$  s while times for the placebo group slowed by  $1.2 \pm 2.9$  s ( $p = 0.055$ ). Race split times and average power outputs improved significantly ( $p < 0.05$ ) following supplementation with beta-alanine at the 750 and 1000 m distances (750 m time  $-0.7$  s, power  $+3.6\%$ ; 1000 m time  $-0.5$  s, power  $+2.9\%$ ). This was supported qualitatively (smallest worthwhile change) by an 87% likely benefit for the 750 m race time and 80% likely benefit for the average power output. Further, performance was significantly impaired ( $p < 0.05$ ) following placebo supplementation at both the 750 and 1000 m distances (time 750 m  $+0.7$  s, power 750 m  $-3.2\%$ ; time 1000 m  $+0.6$  s, power 1000 m  $-2.8\%$ ). **Discussion** Twenty eight days of beta-alanine supplementation ( $80 \text{ mg} \cdot \text{kg}^{-1} \text{BM} \cdot \text{day}^{-1}$  / mean dose =  $6.72 \text{ g} \cdot \text{day}^{-1}$ ) significantly improved 2000 m rowing ergometer performance in well trained rowers. The 2.9 s improvement in race time is similar to the 2.7 s improvement reported by Baguet et al. (2010) following 7 weeks of beta-alanine supplementation ( $5 \text{ g} \cdot \text{day}^{-1}$ ). This improvement in performance is likely due to improved intramuscular  $\text{H}^+$  buffering however, other proposed roles of carnosine within the body (increased sensitivity of the calcium release channels and contractile apparatus to calcium, vasodilatory and protective effects due to the role of carnosine as a multifunctional antioxidant) cannot be excluded. **In conclusion**, supplementing with beta-alanine for 4 weeks is sufficient to improve 2000 m rowing ergometer performance. **References** Baguet, A., Bourgois, J., Vahnee, L., Achten, E., & Derave, W. (2010). Important role of muscle carnosine in rowing performance. *Journal of Applied Physiology*, 109, 1096-1101.

**THE EFFECT OF N-ACETYLCYSTEINE ON CYCLING PERFORMANCE FOLLOWING INTENSIFIED TRAINING IN WELL-TRAINED TRIATHLETES: A DOUBLE BLIND PLACEBO CONTROLLED STUDY**

Slattery, K., Dascombe, B., Wallace, L., Bentley, D., Coutts, A.

*University of Technology, Sydney*

**Introduction** The antioxidant N-acetylcysteine (NAC) has been demonstrated to reduce muscle contractile fatigue in a laboratory setting (Reid et al., 1994). This investigation aimed to examine the ergogenic effect of short-term oral NAC supplementation and associated changes in red-ox balance and inflammation during intense training. **Methods** A double blind, randomised placebo-controlled crossover design was used to assess 9 d oral NAC supplementation (1200 mg/day) in 8 well-trained triathletes (age  $23.6 \pm 3.2$  yrs,  $\text{VO}_2\text{peak}$   $63.3 \pm 4.8$  ml/kg/min). For each supplement trial (NAC and placebo), baseline venous blood and urine samples were taken and a pre-supplementation cycle ergometer race simulation was performed. Following the loading period, further samples were collected pre-exercise, post-exercise, 2 h and 24 h following the post-supplementation cycle ergometer race simulation which consisted of sprint and time trial efforts. Changes in plasma total antioxidant capacity (TAC), ferric reducing ability of plasma (FRAP), thiobarbituric acid-reactive substances (TBARS), interleukin-6 (IL-6), monocyte chemoattractant protein-1 (MCP-1) were assessed. Nuclear factor- $\kappa$ B (NF- $\kappa$ B) in peripheral mononuclear cells extracts and urinary 15-isoprostane F<sub>2t</sub> concentration (F<sub>2t</sub>isoprostanes) were measured at the same time points. Training load was matched for each trial and the Daily Analysis of Like Demands for Athletes (DALDA) was used to monitor well-being. The experimental procedure was repeated with the remaining supplement after a 3 week washout. Changes in biochemical and performance parameters were analysed using a factorial two-way analysis of variance. **Results** NAC improved sprint performance during the cycle ergometer race simulation ( $P < 0.001$ ), but not time trial performance. Supplementation with NAC augmented post-exercise plasma TAC ( $P = 0.005$ ), reduced exercise-induced oxidative damage, [plasma TBARS ( $P = 0.002$ ); urinary F<sub>2t</sub>isoprostanes ( $P = 0.010$ )] and attenuated inflammation [plasma IL-6 ( $P = 0.002$ ); MCP-1 ( $P = 0.012$ )]. NAC increased post-exercise NF- $\kappa$ B activity ( $P < 0.001$ ). A greater number of 'worse than normal' responses in the DALDA ( $P = 0.050$ ) was reported in the placebo trial. **Discussion** Oral NAC supplementation improved cycling performance via an improved red-ox balance and promoted adaptive processes in well-trained athletes undergoing strenuous physical training. This finding supports the use of NAC as an ergogenic aid in a practical sporting setting. Moreover, in agreement with previous research, athletes displayed a greater ability to cope with intense physical training with antioxidant supplementation which did not interfere with physiological adaptive processes (Palazzetti et al., 2004). **References** Reid M, Stokic D, Koch S, Khawli F, Leis A. (1994). *J Clin Invest*, 94(6), 2468-2474. Palazzetti S, Rousseau A, Richard M, Favier A, Margaritis I. (2004). *Br J Nutr*, 91(1), 91-100.

**13:45 - 14:45****Poster presentations****PP-PM03 Physical Activity****INFLUENCES ON CHILDREN'S WEEKDAY AND WEEKEND DAY PHYSICAL ACTIVITY: THE CHANGE! PROJECT**

Mackintosh, K.A.1,2, Ridgers, N.D.4, Boddy, L.M.1,2, Abayomi, J.C.2, Davies, I.G.1,2 Warburton, G.L.1,2, Gobbi, R.1,2, Stratton, G.1,3, Fairclough, S.J.1,2

*1 REACH Group, 2 Faculty of Education, Community and Leisure, 3 RISES (Liverpool John Moores University, UK), and 4 Centre for Physical Activity and Nutrition Research (Deakin University, Australia)*

**Objectives** To investigate the impact of the CHANGE! curriculum-based intervention across time on children's weekday and weekend day physical activity (PA) levels and to report effect of covariates on the outcome measures. **Methods** Twelve primary schools were randomised to an Intervention ( $N = 6$ ) or Control condition. Baseline, 20-week post-intervention and 10-week follow-up measures of PA (7-day

accelerometry), cardiorespiratory fitness (CRF) and anthropometric measures were completed. Outcome measures were total physical activity (TPA; counts•min<sup>-1</sup>), minutes per weekday and weekend day spent being sedentary (SED), and in moderate (MPA), vigorous (VPA), and moderate-to-vigorous physical activity (MVPA). Multilevel modelling was used to assess the effect of the intervention on the outcome variables, as well as the influence of school level (temperature, rainfall, playground area per child, and number of children on roll) and child level (sex, maturation, weight status, accelerometer wear time, CRF, and socioeconomic status (SES)) covariates. Results There was a significant intervention effect for weekday TPA with children in the Intervention group recording 88.71 cpm more than Control children ( $p=0.02$ ). The Intervention group engaged in more weekday SED, MPA, VPA, and MVPA, and more bouts, for a longer duration. At weekends Intervention children accrued more SED and VPA mins than Control children, and less TPA, MPA, and MVPA. Boys did significantly more MPA (9.55) and MVPA (13.95) on weekdays and engaged in 5.49 and 2.69 mins MPA and VPA, respectively, during school hours ( $p<.01$ ). Weekday PA was significantly influenced by maturation, CRF and playground area per child ( $p<.05$ ). Specifically, school-time MVPA mins were predicted by number of children on roll (0.02), temperature (1.19) and maturity offset (7.57), whereas children in the high BMI group engaged in 1.73 mins less VPA ( $p<.05$ ). Out of school weekday PA was influenced by CRF, SES and maturity ( $p<.05$ ). High MVPA Intervention children increased weekday bouts and had less SED mins during school hours, whereas low SES Intervention children engaged in more weekday bouts and increased TPA ( $p<.05$ ). Discussion A significant intervention effect was observed for weekday TPA, but Intervention children did less on weekends than those in the control group. This suggests that the intervention may have influenced the Intervention children's PA behaviours differently on weekdays and at weekends.

## IS PARENTAL PHYSICAL ACTIVITY AN INFLUENTIAL FACTOR ON PA IN CHILDREN?

Fischbach, N.

*University of Ulm, Medical Center*

Nanette Fischbach<sup>1</sup>, Susanne Kobel<sup>1</sup>, Sarah Kettner<sup>1</sup>, Clemens Drenowatz<sup>1</sup>, Jürgen Michael Steinacker<sup>1</sup> <sup>1</sup>Sports- and Rehabilitation-Medicine, Ulm University, Germany Purpose The increasing prevalence of overweight and obesity in children and adolescents has been associated with a decline in physical activity (PA). The majority of children display insufficient activity levels (Trojano et al, 2008). Various environmental and biological constraints have been shown to influence children's PA but only limited information is available on the effects of parental behaviour. Therefore, this study examined the effect of parental sports participation on children's PA and body composition. Methods Baseline data from the school-based health promotion programme "Komm mit in das gesunde Boot" (Join the Healthy Boat) in south-west Germany funded by Baden-Württemberg-Stiftung was used. The initial sample size was 1943 (50,2% boys) first and second grade children, but due to missing data only 1437 subjects (50,6% boys) 7.1 ± 0.6 years of age were entered in the analysis. Children's bodyweight and height was measured by trained technicians and BMI was calculated and converted to BMI percentiles (BMIPCT). Parent questionnaires were used to determine parental sports participation and children's PA. Three parental activity groups were created (both sportily active, one parent sportily active, both inactive). ANCOVA, controlling for age and sex was used to examine differences in children's PA and BMIPCT. Results On average children reached the 60 min of MVPA on 2.8 ± 1.7 days a week. Boys spent significantly more days with 60 minutes MVPA than girls. 44.1% of parents reported both being active, 28.3% both being inactive and 27.7% reported that one parent is active. Children of active parents displayed significantly lower BMIPCT compared their peers with one or both inactive parents. There was, however, no significant difference between the parental activity groups in children's PA. Conclusion Reported activity levels are in line with previous research. Children whose parents were both active displayed lower BMIPCT however no difference in PA was found. One reason for this result could be that active parents may be more conscious about the activity level of their children and, therefore, their reports were more accurate. It is, however, also possible that children at this age are inherently active and do not require additional support from their parents. The difference in body composition could then be due to an overall healthier lifestyle of active parents. Even if PA does not differ, a healthier diet may lead to a healthier body composition. Overall more research is needed to enhance the understanding of parental influence on children's PA and body composition. References Troiano RP et al (2008). Physical activity in the United States measured by accelerometer. *MSSE*. 2008;40:181-188.

## EVALUATING THE LONG-TERM EFFECTIVENESS OF THREE PHYSICAL ACTIVITY PROGRAMS AMONG OLDER ADULTS.

Van Hoecke, A.S., Delecluse, C., Bogaerts, A., Boen, F.

*KU Leuven*

There is a lack of consensus on the most appropriate counseling format to assist older adults in pursuing and maintaining a physically active lifestyle. This study evaluated the relative impact of an individualized need-supportive physical activity program, based on the self-determination theory (SDT), compared with less intensive counseling formats. A total of 442 Flemish sedentary adults over the age of 60 were randomly assigned to: 1) an exercise promotion condition, consisting of a single advice session in which the coach clarified existing local opportunities; 2) a walking condition, consisting of a single advice session in which the coach additionally explained a prestructured individually-tailored walking program; and 3) a need-supportive condition, consisting of additional regular contacts in which an individualized exercise plan was set up. Furthermore, the coach fostered the SDT-related psychological needs for autonomy, competence and relatedness in order to increase autonomously motivated physical activity. Autonomous motivation, self-reported and objective physical activity were measured before (pre), after (post) and one year after the beginning of (follow-up) the ten-week intervention by the Behavioural Regulation Exercise Questionnaire, Godin Leisure-Time Exercise Questionnaire and pedometers respectively. Perceived need-support was assessed at post-test by a modified version of the Teacher As Social Context Questionnaire. Linear mixed model analyses demonstrated an increase in self-reported physical activity post-intervention and in the long term in the three interventions. However, the walking and need-supportive program yield larger increases than the exercise promotion. Results on objective physical activity showed an increase in daily steps from pre- to post-test in all conditions. However, the walking condition increased significantly more compared with the exercise promotion condition. Long-term analyses (i.e. from pre- to follow-up-test) did not demonstrate significant time by condition interaction effects. Nevertheless, the walking and need-supportive condition increased their daily number of steps, whereas no changes were found in the exercise promotion condition. Bootstrapping analyses revealed that, irrespective of condition, higher levels of perceived need-support resulted in higher levels of physical activity at post- and follow-up-test. These effects were mediated by autonomous motivation. The findings demonstrate post-intervention as well as long-term effectiveness of three physical activity programs varying in counseling intensity among sedentary older adults. Providing a specific and individually-tailored physical activity plan seems to be more effective than referring older adults to wide-spread existing physical activity opportunities. Furthermore, the different patterns in self-reported and objective physical activity after the intervention need further consideration. Finally, the mediation effects imply the importance of self-determined motivation to perform short- and long-term behavior.

### THE IMPACT OF CHILDREN'S HEALTH ACTIVITY AND NUTRITION: GET EDUCATED PILOT STUDY ON CARDIORESPIRATORY FITNESS, CARDIOMETABOLIC RISK AND BODY SIZE IN 10 TO 11 YEAR OLD CHILDREN.

Gobbi, R.1,2, Davies, I.G.2, Fairclough, S.J.1,3, Abayomi, J.C.2, Mackintosh, K.A.1,2, Warburton, G.L.1,2, Stratton, G.1,3, George, K.P.3, Boddy, L.M.1,3

1. REACH Group; 2. Faculty of Education, Community & Leisure, & 3. Research Institute for Sports & Exercise Sciences, Liverpool John Moores University.

**Objectives:** To investigate the impact of the CHANGE! Curriculum based intervention on cardiorespiratory fitness (CRF), cardiometabolic risk and body size in 10-11 year old children. **Methods:** Twelve primary schools were randomised into an Intervention (n=6) or Control condition. Baseline, 20 week post-intervention and 10 week follow-up measures of body composition, CRF and cardiometabolic risk were assessed in a subsample of participants (n=55). Outcome measures were: anthropometrics (stature, sitting stature, weight, waist circumference [WC] and hip circumference [HC]), resting blood pressure (SBP and DBP), CRF (VO<sub>2</sub>peak), fasting capillary blood total cholesterol (TC), high density lipoprotein cholesterol (HDL-C) and glucose, left ventricular diastolic filling (E/A Ratio), septal myocardial tissue velocities (E'A'), and left ventricular mass (LV mass index). Change scores between time points were calculated for each measure. Group differences between mean change scores were assessed using one way analysis of covariance (ANCOVA), with covariates of gender, somatic maturation, and change in maturation, Indices of Multiple Deprivation (IMD) and the dependent variable. Results: There was a significant group difference in WC at 20 week post-intervention with children in the intervention group reducing WC and children in the control group increasing WC (Adjusted mean (SE) change in WC for control =+1.3 (0.3) cm; intervention -0.2 (0.4) cm, p=0.006). At follow up the intervention group maintained WC, however there were no significant group differences in mean change at follow up. Although there was no significant intervention effect on CRF at post intervention, there were significant group differences at follow up (adjusted mean (SE) change in VO<sub>2</sub>Peak control = -1.96 (1.43) ml/kg/min; intervention = +3.6 (1.53) ml/kg/min, p=0.014). There were no significant intervention effects on cardiometabolic risk markers at post-intervention or follow-up. **Discussion:** There was a significant effect on WC at post-intervention and this reduction in WC in the intervention group was maintained at follow up. At 10 week follow-up the intervention group had significantly improved CRF, however there were no significant intervention effects on cardiometabolic risk markers. This suggests that these improvements in CRF and WC did not have clinical implications on cardiometabolic risk markers. Further investigation is warranted to elucidate these findings.

### A CROSS-CULTURAL COMPARISON OF ADOLESCENTS' PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOURS IN SPAIN AND FRANCE ACROSS A SCHOLAR YEAR.

Aibar, A.1,2, Bois, J.2, Zaragoza, J.1, Generelo, E.1, Julián, J.A.1, Paillard, T.2

<sup>1</sup> University of Zaragoza (Spain) <sup>2</sup> University of Pau and Countries of Adour (France)

**Introduction** Evidences show that physical activity (PA) has important health benefits in youth. However, incidental PA and exercise declines during adolescence (Van der Horst et al., 2007). There is also an emerging concern about the negative effect that sedentary lifestyles are having on the health of youth (Pate et al., 2011). The main aim of this study is to describe and compare levels of moderate to vigorous physical activity (MVPA) and sedentary activity (SA) in adolescents in two European countries throughout one scholar year. **Method** The sample consisted of 179 adolescents (48% Spanish; 58,7% girls) with a mean age of 14.40 ± 0.66 years. The GT3X accelerometer was used to assess PA intensities continuously during waking hours of two 7 day periods, at the beginning and at the end respectively, of the scholar year. Two 2x2x2x2 (country by gender by period of the week by moment of the measure) ANCOVA with repeated measures on the two last factors were conducted with MVPA and SA as dependant variables. BMI, socioeconomic status, temperatures and precipitations were used as co-variables. Results No significant differences were found nor MVPA neither SA according to the moment of the measure in the scholar year. However, Spanish adolescents revealed significant higher levels of MVPA than French subjects. Significant effects of gender (more engaged time of boys than girls) and period of the week (higher levels during weekdays) were also found. High levels of SA were appreciated, but no main significant effects were found. MVPA and SA showed a significant negative correlation in both moments of measure. **Discussion** Consistently with other studies our results offer evidence for the low MVPA levels in adolescents, being lower in girls (Nader et al., 2008). High levels of SA levels are also reported in our study (Pate et al., 2011), underlying one of the biggest concerns of our society. Moreover, our results seem to be consistent with the hypothesis that sedentary behaviours replace PA (Van der Horst et al., 2007). References Nader, P. R., R. H. Bradley, R. M. Houts, S. L. McRitchie, and M. O'Brien. 'Moderate-to-Vigorous Physical Activity from Ages 9 to 15 Years.' JAMA - Journal of the American Medical Association 300, no. 3 (2008): 295-305. Pate, R. R., J. A. Mitchell, W. Byun, and M. Dowda. 'Sedentary Behaviour in Youth.' British Journal of Sports Medicine 45, no. 11 (2011): 906-913. Van Der Horst, K., M. J. C. A. Paw, J. W. R. Twisk, and W. Van Mechelen. 'A Brief Review on Correlates of Physical Activity and Sedentariness in Youth.' Medicine and Science in Sports and Exercise 39, no. 8 (2007): 1241-1250.

### COMBINED INFLUENCE OF HEALTHY DIET AND ACTIVE LIFESTYLE ON CARDIOVASCULAR DISEASE RISK FACTORS IN ADOLESCENTS: THE HELENA STUDY

Cuenca García, M., Ortega, F., Ruiz, J., Labayen, I., Jago, R., Martínez-Gómez, D., Dallongeville, J., Bel-Serrat, S., Moreno, L.A., Kersting, M., González-Gross, M., Castillo, M., Sjöström, M. et al

1,12-FM-UGR(Granada), 2,13-PREVNUT-KII(Huddinge), 3-FCAFD-UGR(Granada), 4-UPV/EHU (Vitoria), 5-CENHS(Bristol), 6-CTAN/CSIC(Madrid), 7-FACHRU(Lille), 8,9-UNIZA(Zaragoza), 10-FKE (Bonn), 11-PUMI(Madrid)

**Aim:** To investigate the combined influence of diet quality and physical activity on cardiovascular diseases (CVD) risk factors in European adolescents. **Method:** Cross-sectional study that included 1513 adolescents aged 12.5 -17.5 years (45% boys) from eight European countries participating in the HELENA study. Dietary intake was registered using a 24h recall (on two non-consecutive days and a diet quality index was calculated. Daily physical activity was assessed by accelerometry. Lifestyle groups were computed as follows: 0=healthy diet and active, 1=unhealthy diet but active, 2= healthy diet but inactive, 3=unhealthy diet and inactive. CVD risk factors measurements included cardiorespiratory fitness, adiposity indicators, lipid profile, blood pressure and insulin resistance. A CVD risk score was computed by mean of z-scores of the following risk factors: cardiorespiratory fitness, sum of four skinfolds, triglyceride, total cholesterol/high-density lipoprotein cholesterol ratio (TC/HDLc ratio), systolic blood pressure and homeostasis model assessment (HOMA). Results: The healthy diet and active group had a more favourable cardiorespiratory profile, fat mass index and triglycerides and high-density lipoprotein cholesterol levels (all p≤0.05). Overall, active adolescents showed higher cardiorespiratory fitness, lower fat mass index, healthier TC/HDLc ratio and blood pressure and lower HOMA levels than their inactive peers with either healthy or unhealthy diet (all p≤0.05).

Healthier CVD risk score was observed in the healthy diet and active group compared with the inactive groups (all  $p \leq 0.02$ ). Conclusion: A combined influence of healthy diet and active lifestyle could be the key to prevent the risk of CVD. Moreover, an active lifestyle may reduce the adverse consequence of an unhealthy diet, but a healthy diet does not seem to overcome the adverse consequences of an inactive lifestyle.

### **DOES THE SCHOOL-BASED INTERVENTION "JOIN THE HEALTHY BOAT" PROMOTE PHYSICAL ACTIVITY IF MEASURED OBJECTIVELY?**

Kettner, S., Kobel, S., Drenowatz, C., Fischbach, N., Dreyhaupt, J., Steinacker, J.M.

*Ulm University*

**Introduction** It is well known, that sufficient physical activity (PA) is essential for childhood development and highly relevant to health. The school-based intervention "Komm mit in das gesunde Boot – Grundschule" (Join the Healthy Boat) focuses on the promotion of PA and other health related topics (e.g. healthy food, screen media use). Current international guidelines encourage children to achieve 60 min moderate to vigorous PA per day (WHO, 2010). The purpose of this study was to examine whether the intervention of the "Healthy Boat" shows a positive effect in PA after one year and how much time children spend in moderate and vigorous PA. **Methods** The study is a prospective, cluster-randomised, longitudinal study with an intervention (IG) and control group (CG). At baseline as well as at follow-up one year later, PA was measured on 323 children. Data used in this analysis includes 117 children ( $8.0 \pm 0.7$  yrs; male: 43.6%; IG: 44.4%) for baseline and follow-up. Participants wore an accelerometer (Actiheart®, CamNTEch, Cambridge, UK) for six consecutive days with recording intervals of 15 sec. First and last recording days and individual sleeping time were excluded from analysis. On the basis of heart rate (HR) data different activity levels were categorised as follows: light =  $HR < 140$  bpm, moderate =  $HR > 140$  and  $< 160$  bpm, vigorous =  $HR > 160$  bpm (Armstrong & Welsman, 2006). Data were analysed by ANCOVA, controlling for sex and age, and paired t-test. **Results** First analysis of 117 participants including all four days reveal that children spent 12.9 h (SD 1.0) per day in light, 32.2 min per day (SD 14.4) in moderate and 18.5 min per day (SD 12.8) in vigorous intensity. On average 35.9% of the children achieved the guidelines. There was no significant difference between IG and CG. There was, however, a significant decline in moderate physical activity in the CG while the IG maintained their activity levels. **Conclusion** Even though no group differences in PA could be shown results indicate that a low-dose school-based intervention can attenuate the age-related decline in PA. To increase PA a stronger intervention may be necessary. The analysis, however, is not completed yet and only the recorded heart-rate has been used to determine PA. **References** Armstrong N, Welsman JR (2006). The physical activity patterns of European youth with reference to methods of assessment. *Sports med*, 36(12), 1067-1086. World Health Organization (WHO) (2010). Global Recommendations on Physical Activity for Health. WHO, Geneva.

### **PHYSICAL ACTIVITY LEVELS DURING THE SCHOOL DAY OF GERMAN SECONDARY SCHOOL STUDENTS**

Kretschmann, R.

*University of Stuttgart*

**Introduction:** Students spend a huge amount of their daytime in school. Furthermore, school plays a significant role in children's physical activity (PA) (Trost et al., 2002). However, to date, physical activity levels (PALs) of school students in German schools are unclear. Hence, the aim of this study was to investigate PALs of students during the school day, including school way, recess time, physical education (PE), and leisure time in contrast. **Material and Methods:** PA was objectively measured via combined accelerometry and heart rate monitoring using the Actiheart device (Crouter et al., 2008). 26 ninth class school students ( $M=15.28$  years;  $SD=0.47$ ) of a German secondary school wore the Actiheart the whole day for one week, including weekend. **Results:** The way to school significantly ( $p < 0.01$ ) adds above-average PALs ( $M=2.8$  MET;  $SD=0.49$ ), although, active transportation wasn't common for the German sample. However, active transportation didn't accumulate higher amounts and levels of PA. Students showed significantly ( $p < 0.01$ ) higher amounts of PA during recess time ( $M=2.4$ ;  $SD=0.36$ ) as compared to mere lesson time ( $M=1.58$  MET;  $SD=0.17$ ). According to Total Energy Expenditure (TEE), days with PE lessons ( $M=2444$  kcal;  $SD=525$ ) reached significantly ( $p < 0.01$ ) higher PALs compared to school days without PE ( $M=2173$ ;  $SD=625$ ). Leisure time's PALs ( $M=1.94$  MET;  $SD=0.17$ ) were slightly higher compared to school time's PALs ( $M=1.68$ ;  $SD=0.20$ ), but don't show a statistically significant difference. Surprisingly, students showed significantly ( $p < 0.05$ ) lower PALs during the weekend ( $M=1.7$  MET;  $SD=0.28$ ) than during the school week ( $M=1.86$  MET;  $SD=0.21$ ). Compared to the Expert Consultation of Human Energy Requirements (2004), 21 students showed an active/ moderately active or vigorous/ vigorously active lifestyle for the assessed whole week. **Discussion and Conclusion:** School, as an institution that has a major effect on children's lifestyle, doesn't only play an influencing role in the daily routine of students, it also serves as a main socializing agent and environment, especially in terms of getting children in touch with PA. Moreover, study results indicate that school is an important source for overall PA. Therefore, school should be a focus point in PA interventions, also and naturally including PE (Slingerland et al., 2011). **References:** Crouter et al. (2008). Accuracy of the Actiheart for the assessment of energy expenditure in adults. *Europ J Clin Nutr*, 62(6), 704-711. Expert Consultation of Human Energy Requirements (2004). Human energy requirements: Report of a joint FAO/WHO/UNO expert consultation. FAO food and nutrition technical report series: Vol 1. United Nations Univ., Rome. Slingerland et al. (2011). Physical activity levels during Dutch primary and secondary school physical education. *Europ J Sport Sci*, 11(4), 249-257. Trost et al. (2002). Age and gender differences in objectively measured physical activity in youth. *Med Sci Sports Exerc*, 34, 350-355

### **ASSOCIATIONS OF DAILY ENERGY EXPENDITURE AND PHYSICAL ACTIVITY WITH BODY FAT IN 11-YEAR OLD CHILDREN**

Soric, M.1, Borer, K.T.2, Misigoj-Durakovic, M.1

*The Faculty of Kinesiology*

<sup>1</sup>Faculty of Kinesiology, University of Zagreb, Croatia; <sup>2</sup>University of Michigan, Ann Arbor, Michigan, USA; **Introduction** Physical inactivity, alongside inadequate nutrition, is one of the main reasons of the growing prevalence of obesity. Therefore, the purpose of this study was to describe the associations between body fat and physical activity in 11-year old children. **Methods** The sample consisted of 142 fifth grade students (66 boys and 76 girls, mean age (standard deviation) = 11.2 (0.3), from Zagreb (Croatia) and Ann Arbor (Michigan, USA) volunteered to participate in this study. Energy expenditure and physical activity were assessed during two weekdays and two weekend days using a multiple-sensor body monitor (SenseWear Armband; BodyMedia Inc., Pittsburgh, PA, USA) (1). Percent body fat (%BF) was calculated using triceps and calf skinfolds according to the equation proposed by Slauther et al. (2). The associations between %BF and energy expenditure or physical activity was assessed by Pearson's correlation coefficients. In addition, children were divided in high and low %BF groups based on the gender specific median split. After that, differences in energy expenditure and physical activity between the

high and low %BF groups were assessed using t-tests for independent samples. Results Percent body fat was inversely related to the amount of moderate physical activity in both boys ( $r=-0.35$ ,  $p=0.005$ ) and girls ( $r=-0.25$ ,  $p=0.03$ ). In contrast, the association between %BF and vigorous activity was noted in boys ( $r=-0.33$ ,  $p=0.005$ ), but not in girls ( $r=-0.12$ ,  $p=0.26$ ). The amount of time spent sleeping and lying down were not related to %BF in either gender. Daily energy expenditure expressed per unit of fat free mass was correlated with %BF in both boys ( $r=0.40$ ,  $p=0.002$ ) and girls ( $r=0.28$ ,  $p=0.02$ ). On the other hand, energy expended on physical activity was not related to %BF in either gender ( $r=-0.18$ ,  $p=0.18$  in boys and  $r=0.03$ ,  $p=0.79$  in girls). Similarly, high %BF group exhibited lower levels of both moderate and vigorous activity in boys, while in girls no differences in physical activity between the two groups were noted. However, energy expended for daily physical activity did not differ between the groups in neither boys nor girls. Conclusion The findings of this study indicate that %BF is inversely related to the amount of physical activity with the associations being stronger and more consistent in boys. Still, more physical activity did not result in higher active energy expenditure in children with more body fat. References 1. Arvidsson D, Slinde F, Hulthen L. *Clin Nutr* 2009; 28: 305–12. 2. Slaughter MH et al. *Hum. Biol.* 60(5):709–23, 1988.

## PHYSICAL ACTIVITY AND HEALTH-RELATED QUALITY OF LIFE OF ADOLESCENTS IN DISASTER AREAS

Suzuki, K.1, Okazaki, K.1, Sasaki, K.1, Takahashi, S.1, Sakamoto, Y.2

1:Tohoku Gakuin University (JAPAN), 2:Tohoku Institute of Technology (JAPAN)

**Introduction** The environment related to physical activity in children was dramatically changed by The Great East Japan Earthquake in 2011. Deterioration in the physical activity environment might affect health-related quality of life (HRQL) in adolescents. The purpose of this study was to clarify the present state of physical activity and HRQL in Japanese adolescents living in regions affected by the earthquake and tsunami in 2011, and to examine the differences in the relationship between physical activity and HRQL in adolescents living in different regions affected by the disaster. **Methods** The participants were 349 adolescents aged 11-13 (184 boys, and 165 girls) in East Matsushima city (where housing damage affected 10% of participants: low damage group) and 183 adolescents aged 11-13 (95 boys, and 88 girls) in the town of Onagawa (where housing damage affected 60% of participants: high damage group). The survey was performed in July (for East Matsushima) and September (for Onagawa), 2011. Survey items included time spent on physical activity (min/wk), HRQL (the 23-item Pediatric Quality of Life Inventory Version 4.0 Generic Core Scales). **Results** The results of a chi-square test showed that there were no significant differences in the rate of time spent category (less than 60min/wk, from 60 to less than 420 min/wk, more than 420min/wk) between the low damage group and the high damage group. However, the rate of less than 60min/wk in both groups showed higher percentages than in the general population (MEXT, 2011) in Japanese adolescents (low damage group: boys 15.2%; girls 44.2%, high damage group: boys 17.9%; girls 43.2%, general population: boys 9.3%; girls 31.1%). The results of an unpaired t-test indicated that there was a statistically significant difference in HRQL total score between the low damage group (81.4+/-12.5) and the high damage group (77.1+/-12.7) for girls. Also, the average HRQL total score for girls in the high damage group was especially low compared to a previous study (adolescents: 83.7+/-13.3, Varni et al., 2003). On the other hand, the difference in boys was not significant (low damage group: 84.1+/-13.1, high damage group: 83.9+/-12.6). One-way ANOVAs for each physical activity level showed significant differences between those whose rate was less than 60min/wk and those whose rate was more than 420min/wk in all groups except girls in the high damage group. **Conclusions** These findings might suggest the following: 1) the physical activity level of adolescents living in disaster areas is decreased by a tsunami and earthquake hit regardless of the damage situation, 2) the HRQL level of adolescent girls varies depending on the damage situation, 3) an increase in physical activity level is associated with an improvement of HRQL for adolescent boys and girls over normal HRQL level, 4) an increase of physical activity level in the group with low HRQL level might not affect improvement of HRQL for adolescents living in disaster areas. [Supported by Grant-in-Aid for Young Scientists]

## RIGHT AND LEFT VENTRICULAR ADAPTATION TO REGULAR PHYSICAL ACTIVITY IN ELITE MALE ATHLETES

Major, Z., Kneffel, Z., Csajági, E., Tóth, M., Pavlik, G.

Semmelweis University, Faculty of Physical Education and Sport Sciences

**Introduction** The athlete's heart undergoes morphological and functional changes as a result of regular physical activity. Left ventricular dimensions, wall thicknesses and function are echocardiographic measurements widely used in research, but the functional adaptation of the right ventricle remains unknown. The aim of this study was to assess left and right ventricular function and enlargement in elite athletes and in healthy sedentary non-athletes. **Methods** The study population consisted of 20 elite highly-trained male athletes and 15 age-matched normotensive healthy non-athletes. In addition, left and right ventricular systolic (S') and diastolic functions (E peak, A peak, E/A ratio, E', A' velocities and E'/A' ratio) were determined by conventional PW Doppler echocardiography and Pulsed wave Tissue Doppler imaging at the septal and lateral corners of the mitral and tricuspid annulus. Tricuspid and mitral inflow velocities were obtained in a four-chamber view by placing a cursor at the tips of the mitral and tricuspid valve. Right and left ventricular longitudinal diameters were also determined. Measurements represent the average of three cycles. Comparisons among data were performed with Student's test. **Results** The athletes and members of the control group did not differ significantly in mean body surface area ( $p<0,3$ ). The group of athletes showed highly but not statistically significant velocity of mitral and tricuspid E ( $p<0,5$ ;  $p<0,6$ ) wave, and the tricuspid E/A ( $p<0,4$ ) ratio than non-athletes. Mitral and tricuspid annulus Am (both  $p<0,005$ ), and Aa ( $p<0,0001$  and  $p<0,001$ ) were significantly smaller in athletes than in non-athletes. E/Em ratio on the right side ( $p<0,05$ ) was also significantly less in athlete's group than in controls. Em/Am ratio (both  $p<0,05$ ), and Ea/Aa on either side ( $p<0,001$  and  $p<0,005$ ) were significantly higher in athletes than in sedentary controls. In the group of non-athletes and in the competitors of several kind of sport the right ventricular systolic function was not statistically significant, although, we found significant difference between the two groups in the left ventricular dimensions ( $p<0,05$ ). In the end-diastolic dimension of the right ventricle between the two groups proved to be significant as well ( $p<0,05$ ). **Discussion** Regular and extensive training results in similar changes in right ventricular function to that of the left ventricle.



**13:45 - 14:45****Poster presentations****PP-PM04 Physiology and Biochemistry****GLUT4 PROTEIN EXPRESSION AND LOCALISATION IN HUMAN SKELETAL MUSCLE FOLLOWING ENDURANCE AND HIGH INTENSITY INTERVAL TRAINING**

Bradley, H., Shepherd, S.O., Cocks, M., Shaw, C.S., Wagenmakers, A.J.M.

*University of Birmingham*

Glucose transporter 4 (GLUT4) is responsible for insulin-mediated glucose uptake in skeletal muscle. GLUT4 storage vesicles (GSVs) translocate from intracellular stores to the plasma membrane upon insulin stimulation, allowing glucose uptake into the muscle cell. In a previous study from our lab (Shepherd et al. ECSS abstract 2011) we have shown that both endurance training (ET) and high intensity training (HIT) increase insulin-mediated glucose uptake. Here we use immunofluorescence microscopy to investigate muscle fibre type specific GLUT4 content and localisation in the basal state before and after 6 weeks of ET or HIT. Sixteen young sedentary males ( $21 \pm 0.7$  years, BMI  $23.7 \pm 0.8$  kg.m<sup>-2</sup>) were randomly assigned to ET (40-60 min of cycling at  $\sim 65\%$  VO<sub>2</sub>peak, 5 times per week) or HIT (4-6 Wingate tests per session, 3 times per week). Muscle biopsies were taken from the m. vastus lateralis before and after 6 weeks of training. GLUT4 content and localisation were assessed using confocal immunofluorescence microscopy. Statistical significance was determined using a repeated measures ANOVA. GLUT4 staining presents bright punctuate spots located throughout the cell interior and around the plasma membrane and nuclei. Total GLUT4 fluorescence intensity increased following ET (type I fibres  $15\% \pm 6\%$ , type II fibres  $16\% \pm 6\%$ , training effect  $P = 0.037$ ) and HIT (type I fibres  $14\% \pm 5\%$ , type II fibres  $16\% \pm 5\%$ , training effect  $P = 0.014$ ). The number of intracellular GLUT4-containing spots per fibre, likely representing GSVs, increased following ET (type I fibres  $25\% \pm 9\%$ , type II fibres  $26\% \pm 13\%$ , training effect  $P = 0.05$ ) and HIT (type I fibres  $36\% \pm 16\%$ , type II fibres  $48\% \pm 16\%$ , training effect  $P = 0.03$ ). There was a trend for an increase in GLUT4 colocalisation with the plasma membrane marker dystrophin which failed to reach statistical significance (training effect,  $P = 0.075$ ). There were no fibre type specific differences or differences between the effect of ET and HIT on GLUT4 content. In summary, we have successfully used immunofluorescence microscopy techniques to show that 6 weeks of HIT is at least as efficient as ET to increase total GLUT4 content. The increase occurred in both type I and type II fibres and was due to an increase in the number of GLUT4-containing spots, likely representing GSVs. Future studies will further investigate GLUT4 content and localisation, which are important factors in determining rates of glucose uptake, as a function of training status in response to exercise and insulin stimulation.

**EFFECT OF EPIGALLOCATECHON-3-GALLATE ON TUMOR METABOLISM IN BREAST CANER CELLS.**

Huang, H.P., Wang, H.S., Chang, J.M.

*National Taiwan Normal University*

**Introduction** The "Warburg effect" is hypothesized that tumor cells have a high rate of glycolysis in spite of oxygen-rich conditions with a high level of lactate. In addition, up-regulation expression of hypoxia inducible factor 1  $\alpha$  (HIF-1 $\alpha$ ), which is a consequence of hypoxia condition as well as alters in certain oncogenes or mutations in tumor suppressor genes, resulting in increase of gene transcription involved in glucose transport, glucose metabolism, lactate formation, and lactate efflux from cells. However, lactate efflux across the plasma membrane is mediated by monocarboxylate transporter (MCT). The aim of this study was to investigate the effect of epigallocatechin-3-gallate (EGCG), a MCTs inhibitor, on breast cancer whether mediate through the MCT and HIF-1 $\alpha$  molecules. **Method** MDA-MB-231 cells were incubated with L-15 medium containing 10 % fetal bovine serum but absence of glucose. Thereafter, cells were treated with EGCG (0.1 mM) for 30 minutes, and glucose (10 mM) was treated to MDA-MB-231 cells for additional 3 hours after drug treatment following the assessments of MCT1, HIF-1 $\alpha$ , CD147 protein amount and lactate level. **Results** In biochemical analysis, the intracellular lactate level was increased to 34% in glucose treatment, 14% in EGCG treatment and 46% in EGCG combined with glucose treatment compared with cell only control. However, the protein amount of MCT1, HIF-1 $\alpha$  and CD147 were not altered in response to glucose, EGCG and glucose plus EGCG. **Discussion** It has been reported that some MCT play an important role in cancer metabolism (Kennedy & Dewhirst, 2010). In this study, the high level of intracellular lactate might be increased in EGCG treatment, a possible MCTs inhibitor. The both transporters, MCT1 and MCT4, functionally interact with chaperone CD147 and co-expressed on the plasma and mitochondrial membranes (Kirk et al., 2000; Pinheiro et al., 2010). In additionally, the expression of the membrane transporters MCT1 and CD147 was not altered in breast cancer cells. It is suggested that inhibition of MCTs resulted in the lower intracellular pH value, which might lead to cell death. Moreover, the changes of MCTs expression could inhibit cell migration. In the future, targeting to CD147 and MCT molecules might be beneficial to cancer patient in therapy. Further investigation on the CD147/MCT in the cancer treatment will be addressed. **References** Kennedy, K. M., & Dewhirst, M. W. (2010). *Future Oncol*, 6(1), 127-148. Kirk, P., Wilson, M. C., Hedde, C., Brown, M. H., Barclay, A. N., & Halestrap, A. P. (2000). *EMBO J*, 19(15), 3896-3904. Pinheiro, C., Albergaria, A., Paredes, J., Sousa, B., Duffloth, R., Vieira, D., Baltazar, F. (2010). *Histopathology*, 56(7), 860-867.

**A SINGLE BOUT OF ECCENTRIC EXERCISE RESULTS IN A TYPE II MUSCLE FIBER SPECIFIC INCREASE IN SATELLITE CELL CONTENT AND ACTIVATION STATUS**

Smeets, J.S.J.1, Cermak, N.1,2, Snijders, T.1, Verdijk, L.B.1, Parise, G.2, van Loon, L.J.C.1

1. *Department of Human Movement Sciences, Maastricht University Medical Centre+, Maastricht, the Netherlands.* 2. *Department of Kinesiology, McMaster University, Hamilton, Ontario, Canada*

**INTRODUCTION:** Satellite cells (SCs) are instrumental for repair, regeneration and growth of human skeletal muscle tissue. Following a single bout of exercise skeletal muscle SC can activate, proliferate and differentiate to form new SCs. In accordance, increases in mixed muscle SC content have been reported after 24-48 h of recovery from a single bout of exercise. So far, little data exists on the fiber type-specific changes in SC content and activation status during post-exercise recovery. The present study investigates the impact of a single bout of eccentric exercise on skeletal muscle fiber type specific SC content and activation status following 24 h of post-exercise recovery. **METHODS:** Skeletal muscle biopsies were collected from the m. vastus lateralis of 10 healthy, recreationally active males ( $23 \pm 1$ y) prior to

and 24 h after performing 300 high-force eccentric actions using the knee extensors. Muscle fiber type-specific SC content and activation status were assessed by immunohistochemical analyses. SC activation status was assessed by co-staining CD56 with DLK1 and Ki67. Statistical analysis was performed using a two-factor repeated measures analysis of variance (ANOVA) with the level of significance set at  $P < 0.05$ . RESULTS: At baseline, no differences in SC content were observed between type I and type II muscle fibers. In addition, no differences were observed in the number of DLK1+ and Ki67+ SCs between fiber types. Following 24 h of post-exercise recovery, type II muscle fiber SC content had increased substantially from  $0.085 \pm 0.012$  to  $0.133 \pm 0.016$  ( $P < 0.05$ ). In contrast, no changes were observed in the type I muscle fibers ( $0.099 \pm 0.009$  to  $0.092 \pm 0.011$ ; interaction between fiber types  $P < 0.05$ ). The number of DLK1+ SCs increased in the type II muscle fibers only (from  $0.027 \pm 0.008$  to  $0.070 \pm 0.017$  DLK1+ SCs per fiber;  $P < 0.01$ ). No significant differences were observed in the number of Ki67+ SCs over time or between fiber types. CONCLUSION: A single bout of eccentric exercise induces a type II muscle fiber type-specific increase in both SC content and activation status within 24h of post-exercise recovery.

#### IDENTIFICATION OF TWO METABOLICALLY DISTINCT POPULATIONS OF MYOSIN HEAVY CHAIN TYPE I EXPRESSING MUSCLE FIBERS IN HUMAN SKELETAL MUSCLE

Gómez-Cabello, A., Ploug, T., Nordby, P., Andersen, J.L., Dela, F., Helge, J.W., Prats, C.

*GENUD Research Group. University of Zaragoza*

Identification of two metabolically distinct populations of myosin heavy chain type I expressing muscle fibers in human vastus lateralis and characterization of exhausting exercise-induced intracellular energy stores utilization Gómez-Cabello A 3, Ploug T 1, Nordby P 1, Andersen JL 2, Dela F 1, Helge JW 1, Prats C 1 Center for Healthy Aging, 1 Dep. of Biomedical Sciences and 2Dep. of Sports Medicine Copenhagen, Faculty of Health Sciences, University of Copenhagen, Denmark 3 GENUD Research Group. Faculty of Health and Sport Science, Dep. of Psychiatry and Nursing, University of Zaragoza, Spain Introduction: Skeletal muscle metabolism has been subject of extensive research for decades. Skeletal muscle is a heterogenic tissue; it consists of different proportions of different muscle fiber types. Muscle fibers have been traditionally classified based on the expression of the predominant myosin heavy chain (MHC) isoforms. According to such classification, human skeletal muscle consists of three fiber types (I, IIA, and IIX). The aim of the present study was to optimize a fluorescence histochemical technique to semi-quantify glucose and lipid intracellular stores and their relative use during exhausting exercise. Material and Methods: Ten healthy males ( $26.4 \pm 0.9$  years, BMI  $24.4 \pm 0.7$  kg/m<sup>2</sup>) participated in the study. On the first day, one leg was glycogen-depleted (D) by exhaustive intermittent exercise following by low carbohydrate diet. Next day, muscle biopsies were excised from vastus lateralis before and after exhaustive exercise from both D and control leg (C) (I). Muscle cryosections were used to optimize a histochemical technique to fiber-type muscle and, semi-quantify glycogen and lipid content. Results: Analysis of C basal muscle reveals 4 metabolically distinct muscle fiber types: two MHC type I expressing populations, which we name I-high and I-low, and two MHC type II populations, which correspond to IIA and IIX expressing fiber types. Fibers I-high have a smaller cross-sectional area and a higher lipid droplet (LD) density than fibers I-low. After exhaustive exercise, muscle glycogen content was decreased in type IIA and IIX muscle fibers in the C leg and only in type IIX muscle fibers in the D leg ( $p < 0.05$ ). Exhaustive exercise-induced IMTG utilization was detected in type I-high muscle fibers from both C and D legs, as a decrease in LD size and density. Only in the C leg a significant decrease in LD density was detected in type I-low muscle fibers. Conclusion: The presented data show the existence of two metabolically distinct type I human muscle fibers and characterize their fiber type specific metabolic response to exhausting exercise. References: 1. Nordby P et al. Muscle ceramide content in man is higher in type I than type II fibers and not influenced by glycogen content. *Eur J Appl Physiol*, 2010.

#### EXPLOSIVE-TYPE OF MODERATE-RESISTANCE TRAINING IN THE ELDERLY: BIOLOGICAL AND FUNCTIONAL EFFECTS

Beltran Valls, R.M.1, Brunelli, A.1, Dimauro, I.1, Caserotti, P.2, Di Salvo, V.1, Ciminelli, E.1, Quaranta, F.1, Tranchita, E.1, Parisi, A.1, Caporossi, D.1

*Università degli Studi di Roma Foro Italico*

Introduction Despite explosive-type heavy-resistance training does increase muscle strength and power in the elderly (Caserotti, 2008), little is known on the effect of explosive-type moderate-resistance training (EMRT) on cardiovascular capacity, functional performance and biomarkers of aging. Therefore, the aim of the study was to analyse the effects of 12 weeks low frequency (2days/week) EMRT on cardiovascular fitness, muscle power, daily living activities (ADL) performance, and on molecular markers related to cardiovascular risk (MPO, BNP) and cellular stress response (HSPs) in older adults. Methods Twenty-one medically stable men and women ( $72 \pm 3$  yrs) were divided into training ( $n=13$ ) and control group ( $n=8$ ). Training included lower and upper body exercises performed at 70%1RM with the concentric and eccentric phases of the movement executed at maximal intentional acceleration and moderate speed, respectively. Cardiovascular fitness (ECG, heart rate, blood pressure) was assessed by maximal graded exercise stress test (GXT). Muscle power was assessed with a standardized countermovement jump (CMJ) and during leg extension, leg curl, low row and chest press devices with load at 70% 1RM recorded at baseline (FreePower, Sensorize). Functional performance was measured by 6-m maximum walking (6MW) and stairs climbing (SC) tests (Ergotimer, Globus). HSP70,  $\alpha$ B-cry and HSP27 expression in PBMC was analyzed by western blot. MPO and BNP were quantified by ELISA. Results Training significantly increased maximum GXT load (16%,  $p < 0.05$ ) without affecting heart rate and blood pressure recorded at the same relative work intensity. Peak power measured on the 4 training devices and during the CMJ increased significantly (20-30%,  $p < 0.05$ ) along with increase in the 6MW and SC speed ( $p < 0.05$ ). Preliminary results indicate no significant modification induced by training on biomarkers ( $p > 0.05$ ), which levels remained unchanged or improved in the trained group. Conclusion These findings show that EMRT improves endurance capacity, functional performance and muscle power in older adults. Endurance improvement obtained during maximal exercise, along with the muscle power increase, may facilitate ADL performance, as observed with other type of resistance training protocols (Henwood, 2008). The trend to reduced heart rate, blood pressure and CDV risk although not significant, indicate that EMRT may be safe for this age population. References Caserotti et al. (2008) *Scand J Med Sci Sports*. 18(6):773-82 Henwood et al. (2008) *J Gerontol A Biol Sci Med Sci*. 63(1):83-91 Grant 2009 by Foro Italico University

#### EFFECTS OF COLD EXPOSURE ON ENERGY METABOLISM DURING SUBMAXIMAL EXERCISE

Gagnon, D.D., Rintamäki, H., Gagnon, S.S., Herzig, K.H., Kyröläinen, H.

*University of Jyväskylä*

Introduction Cold environments may modify the use of carbohydrates and fat during exercise (Hurley & Haymes 1982; Layden et al. 2002). This has mostly been observed in cycling studies, which do not represent whole-body energy metabolism as accurately as walk-

ing and running. The purpose of this study was to examine energy availability and utilization during treadmill exercise at low (walking) and moderate (running) intensities in the cold. Methods Ten male subjects, dressed in shorts and t-shirt, completed 4 trials during which they exercised for 60-min at 50% (walking) or 70% (running) of maximal oxygen consumption (VO<sub>2</sub>) in a climatic chamber set at either 0°C (cold) or 22°C (warm). Core temperature (T<sub>core</sub>), weighted mean skin temperature (T<sub>skin</sub>), VO<sub>2</sub>, heart rate (HR), and respiratory quotient (RQ) were continuously recorded and averaged over the last 10-min of every 15-min period during exercise. Blood samples were collected before entering the chamber (baseline) and at 30- and 60-min, to determine changes in availability of serum energy biomarkers (non-esterified fatty acids [NEFA], glycerol [GLY] and glucose [GLU]). Data was analyzed using a three-way ANOVA (factors: temperature, exercise intensity and time) for repeated measures with significance at  $p < 0.05$ . Results Low ( $48 \pm 1\%$  VO<sub>2</sub>) and moderate ( $70 \pm 1\%$ ) exercise intensities affected HR, which was lower in the cold from 15-min to the end of exercise ( $p < 0.001$ ). A modest increase in T<sub>core</sub> was seen over time ( $p < 0.05$ ), which was greater in moderate ( $37.87 \pm 0.03^\circ\text{C}$ ) compared to low ( $37.36 \pm 0.07^\circ\text{C}$ ) exercise intensity ( $p < 0.001$ ). An interaction in T<sub>skin</sub> was observed indicating lower T<sub>skin</sub> in cold vs. warm within both exercise intensities at each time point during exercise ( $p < 0.05$ ). Neither NEFA, GLY nor GLU were influenced by cold exposure at any time point ( $p \geq 0.11$ ). Meanwhile, RQ was modulated by temperature, as cold exposure lowered RQ values across time and exercise intensities (cold  $0.85 \pm 0.01$ ; warm  $0.88 \pm 0.01$ ,  $p < 0.05$ ). Conclusion The large contribution of tissue mass (muscle and adipose) in walking and running, demonstrated a greater energy reliance on fat sources independently of exercise intensity when the body was cold exposed. This occurred despite no changes in substrate availability. This phenomenon may stem from a centrally mediated enhanced fat uptake mechanism initiated by the increase in sympathetic nervous activity due to skin cooling during whole-body exercise. References Hurley BF & Haymes EM (1982). *Aviat Space Environ Med*, 53(12), 1193-7 Layden JD et al. (2002). *Med Sci Sports Exerc*, 34(5), 774-9

### THE CAPACITY TO RECRUIT AND STORE LIPIDS IN SKELETAL MUSCLE DOES NOT ADAPT TO 14 DAYS OF VERY PROLONGED ENDURANCE EXERCISE

Hansen, A.V., Morville, T., Larsen, M.R., Munch-Andersen, T., Riis, P., Kjær, K., Dela, F., Helge, J.W.

*University of Copenhagen*

Introduction Endurance training leads to high levels of intramuscular triacylglycerol (IMTG). This includes a high capacity to recruit, store, and oxidize both endogenous and exogenous fatty acids during exercise. In recent years, lipid droplet associated proteins and their interactions with enzymes have been demonstrated to influence IMTG storage and breakdown capacity. This study investigates changes in expression of the primary proteins and enzymes in fatty acid uptake, lipid droplet storage and mobilisation for oxidation after very prolonged endurance exercise at moderate intensity. Methods Six healthy (61±/−4 yrs), cycle-trained (VO<sub>2</sub>-max: 48±/−2 ml kg<sup>-1</sup> min<sup>-1</sup>) males completed a 2770 km bike ride in 14 days. A muscle biopsy (m. vastus lateralis) was obtained before and 30-34 hours after completing the bike ride. The biopsies were taken at rest and after overnight fasting. Muscle samples were analysed by Western-blotting for expression of: endothelial lipase (EL), lipoprotein lipase (LPL), fatty acid binding protein (FABP), diglyceride acyltransferase 1 and 2 (DGAT 1 and 2), perilipin 2, 3, and 5, adipose triglyceride lipase (ATGL), and hormone-sensitive lipase (HSL). The Western-blotting was normalised to the average arbitrary unit of a standard control homogenate. Results Across the 14 days body weight remained unchanged ( $77.4 \pm 4.6$  to  $77.7 \pm 4.8$  kg). The expression of EL, LPL, FABP, DGAT 1 & 2, Perilipin 2, 3 & 5, ATGL and HSL were unchanged after 14 days of prolonged ( $580 \pm 30$  min/day) endurance exercise at moderate intensity ( $53 \pm 1\%$  VO<sub>2</sub>-max). However, the expression of LPL tended ( $P = 0.08$ ) to be increased by two fold. Discussion In the present study there was no adaptation in capacity for fatty acid recruitment, storage in lipid droplets and promotion for oxidation, after 14 days of very prolonged exercise. It is intriguing that the major increase in energy turnover was insufficient to induce changes in muscle lipid recruitment and storage pathways even though the body weight remained unchanged. The trend towards an increased muscle LPL expression implies that the exogenous supply of plasma derived triacylglycerol was important to generate the increased muscle substrate turnover during the 14 days.

### CHANGES IN FAT OXIDATION AFTER VOLUNTARY WEIGHT LOSS IN MORBIDLY OBESE PATIENTS WITH OR WITHOUT TYPE 2 DIABETES

Lund, M.1,2, Hansen, M.1, Dela, F.1, Helge, J.1

*1: University of Copenhagen, 2: Koege Hospital.*

Introduction Obesity and type 2 diabetes is accompanied by intramyocellular lipid accumulation. This may in part be explained by an impaired mitochondrial fat oxidation and increased availability of plasma free fatty acids. Our aim was to examine and compare fat oxidation changes after a voluntary weight loss in morbidly obese patients with or without T2DM. Patients included were losing weight prior to a scheduled gastric bypass operation. Methods 28 morbidly obese patients (6M/22F; 9 with (T2DM) and 17 (OB) without type 2 diabetes) reported twice to the lab after an 12 hr overnight fast: After signing up for surgery prior to any weight loss and two months later just prior to the operation. Dual Energy X-ray Absorption Scan was performed to measure body composition, followed by measurement of the maximal fat oxidation (MFO) rate and the intensity where this occurred (FATmax) by indirect calorimetry during a graded exercise test on a stationary bike (15W warm-up 4 min., increase 25W/3 min.) (Modified after Achten J et al. 2002). Results There were no baseline differences in age: 39±10 vs. 40±7 yrs; BMI: 42.5±1.0 vs. 42.1±1.6 Kg·m<sup>-2</sup>; Fat Free mass (FFM): 59.8±2.3 vs. 64.2±3.9 kg in OB and T2DM, respectively. Weight loss was similar in the two groups: 6.0±0.7 vs. 5.3±0.9 kg and there were no significant changes in VO<sub>2</sub>Max: 2.7±0.2 and 2.5±0.2 L O<sub>2</sub>·min<sup>-1</sup> or MFO rate: 0.3±0.03 and 0.3±0.04 g·min<sup>-1</sup> in OB and T2DM, respectively. However, the weight loss always resulted in FATmax at a lower relative workload: 39.3±1.8 vs. 36.0±1.1 %VO<sub>2</sub>max, ( $p = 0.004$ ) and 41.4±1.4 vs. 37.4±2.1 %VO<sub>2</sub>max ( $p = 0.018$ ), in OB and T2DM, respectively. Discussion We have found that morbidly obese patients with or without type 2 diabetes achieve their MFO rate at a lower relative workload after only a modest (<7 kg) weight loss. There were no differences in FFM, MFO rate, VO<sub>2</sub>max, before and after the weight loss. An earlier study by our group testing a weight stable obese and postobese group (Ara I et al. 2010) did not find any differences in MFO rate and FATmax between the two. In contrast, in the present study the patients were still in a catabolic state losing weight which might cause the different findings. It is well known that weight loss reduces intramuscular triglyceride level, and our results is most likely due to a lower availability of fatty acids in plasma and muscle during exercise, consistent with the observed and ongoing weight loss. References Achten J, Gleeson M, Jeukendrup AE. *Med Sci Sports Exerc* 2002; 34: 92–97. Ara I, Larsen S, Stallknecht B, Guerra B, Morales-Alamo D, Andersen JL, Ponce-Gonzalez JG, Guadalupe-Grau A, Galbo H, Calbet JAL and Helge JW. *International Journal of Obesity* 2010; 35(1):99-108.

**FRAIL ELDERLY WITH FALL-RELATED HIP FRACTURES SHOW GREATER TYPE II MUSCLE FIBER ATROPHY AND CONCOMITANT LOWER MUSCLE FIBER SATELLITE CELL CONTENT**

Kramer, I.F.1,2, Snijders, T.1, Poeze, M.2, Verdijk, L.B.1, van Loon, L.J.C.1

*NUTRIM, School for Nutrition, Toxicology and Metabolism, Maastricht University Medical Centre+, Maastricht, The Netherlands*

**Introduction** The incidence of hip fractures will increase exponentially to an estimated 6.3 million per year in 2050. The progressive loss of skeletal muscle mass and function with aging may be an important risk factor for the elderly patient to suffer a fall-related hip fracture. Yet, the myocellular phenotype that characterizes hip fracture patients remains to be determined. This study compares the muscle fiber type characteristics of elderly hip fracture patients with healthy young and elderly control subjects. **Methods** Percutaneous needle biopsies were collected from the vastus lateralis muscle in 15 elderly women admitted with fall-related hip fractures, 15 healthy elderly women, and 15 young women. Immunohistochemical analyses were performed to assess muscle fiber size and satellite cell (SC) content in a fiber type-specific manner. **Results** So far, data were obtained from 12 hip fracture patients ( $85 \pm 2$  y), 12 healthy elderly ( $73 \pm 2$  y), and 10 healthy controls ( $21 \pm 1$  y). Type I muscle fiber size did not differ between the groups. In contrast, type II muscle fiber size was significantly smaller in the hip fracture patients ( $2327 \pm 163 \mu\text{m}^2$ ) when compared with the healthy elderly ( $3348 \pm 263 \mu\text{m}^2$ ) and young ( $4460 \pm 364.4 \mu\text{m}^2$ ) controls ( $P < 0.05$ ). Furthermore, type II muscle fiber size was also significantly smaller in the healthy older compared with the young women ( $P < 0.05$ ). In all groups, the number of SC per muscle fiber was significantly smaller in the type II vs type I muscle fibers. Whereas type I muscle fiber SC content did not differ between groups, type II muscle fiber SC content was significantly lower in the hip fracture patients compared with the healthy elderly females ( $0.024 \pm 0.003$  vs  $0.051 \pm 0.007$  SC per fiber, respectively;  $P < 0.01$ ). More results from the total group of participants (i.e.  $n=45$ ) will be presented at the conference. **Conclusion** Frail elderly with fall-related hip fractures show greater type II muscle fiber atrophy and a further reduction in type II muscle fiber SC content when compared with healthy elderly subjects. This type II muscle fiber atrophy might be responsible for reduced muscle strength and functional capacity, increasing the risk of falling and sustaining a fracture. Exercise and nutritional intervention strategies should be defined and implemented to prevent the prevalence of fall-related fractures in this frail population.

**13:45 - 14:45****Poster presentations****PP-PM05 Neuromuscular Physiology 1****POSTACTIVATION POTENTIATION IN TRICEPS SURAE MUSCLES AFTER HOPPINGS CONTRIBUTES TO INCREASED PERFORMANCE IN SUBSEQUENT MAXIMAL JUMPS**

Bergmann, J., Gruber, M.

*University of Konstanz*

**Introduction** Many top athletes use hops to prepare for a subsequent sprint or jump. A possible mechanism that could explain enhanced performance is post activation potentiation (PAP) (for review see Tillin & Bishop 2009). However, there is no scientific proof for its occurrence or effectiveness. We hypothesized to find i) PAP after a bout of maximal hoppings, ii) increases in jump height in subsequent maximal drop jumps (DJ) and iii) a correlation between the amount of PAP and increases in DJ height. **Methods** 12 healthy subjects (7 woman and 5 men, age  $25 \pm 3$  years, height  $175 \pm 9$  cm, weight  $71 \pm 11$  kg) participated in the study. To quantify PAP, twitch peak torques (TPT) were measured with and without 10 preceded maximal hoppings as conditioning contractions. Muscle twitches were evoked by supramaximal stimulation of the tibial nerve and TPT of the triceps surae muscles were determined in an ankle dynamometer. Thereafter, 8 maximal DJ were performed with and 8 were performed without conditioning hops in a randomized order on a force plate. DJ height was calculated by the flight-time method. To examine potential underlying mechanisms we analyzed background EMG activities of gastrocnemius, soleus, tibialis anterior, vastus medialis and biceps femoris muscles in distinct time intervals during the DJ (PRE=150 ms before touchdown (TD) until TD; SLR=30–60ms after TD; LLR=90–120ms after TD). Additionally, we elicited M- and V-waves, so that they coincided with the SLR and LLR. TPT, jump height, RMS values of background EMG and V/M-ratios were compared by means of one-way ANOVA and post hoc Bonferroni analysis. Pearson analysis was used to correlate changes in TPT and DJ height. Statistical significance was set at  $P < 0.05$ . **Results** After 10 maximal hops TPT of triceps surae muscles was  $32 \pm 8\%$  ( $P < 0.01$ ) higher compared to baseline values. In DJ, in which a preceded bout of maximal hops was performed, jump height increased by  $12 \pm 11\%$  ( $P < 0.05$ ). Higher TPT and changes in DJ heights were positively correlated ( $R^2 = .263$ ,  $P < 0.05$ ). Neither background EMG data nor V/M-ratios revealed any statistical differences between the conditions. **Discussion** In the present study we were able to induce a clear PAP effect with 10 maximal hops and to demonstrate increased DJ height. Based on the correlation analysis, it can be concluded that PAP contributed to the higher performance in DJ. Unchanged EMG data and V/M-ratios indicate that neural control remained unaffected. Therefore, enhanced performance in DJ after PAP is more likely the result of intramuscular mechanisms, like e.g. phosphorylation of regulatory light chains (Houston et al. 1985). References Tillin NA & Bishop D (2009). *Sports Med*, 39, 147-166. Houston ME, Green HJ & Stull JT (1985). *Pflügers Archiv*, 403, 348-352.

**ACTIONS OF  $\beta_2$ -ADRENOCEPTOR AGONIST DRUG ON HUMAN SOLEUS MUSCLE CONTRACTION**

Crivelli, G.1, Capt, R.1, Borrani, F.1, Maffioletti, N.A.2

*University of Lausanne*

**ISSUL, University of Lausanne (CH) 2Neuromuscular Research Laboratory, Schullthess Clinic (CH)** **Introduction** In animal models, the stimulation of  $\beta_2$ -adrenergic receptors is able to modulate the contractility of slow skeletal muscle fibers. For example,  $\beta_2$ -agonists enhanced twitch relaxation rate and reduced force level in subtetanic contractions of the cat soleus muscle in vivo (Bowman, 1980). In humans, the effects of  $\beta_2$ -agonists are unclear as it remains to be ascertained whether (1) the alterations of contractile properties in vivo are compatible with those observed in animal preparations, and (2) central motor drive (CMD) during voluntary contractions could compensate for the contractile changes. The aim of this study was to investigate central and peripheral neuromuscular effects induced by the  $\beta_2$ -agonist terbutaline on the human soleus muscle. **Methods** Twelve healthy men (age  $31 \pm 5$  years) ingested either a single dose of 8 mg of

terbutaline or placebo in a randomized double-blind order (two sessions). Isometric plantar flexion torque of electrically evoked twitch and tetani (10 and 100 Hz) as well as of submaximal and maximal voluntary contractions (MVC) was measured while the subjects were seated with hip, knee and ankle angles of 90°. Half-relaxation time was also calculated from twitch torque traces. CMD was estimated via soleus electromyographic recordings obtained during steady submaximal (50% MVC) voluntary contractions. Results MVC and peak twitch torque were unaffected by terbutaline. Twitch half-relaxation time was 28% shorter after terbutaline administration compared to placebo ( $P < 0.001$ ). Tetanic torques at 10 and 100 Hz were significantly depressed after terbutaline ingestion, respectively by -40% and -24% (both  $P < 0.001$ ). Although the mean torque of the submaximal voluntary contraction was comparable for the two conditions, CMD was 9% higher after terbutaline intake compared to placebo ( $P < 0.001$ ). Discussion This study provided evidence that stimulation of  $\beta_2$ -adrenergic receptors via terbutaline ingestion is able to modulate the contractility of human slow skeletal muscle in vivo. The effect of terbutaline on muscle relaxation may be due to an increased rate of sarcoplasmic reticulum  $Ca^{2+}$  uptake (Ha et al., 1999). The same mechanism could also be responsible for the weakening action of  $\beta_2$ -agonist on slow skeletal muscle, which may have affected evoked tetanic torque by decreasing the permanence of  $Ca^{2+}$  in the cytoplasm. The increase in CMD during submaximal contractions may be viewed as a compensatory adjustment of the central nervous system to counter the weakening effect of terbutaline on slow muscle fibers (Roatta et al., 2008). References Bowman (1980). Handbook of Experimental Pharmacology, 47-128. Ha et al. (1999). Br J Pharmacol, 126, 1717-1724. Roatta et al. (2008). J Physiol, 586, 5561-5574.

### SUBTHRESHOLD ELECTRICAL NOISE STIMULATION REDUCES THE FLUCTUATIONS IN THE INDEX FINGER MOVEMENTS

Nagata, K., Kouzaki, M.

*Kyoto University*

Introduction Accurate movement of the fingers is an important functional skill that greatly influences our ability to perform skillful activities, e.g., grasping and lifting the objects. Thus, deteriorations in this accuracy become serious problem in our daily living. Age-related decrease in this becomes serious problem. However, it is not well obvious that factors for improvement of accurate movement of the hand muscles. Therefore, the aim of this study was to examine whether the index finger steadiness increases due to subthreshold electrical noise stimulation, which is based on the concept of stochastic resonance (SR). Methods The experiments were performed on the left hand of 8 healthy male subjects. Each subject performed six trial position-holding tasks with a submaximal load at ~5% of MVC for 50 s while giving subthreshold electrical noise stimulation for 40 s. Electrical stimulation (ES) applied to the ulnar nerve of innervation of the first dorsal interosseous (FDI) muscle at the left wrist. The ES intensity was determined based on the recruitment threshold of the FDI muscle. The lowest intensity that caused the motor unit action potential to start firing was identified as the ES intensity (ES-1). Such an electrical signal consisted of a randomly varying white noise signal with bandwidth between near 1 and 100 Hz. The ES intensity was decided 0.0 (without stimulation) to 1.0 times of ES-1 with 0.2 steps. To assess the magnitude of fluctuations in the index finger movement during the position-holding tasks, the path length (PL) of finger displacement were calculated with a charge coupled device laser displacement sensor with a spatial resolution of 10  $\mu$ m (Nagata et al. 2012). Results The finger displacement fluctuated around the target position in not only the adduction-abduction but the extension-flexion directions. The ES intensity at which the PL is local minimal value was found except for two subjects. For two subjects, there was no influence of electrical stimulation on PL values. Discussion The subthreshold electrical noise stimulation used in the present study does not excite the motor nerve fiber, but it might do affect the afferent fiber because the ES intensity was below recruitment threshold. Thus, such stimulation appropriately enhances the sensitivity of the  $\alpha$ -motoneuron pool via the afferent fibers than motor nerve fibers. Therefore, the subthreshold electrical noise stimulation would modulate  $\alpha$ -motoneuron properties via afferent fibers. In addition, according to the concept of SR, the subthreshold electrical noise stimulation was likely effective in enhancing the function of the sensorimotor system because of the electrical nature of information transfer in sensory neurons. References Nagata K, Hagio S, Tanabe H, Kouzaki M. (2012). J Electromyogr Kinesiol, in Press.

### EFFECTS OF AGING ON THE DEVELOPMENT OF FUNCTIONAL CONSEQUENCES OF CENTRAL AND PERIPHERAL FATIGUE DURING LOCOMOTOR EXERCISE

Elmer, S., Bohn, J., Amann, M., McDaniel, J., Martin, D., Martin, J.

*Swedish Winter Sports Research Centre-Mid Sweden University, University of Utah*

Introduction Results from a recent systematic review and meta analysis of skeletal muscle fatigue and aging indicate that older individuals develop greater fatigue than young individuals during dynamic muscle contractions. However, the relative importance of central and peripheral factors in fatigue during dynamic contractions in the elderly is unclear. Our purpose was to evaluate the effects of aging on the development of functional consequences of central and peripheral fatigue induced via dynamic exercise involving a large muscle mass. Specifically, we used high-intensity single-leg cycling to induce fatigue and evaluated associated effects on maximum cycling power ( $P_{max}$ ) in the fatigued ipsilateral leg (FATleg) as well as the rested contralateral leg (RESTleg). Methods On separate days, 12 young ( $26 \pm 4$  yr) and 12 masters ( $57 \pm 5$  yr) cyclists performed right leg  $P_{max}$  trials before and again 30s, 3, 5, and 10min after a cycling time trial (TT, 10min) performed either with their right or left leg. Fatigue was estimated by comparing exercise-induced changes in  $P_{max}$  as quantified via inertial-load cycling. Pre-to post-TT changes in maximum handgrip isometric force ( $F_{max}$ ) were also assessed. Results Relative power produced during the right and left leg TT's did not differ between young and masters cyclists (~33% vs. 36% of  $P_{max}$ ; leg effect,  $P=0.70$ ; leg x age,  $P=0.73$ ). Compared to pre-TT, FATleg  $P_{max}$  was reduced by  $22 \pm 3\%$  and  $21 \pm 3\%$  for young and masters cyclists at 30s post-TT, respectively, (time effect,  $P < 0.01$ ; time x age,  $P=0.48$ ). At 10min post-TT, FATleg  $P_{max}$  was similar to pre-TT values for both young and masters cyclists ( $P=0.06$ ). Post-TT  $P_{max}$  produced by the RESTleg did not differ from pre-TT values for young and masters cyclists (time effect,  $P=0.45$ ; time x age,  $P=0.53$ ).  $F_{max}$  increased for young and masters cyclists at 10min post-TT (time effect,  $P < 0.05$ ; time x age,  $P=0.12$ ). Discussion Even with  $> 30$  yr difference in age, masters cyclists exhibited nearly identical levels of fatigue compared to young cyclists in the FATleg and also exhibited similar recovery patterns. Further, despite considerable fatigue in the FATleg, both young and masters cyclists were able to maintain maximum cycling power in the RESTleg. This suggests that a cross-over of fatigue (likely central in origin) was either not present or not large enough to impair maximum cycling power in the RESTleg. These results along with the lack of changes in  $F_{max}$  indicate that impairments in maximal voluntary neuromuscular function were specific to the working muscles for both young and masters cyclists. We conclude that fatigue induced via high-intensity single-leg cycling has similar functional consequences for endurance trained young and masters cyclists. Finally, these results likely represent a best case scenario for highly active aging.

## NEUROMUSCULAR FATIGUE DEVELOPMENT AND BIOMECHANICAL CHANGES DURING CONSTANT-LOAD, HIGH-INTENSITY CYCLING EXERCISE

Overton, A.J., Abbiss, C., Blazevich, A.J.

*Edith Cowan University*

**Introduction** Neuromuscular function during fatiguing exercise has primarily been examined at the onset and termination of an exercise bout. However this does not capture the time course, or relative contribution, of central and peripheral fatigue mechanisms and assumes a linear progression to exhaustion. Importantly, associated biomechanical (muscle activity and kinematic) changes have not been simultaneously investigated. **Methods** Nine well trained male cyclists performed seven testing sessions; session 1: incremental cycling test to exhaustion; session 2: constant-load cycling time to exhaustion (TTE) test; sessions 3-6: constant-load cycling tests to 20, 40, 60 and 80% (T20-T80) of the time taken to complete the TTE test (T100) in random order; session 7: a TTE test. Cycling tests were performed at a constant cadence ( $89 \pm 10$  rpm) at 90% Pmax (PO that elicits a  $\text{VO}_2$  reading  $< 2.1 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  of the subsequent reading despite increasing workload;  $337 \pm 38$  W). EMG activity of seven lower limb muscles and 3D joint kinematics were recorded at the beginning (T0) and termination (T100) of the first TTE test, and in the final 20 s of the remaining constant-load cycling tests (T20-T80). Neuromuscular assessments (mechanical and EMG responses of the quadriceps to voluntary and electrically stimulated (femoral nerve) contractions) were made before and after exercise. **Results** The participants cycled for  $5:49 \pm 0:51$ . Twitch contraction time increased to T20, and peak twitch torque and the average rate of torque development and relaxation increased to T40 then declined to T100. Neither M-wave amplitude (Mmax) and duration nor twitch one-half relaxation time changed. No changes were observed in peak torque and the rate of torque development measured during voluntary knee extension. Increases in vastus lateralis EMG amplitude and EMG:Mmax from T80-T100 were not significant. No significant changes were observed in %VA, peak EMG amplitudes, rate of EMG rise or EMG mean frequency (MeanF). During cycling, EMG onset and offset times and duration did not change, although peak vastus medialis and gluteus maximus (GMax) EMG amplitude, GMax mean EMG amplitude and GMax EMG impulse significantly increased. No significant changes were observed for EMG MeanF. Increases in trunk flexion from T60, trunk lateral flexion and hip abduction/adduction from T80 and trunk lateral flexion and knee valgus/varus at T100 were observed. **Discussion** Peripheral neuromuscular fatigue mechanisms developed early in the exercise bout and were significant by T60, but were temporarily dissociated from significant kinematic changes. As the exercise bout progressed, efferent drive to the muscle increased from T80-T100 and was associated with a significant change in kinematics at the trunk, hip and knee joints.

## POSTACTIVATION POTENTIATION IS AFFECTED BY PASSIVE SHORTENING AND LENGTHENING DURING TWITCH CONTRACTION

Fukutani, A.1, Hirata, K.1, Miyamoto, N.1, Kanehisa, H.2, Yanai, T.1, Kawakami, Y.1

*1: Waseda University (Tokorozawa, Japan), 2: National Institute of Fitness and Sports in Kanoya (Kanoya, Japan)*

**Introduction** The magnitude of twitch torque increases after a high intensity contraction (conditioning contraction) of the same muscle. This phenomenon is called postactivation potentiation (PAP). Previous studies reported that a conditioning contraction enhanced subsequent maximal voluntary concentric torque (Miyamoto et al. 2011) whereas maximal isometric force was not enhanced (Vandenboom et al. 1993). We hypothesized that this discrepancy be caused by the difference in the behavior of muscle fibers during twitch contraction. Therefore, the purpose of this study was to examine the effect of changing muscle fiber behavior on the magnitude of PAP by imposing length changes during twitch contraction. **Methods** In 15 subjects, twitch contraction of plantar flexion was evoked at the same ankle joint angle (0 deg) during isometric, passive shortening (+120 deg/s) and passive lengthening (-120 deg/s) conditions before and after the maximal voluntary isometric plantar flexion as a conditioning contraction. During twitch contractions, the behavior of the fascicle of the medial gastrocnemius was determined by ultrasonography to confirm the shortening velocity of the fascicle. **Results** The magnitude of PAP in the isometric condition was significantly smaller than that in the passive shortening condition, but significantly larger than that in the passive lengthening condition ( $p < 0.05$ ). Likewise, the shortening velocity of the fascicle of the medial gastrocnemius during a twitch contraction in the isometric condition was significantly smaller than that in the passive shortening condition, and larger than that in the passive lengthening condition ( $p < 0.05$ ). **Discussion** The fascicle shortening velocity was higher in the order of passive lengthening, isometric and passive shortening conditions. In addition, the magnitude of PAP became larger in a similar fashion to that of fascicle shortening velocity. These results support our hypothesis that the magnitude of PAP is related with the shortening velocity of the fascicle during a twitch contraction. A primary mechanism of PAP is myosin regulatory light chain phosphorylation induced by conditioning contraction, which facilitates actin-myosin interaction (Sweeney et al. 1993). Our results suggest that this mechanism is operative more conspicuously when the fascicle shortens at a higher velocity during a twitch contraction. **References** 1. Miyamoto N, Kanehisa H, Fukunaga T, Kawakami Y. (2011). *J Strength Cond Res*, 25(1), 186-192. 2. Vandenboom R, Grange RW, Houston ME. (1993). *Am J Physiol*, 265(6 Pt 1), C1456-1462. 3. Sweeney HL, Bowman BF, Stull JT. (1993). *Am J Physiol*, 264(5 Pt 1), C1085-1095.

## H-REFLEX AND DELAYED-ONSET MUSCLE SORENESS IN THE TRAPEZIUS MUSCLE

Vangsgaard, S., Søgaard, K., Taylor, J.L., Madeleine, P.

*Aalborg University*

**H-REFLEX AND DELAYED-ONSET MUSCLE SORENESS IN THE TRAPEZIUS MUSCLE** Vangsgaard, S.1, Søgaard, K. 2, Taylor, J. L.3, Madeleine, P.1.1: Aalborg University (Aalborg, Denmark), 2: University of Southern Denmark (Odense, Denmark), 3: Neuroscience Research Australia and the University of New South Wales (Sydney, Australia) **Introduction** The separation of the efferent and afferent fibres to trapezius enables H reflexes to be evoked by electrical stimulation without the influence of direct activation of the motor axons (1). Delayed-onset muscle soreness (DOMS) often occurs in relation to sports activities as a result of high-intensity eccentric exercise (2). No studies have investigated the effects of DOMS on the H reflex in the trapezius muscle. The objective of this study was to investigate the modulation of the H reflex 24 h after eccentric exercise in the presence of DOMS. **Methods** H reflexes were recorded from the dominant middle trapezius muscle by electrical stimulation of the C3/4 cervical nerve in 10 healthy subjects. DOMS was induced by eccentric exercise of the dominant shoulder. H reflexes were obtained in three sessions: "24h before", "Pre", and "24h after" eccentric exercise. Ratios of maximal H reflex and M wave responses ( $H_{\text{max}}/M_{\text{max}}$ ) were compared between sessions. Additionally, a between session comparison was done for the ratios of H reflex amplitudes ( $H_{i75}/M_{\text{max}}$ , and  $H_{i50}/M_{\text{max}}$ ) obtained from the stimulus intensity needed to obtain 75% and 50% of  $H_{\text{max}}$  at "24h before". Muscle soreness was assessed using a visual analogue scale (VAS) score and measures of pressure pain threshold (PPT). **Results** A decrease in both  $H_{i75}/M_{\text{max}}$  and  $H_{i50}/M_{\text{max}}$  were observed at "24h after", ( $P < 0.05$ ). VAS scores were

significantly higher at "24h after" compared with "24h before" and "pre", ( $P < 0.05$ ). PPT values were significantly lower "24h after" compared to "24h before" and "pre", ( $P < 0.05$ ). Discussion This study presented evidence that at 24h after exercise stronger stimulus intensity was needed to reach the same magnitude of the H reflex as the recruitment curve was shifted to the right. This modulation of the stimulus-response relationship could be caused by presynaptic inhibition of Ia afferent fibres' input to the motoneuron by group III and IV afferents. References (1) Alexander C, Harrison P. The bilateral reflex control of the trapezius muscle in humans. *Exp Brain Res* 2002;142(3):418-424. (2) Armstrong R. Mechanisms of exercise-induced delayed onset muscular soreness: a brief review. *Med Sci Sports Exerc* 1984;16(6):529.

### REFLEX EXCITABILITY: IS IT A CONTRIBUTOR FOR POST-ACTIVATION POTENTIATION?

Xenofondos, A.

*Aristotle University of Thessaloniki*

**Introduction** The influence of post-activation potentiation (PAP) to enhance subsequent athletic performance after a conditioning contraction has received considerable attention in the past years. However, our knowledge and understanding of the neurophysiology of PAP is limited. Only few studies, have examined the twitch torque and the soleus and gastrocnemius H-reflex after PAP (Guellich and Schmidtbleicher, 1996; Hodgson et al., 2008; Trimble and Harp, 1998). In these studies there are several methodological considerations and their findings seem inconclusive. **Methods** Fourteen healthy, recreationally active male and female participated in this study. The measurement procedures included familiarization for the participant with the tests, the determination of the soleus H- and M-wave amplitude/stimulus intensity curve and the measurement of the MVC. The Mmax and H-reflex were measured before and after a 10 s isometric MVC (conditioning stimulus). We examined the twitch torque properties and H-reflex amplitude, 5 minutes before and for 20 minutes after the conditioning contraction. Results Immediately after a 10 s isometric MVC the twitch torque was significantly increased ( $p < 0.05$ ) while the H-reflex amplitude of both muscles significantly decreased ( $p < 0.05$ ), compared to that before the 10 s isometric MVC. After one minute the H-reflex amplitude returned to baseline levels and remained unchanged. The Mmax did not change significantly during the whole experiment, whereas peak twitch torque was potentiated immediately after the contraction. **Discussion** Recreationally active adults exhibit an inhibition in excitability of motor neurons activated through the Ia afferent pathway. This inhibition gradually recovers with no potentiation above baseline. This neural inhibition could be attributed to the post-activation depression of Ia afferents, and could be a counteracting factor limiting the mechanism of PAP. Reference Guellich A., Schmidtbleicher D. (1996). *New Stud Athle*, 11(4), 67-81. Hodgson MJ, Docherty D, Zehr EP (2008). *Int J Sports Physiol Perform*, 3(2), 219-231. Trimble HH, Harp SS (1998). *Med Sci Sport Exer*, 30(6), 783-787.

### INFLUENCE OF AN ACUTE INCREMENTAL EXHAUSTIVE EXERCISE ON EXECUTIVE FUNCTION: A STUDY ON THE DURATION OF ITS EFFECTIVENESS.

Ochi, G., Akahori, M., Hyodo, K., Soya, H.

*University of Tsukuba (IBARAKI, JAPAN)*

**Introduction** It is important for athletes to maintain cognition during athletic performance in competitive sports. Such cognition could be affected by both peripheral and central fatigue. A previous study had shown that executive function as one of cognitive functions was declined after an acute incremental exhaustive exercise (LaManca et al., 1998). However, it is not known as to physiological and psychological conditions during exercise by which executive function is declined. Also, it is not known how long a decline in cognitive function after exhaustive exercise would last. The purpose of the present study was to examine the duration of the effectiveness of and the influence of acute incremental exhaustive exercise on executive function. **Methods** Eighteen healthy young male subjects who had experiences of exercise participated in this study. There were two sessions of experiments on two separate days. On the first day, they performed a color-word Stroop task (CWST) one of the most commonly used tests for examining executive functions, before cycle ergometer exercise (pre), immediately after (post), and 10 (P10), 20 (P20) and 30 (P30) minutes after exercise. On the second day, all subjects followed the same procedure as for day one, including sitting on the ergometer, but without exercise. Cognitive performance was evaluated by reaction time (RT) for incongruent and neutral tasks of CWST. The exercise intensity that was started at 25 W was increased with a 25W increment in every minute to exhaustion. At baseline and during exercise, expired gas, rate of perceived exertion (RPE), heart rate and blood lactate concentration were determined. Criteria for exhaustion were respiratory exchange ratio was greater than 1.5, RPE was 20, the predicted maximum heart rate was more than 90%, blood lactate was more than 10mmol/l and a clear plateau of O2 uptake with increment of work load. We assumed that subjects who met three out of five of the criteria for exhaustion reached exhaustion in this study. **Result and Discussion** No significant difference was found in RT between the control and exercise experiments in the results of the CWST of 12 subjects who met the exhaustion conditions. Four of twelve subjects did not meet the RPE condition for exhaustive exercise. A previous report had shown that RPE is highly correlated with exhaustion (Presland et al., 2005). Therefore, we hypothesized that RPE 20 may be an important determinant factor effecting executive function. We re-analyzed the CWST RT of eight subjects whose exhaustive exercise condition included RPE 20. In these subject, the incongruent task performance decreased at P10 and P20 ( $p < 0.05$ ). These results suggest that an acute exhaustive exercise impairs executive function, only when the exhaustion criterion included RPE 20, and the effect continued until 20 min after exhaustive exercise. References LaManca J.J., Sisto S.A., DeLuca J, Johnson S.K., Lange G, Pareja J, Cook S, Natelson B.H. (1998). *Am J Med* (3A), 59S-65S Presland J.D., Dowson M.N., Cairns S.P. (2005). *Eur J Appl Physiol*, 95, 42-51

### ACUTE NEUROMUSCULAR AND HORMONAL RESPONSES TO SINGLE-SESSION COMBINED STRENGTH AND ENDURANCE LOADINGS

Taipale, R.S., Schumann, M., Mikkola, J., Nyman, K., Kyroläinen, H., Nummela, A., Häkkinen, K.

*University of Jyväskylä, KIHU – Research Institute for Olympic Sports, Central Hospital of Central Finland*

**INTRODUCTION** Conflicting adaptations have been observed when strength and endurance training are combined (Hickson 1980), which has been attributed to a high intensity and volume of training and as well as training modes (Wilson et al. 2011). Acute responses to the order of exercise in a single session has not been thoroughly investigated, thus this study examined the acute responses and recovery of force production and serum hormone concentrations to single-session combined strength (S) and endurance (E) loadings in which the order of exercises is randomized. **METHODS** Twenty-two recreationally endurance trained subjects 10 women (W) and 12 men (M) ( $36 \pm 8$  years) completed two loadings [S followed by E (SE) and E followed by S (ES)]. The S loading focused on the leg extensors including maximal and explosive exercises while E consisted of moderate intensity running for 60min. Maximal isometric force (MVC), countermovement

jump (CMJ) and serum hormone concentrations (total testosterone, T and cortisol, C) were measured pre, mid, and post loadings as well as at 24h and 48h of recovery. RESULTS Significant decreases were observed in MVC of M at mid and post in both ES ( $p < 0.05$ ) and SE ( $p < 0.001$ ). In W, a significant decrease in MVC was observed at mid only in SE ( $p < 0.01$ ) and at post in both ES ( $p < 0.01$ ) and SE ( $p < 0.05$ ). MVC remained decreased in M at 24h and 48h in both ES and SE ( $p < 0.01-0.09$ ) but recovered in W. A significant decrease in CMJ height was observed in M after S in both loadings. CMJ height did not change during the loadings in W, but was significantly decreased at 24h and 48h of recovery after ES. T concentrations did not change significantly over time in M or W during SE or ES; however, in M (the increase in) concentration of T was significantly higher in ES than in SE at 24h and 48h ( $p < 0.05$ ). C concentrations did not change significantly over time in M, but were slightly higher ( $p = 0.072$ ) in M following SE than ES. Concentrations of C in W decreased during the loadings but were statistically unaltered during recovery. DISCUSSION The present combined S and E loadings induced more decreases in MVC and CMJ height and greater hormonal responses in M than in W. The present ES and SE loadings produced differing neuromuscular and hormonal responses suggesting that the order of concurrent S and E exercise has an influence on acute physiological responses. These findings may have important implications for training in recreational endurance athletes. REFERENCES Hickson (1980) Eur J Appl Physiol. 45: 255-263. Wilson et al. (2011) J Strength Cond Res (Published ahead of print).

## HOW DOES EXTREME-DURATION HEAVY LOAD CARRIAGE AFFECT NEUROMUSCULAR FUNCTION?

Grenier, J.G., Millet, G.Y., Messonnier, L., Morin, J.B.

*University of Saint-Etienne.*

HOW DOES EXTREME-DURATION HEAVY LOAD CARRIAGE AFFECT NEUROMUSCULAR FUNCTION? GRENIER JG (1,2), MILLET GY (1), MESSONNIER L (3), MORIN J-B (1). (1) University of Lyon, F-42023, Saint Etienne, France. Laboratory of Exercise Physiology (EA4338), F-42000, Saint-Etienne, France. (2) Safran Group, Sagem, Land Warfare, F-91300, Massy, France. (3) University of Savoie, Laboratory of Exercise Physiology (EA4338), F-73376, Le Bourget du Lac, France. INTRODUCTION Heavy load carriage for moderate duration exercises (Clarke et al., 1955; Blacker et al., 2010) or exercises of extreme duration but with light equipments carriage (Martin et al., 2010; Millet et al., 2011) can alter the neuromuscular function (NMF). To our knowledge, the combined effects of heavy load carriage and extreme duration of exercise has never been studied so far. This was done in the present study in soldiers performing a simulated military mission (SMM). METHODS Ten experienced infantrymen performed a 21-h SMM in a middle-mountains environment with equipments weighting ~27 kg during simulated battle phases and ~43 kg during road marches. They were allowed 2 \* 3 h of sleep and disposed of a 1-day food ration (3200 kcal). Knee extensors (KE) and plantar flexors (PF) mechanical responses during maximal voluntary contractions (MVC) and nerve electrical stimulations, as well as EMG recordings and ratings of perceived exertion were measured before and immediately after the SMM. RESULTS MVC declined by  $10.2 \pm 3.6\%$  for KE ( $P < 0.01$ , effect size of 0.50) and  $10.7 \pm 16.1\%$  for PF ( $P = 0.06$ , effect size of 0.82) after the SMM. The origin of fatigue was essentially peripheral for both muscle groups. Low frequency fatigue, which has been linked to excitation-contraction coupling failure, was only detected for KE. Finally, these moderate NMF alterations came with a large subjective fatigue. DISCUSSION This study based on a military context reports novel data about the neuromuscular consequences of exercises of extreme duration with heavy load carriage. Surprisingly, the results showed that the NMF alterations due to the 21-h SMM were close to those reported after load carrying exercises lasting less than 3 h (Clarke et al., 1955; Blacker et al., 2010). It is however likely that the mission chronology and the subjects' high capacities for load carriage explained this unexpected result. Finally, the observed large subjective fatigue was attributed to the environmental stress inherent to the outdoor SMM but was not coupled with central alteration of the NMF. REFERENCES 1. Clarke HH, Shay CT, Mathews DK (1955). Res Q, 26, 253-65. 2. Blacker SD, Fallowfield JL, Bilzon JL, Willems ME (2010). Aviat Space Environ Med, 81(8), 745-53. 3. Martin V, Kerhervé H, Messonnier LA, Banfi JC, Geysant A, Bonnefoy R, Féasson L, Millet GY (2010). J Appl Physiol, 108(5), 1224-33. 4. Millet GY, Tomazin K, Verges S, Vincent C, Bonnefoy R, Boisson RC, Gergelé L, Féasson L, Martin V (2011). Plos One, 6(2), e17059.

## EFFECTS OF GRADED HYPOXIA ON THE TIME COURSE OF NEUROMUSCULAR ADJUSTMENTS DURING MAXIMAL, INTERMITTENT LEG EXTENSIONS

Christian, R., Girard, O., Billaut, F., Bishop, D.

*Aspetar - Qatar Orthopaedic and Sports Medicine Hospital, Doha, QATAR, Victoria University, Melbourne, AUSTRALIA*

Effects of graded hypoxia on the time course of neuromuscular adjustments during maximal, intermittent leg extensions Christian R1,2, Girard O1, Billaut F2, Bishop D2 1Aspetar – Qatar Orthopaedic and Sports Medicine Hospital, Doha, QATAR 2Victoria University – School of Sport and Exercise Science, Melbourne, AUSTRALIA Introduction: Fatigue during high-intensity intermittent exercise has been shown to occur as a result of both neural and muscular factors. However, due to neuromuscular assessments usually being restricted to pre- and post-exercise only, the time course, interplay and regulation of neural and muscular adjustments during such exercise is not well understood. Aim: To investigate the effect of hypoxia severity on the time course of neuromuscular adjustments during maximal intermittent leg extensions. Methods: Twelve trained, team-sport athletes (age:  $28 \pm 6$  y; stature:  $180 \pm 6$  cm; mass:  $82 \pm 6$  kg) performed 4 bouts of intermittent exercise (separated by 100 s of rest); each bout included 6 sets (separated by 15 s of rest) of 5 maximal, continuous, isokinetic leg extensions at 300 °/s. There were 3 conditions: normoxia (simulated altitude/fraction of inspired oxygen = 0 m/0.21%), moderate (3000 m/0.14%) and severe hypoxia (5400 m/0.10%) which were performed in a randomised counterbalanced order. Arterial oxygen saturation (SpO<sub>2</sub>), heart rate (HR) and rating of perceived exertion (RPE) were recorded 10 s after each contraction set. Neuromuscular assessments including voluntary and evoked contractions of the knee extensors using both peripheral motor nerve and transcranial magnetic stimulations were completed prior to exercise, in-between each set, immediately, 5, 15 and 30 minutes post-exercise. Results: Preliminary data ( $n=7$ ) show that average peak power output during the first set was similar among the three conditions ( $180.9 \pm 35.7$  N.m-1, all conditions compounded;  $p=1.00$ ). Irrespectively of the conditions average peak power output decreased ( $p < 0.05$ ) from the first to the fourth exercise bout (percentage decrement score: -4.6%, -6.0% and -8.1% in normoxia, moderate and severe hypoxia, respectively), while HR and RPE (+9% and +23%, respectively; all conditions compounded; both  $p < 0.01$ ) increased. RPE values during the fourth bout (+5.0% and +4.2%, respectively) were higher in severe hypoxia than in normoxia or moderate hypoxia. Compared to baseline, SpO<sub>2</sub> remained constant in normoxia (98%) but decreased in moderate and severe hypoxia (91% and 80%, respectively; both  $p < 0.05$ ) after 10 min wash-in. SpO<sub>2</sub> did not further decrease throughout exercise in any condition. Conclusion: During maximal, intermittent leg extensions, preliminary evidence suggests that larger performance decrements occur with increases in hypoxia severity. With our complete sample size, additional data will help to shed more light on the time course of neuromuscular adjustments that may eventually explain the larger performance decrement observed with severe hypoxia.



13:45 - 14:45

## Poster presentations

## PP-PM06 Rehabilitation, Physiotherapy, Health and Fitness

**EFFECTS OF WHOLE BODY VIBRATION IN THE LEAN MASS OF ADOLESCENTS WITH DOWN SYNDROME.**

González-Agüero, A., Gómez-Cabello, A., Matute-Llorente, A., Gómez-Bruton, A., Morales, S., Vicente-Rodríguez, G., Casajús, J.A.

*GENUD Research Group, University of Zaragoza, Spain*

**Introduction:** Persons with Down syndrome (DS) are characterized by lower levels of lean mass(1) which, together with their physiological characteristics, lead them to a concerning low strength levels and lack of autonomy when performing daily activities. This low lean mass may be counteracted through exercise, and it has been demonstrated that whole body vibration (WBV) is an effective method to improve body composition(2). Therefore, our aim was to observe the effect of 20 weeks of WBV in the lean mass of adolescents with DS. **Material and methods:** Thirty adolescents (15.8±2 yr) with DS (11 females) were randomly assigned to the WBV or control groups. Previous to the WBV intervention and immediately after, participants were heighted and weighed; dual energy X-ray absorptiometry (DXA) scans were performed to evaluate lean mass of the whole body, upper and lower limbs, and Tanner stage was also assessed. The intervention consisted in WBV (squatting position) in a platform 3 days per week for 20 weeks (frequency 25-30 Hz; amplitude 2-4mm; duration 30-60 s). Analyses of covariance (ANCOVA) for repeated measures (with Tanner stage and height as covariates) were performed to evaluate possible group by time interactions. Adjusted values were recorded and percentages of change (from pre to post-WBV) were calculated from these adjusted values. **Results:** No group by time interactions were found for any studied variable; however the WBV group showed significantly greater percentages of change for whole body (2.3±1.6 vs. 0.36±2.5), upper (2.7±2.1 vs. 0.59±3.3) and lower limbs lean mass (2.9±3.1 vs. -0.51±4.3) compared with the control group (all p<0.05). **Discussion:** Since our results showed a rather consistent 2-3% increment in lean mass in the WBV compared with 0.5% in the control group; it can be assumed that the WBV training may have a positive effect on the lean mass of adolescents with DS. Other type of training has also been demonstrated as effective for enhancing lean mass in this population (1); however, WBV takes less time and is easily performed by the participants. Therefore, WBV could be a good implementation to any other activities that these adolescents carry out. It is possible to hypothesize that the low intensity and/or absolute duration (20 weeks) of the training, made the analyses not to reach significant interaction. Also the low number of participants could be another reason. Further studies with longer and/or more intense WBV trainings could corroborate our findings. **References:** (1) González-Agüero, A., et al. *Res Dev Disabil*, 2011. (2) Lamont, H.S., et al., *J Strength Cond Res*. 2011.

**MUSCULAR POWER OUTPUT AND EFFICIENCY IN AN ELITE ATHLETE WITH CEREBRAL PALSY**

Prins, L.F., Wolters, P.C.M., De Koning, J.J., Casolino, E., Foster, C., Porcari, J.P., Zimmerman, D.

*VU University Amsterdam*

**MUSCULAR POWER OUTPUT AND EFFICIENCY IN AN ELITE ATHLETE WITH CEREBRAL PALSY** Prins, L.F.1, Wolters, P.C.M.1, De Koning, J.J.1,3, Casolino, E.2, Foster, C. 1,3, Porcari, J.P.3, Zimmerman, D.3 1: VU University (Amsterdam, Netherlands), 2: University of Rome "Foro Italico" (Italy), 3: University of Wisconsin-La Crosse (USA) **Introduction** One of the critical issues in rehabilitation is understanding how patients adapt to pathological conditions to achieve relatively normal function. In this regard, studies of athletes with disabilities can prove instructive regarding the limits of adaptive possibilities. We report the case of an elite runner with cerebral palsy (CP) (T37 class) who participated in the 1996 & 2000 Paralympics in 800m, 1500m and 5000m, silver medal in 1500m in 2000. Personal best: 800m=132s=102.3s=77.5%=WR; 1500m=269s=207.7s=77.2%=WR; 5000m=1060s=769.6s=72.5%=WR. **Methods** He was studied 11 years after his Olympic medal, although he still trained regularly both running and cycling. To assess differences between his affected (A) and normal (N) legs he performed both incremental and steady state (50%PPO) cycle ergometer exercise with both two legs (2L) and single legs (1L). Respiratory metabolism was measured with open-circuit spirometry. **Results** His incremental PPO was 300W, 105W & 190W with 2L, A, & N, respectively. His VO2max (3.74, 3.78 & 3.71 l\*min<sup>-1</sup>) was remarkably constant during both 2L and 1L exercise, potentially secondary to a very much 'whole body' style of riding with both A & N legs. His VO2@VT (2.65, 2.30 & 2.40 l\*min<sup>-1</sup>) & RCT (2.87, 2.75 & 2.75 l\*min<sup>-1</sup>) were also remarkably similar, suggesting that one of his adaptations to his CP was to support his A leg by use of accessory muscles. His gross efficiency (GE) at 50% of the leg specific PPO was 18.4% (2L), 9.3% (A) & 12.2% (N). **Discussion** In a formerly elite, but still well-trained runner with CP, there was little evidence of a central oxygen transport limitation to 1L exercise capacity, potentially because his adaptation to his CP was to make extensive use of accessory muscles. Normally the VO2max during one leg exercise is 70% of 2L VO2 max (Davies & Sargeant, 1974), versus 100% with A and N 1L exercise. However, the reduction in PPO with the A leg appeared to be attributable to a marked reduction in GE during exercise with the A leg. Likewise, the normal expectation with 1L versus 2L exercise is a decrease in GE from ~19% to ~16%. Compared to able bodied persons our subject uses more accessory muscles, resulting in a decrease in GE and increase in aerobic power. **Reference** Davies, C.T.M., Sargeant, A.J. (1974). Physiological responses to one-and two-leg exercise breathing air and 45% oxygen. *JAP*, 2, 142-148.

**DESCRIPTION AND FIRST INSIGHT INTO THE EFFECTIVENESS OF AN EXERCISE-BASED PHYSICAL THERAPY PROGRAM FOR PATELLAR TENDINOPATHY PATIENTS AFTER PLATELET-RICH PLASMA INJECTION: A CASE-SERIES STUDY**

van Ark, M., van den Akker-Scheek, I., Meijer, L.T.B., Zwerver, J.

*University Medical Center Groningen*

**Introduction** Patellar tendinopathy is a common and hard to treat injury. A PRP injection followed by a physical therapy program seems promising for the treatment of patellar tendinopathy in the degenerative phase. However, descriptions of physical therapy programs are often limited and incomplete (van Ark et al, 2011). The first aim of this study was to describe a post platelet-rich plasma (PRP) injection, exercise-based physical therapy program, based on current evidence and expert opinion. The second aim was to investigate feasibility and provide a first insight into the effectiveness of combining a PRP injection with subsequently the physical therapy program. **Methods** Five patellar tendinopathy patients (six knees) in the degenerative phase received a PRP injection followed by a specifically designed

physical therapy program. The main outcome measures were VISA-P score and pain ratings on a VAS during ADL and functional tests. These were assessed before treatment (baseline) and 6, 12, 16 and 26 weeks after injection. Results Five of the six tendons showed an improvement of at least 30 points on the VISA-P after 26 weeks. The VISA-P score increased from a mean of  $49.3 \pm 12.7$  at baseline to  $80.1 \pm 20.4$  at 26 weeks follow-up. Friedman tests revealed statistically significant differences for all outcome measures between the five measurements ( $p=0.004$  for VISA-P). Post-hoc Wilcoxon Signed-Rank tests, with Bonferroni correction, did not show statistically significant differences between baseline and a follow-up measurement. Close to significant results were found 12, 16 and 26 weeks after injection. Discussion This is the first study to extensively describe a physical therapy program after PRP injection for patellar tendinopathy patients. Muscle strength, endurance, power and retraining sport-specific function form the basis for the program aimed at improving the load capacity of the knee. The combination treatment investigated in this study is feasible and seems to be promising for patients in the degenerative phase of patellar tendinopathy. The combination of treatment modalities seems essential because healing of a tendinopathic tendon is interplay of mechanical and biological factors (Khan & Scott, 2009; Rees et al., 2009). To be able to compare results of future research, this physical therapy program can be used in patellar tendinopathy patients after PRP injection. van Ark M, Zwerver J, van den Akker-Scheek I. (2011). *Br J Sports Med* 45(13), 1068-1076. Khan KM, Scott A. (2009). *Br J Sports Med*, 43(4), 247-251. Rees JD, Maffulli N, Cook J. (2009). *Am J Sports Med*, 37(9), 1855-1867.

## PREDICTION OF PEAK OXYGEN UPTAKE FROM PEAK POWER OUTPUT DURING ARM CRANKING IN ABLE-BODIED AND PARAPLEGIC INDIVIDUALS

Al-Rahamneh, H., Eston, R.

*University of Jordan, University of South Australia*

Prediction of Peak Oxygen Uptake from Peak Power Output during Arm Cranking in Able-bodied and Paraplegic Individuals Al-Rahamneh, H.1, Eston, R. 2 1: Faculty of Physical Education, University of Jordan 2: School of Health Sciences, University of South Australia Introduction Peak oxygen uptake ( $\dot{V}O_{2peak}$ ) is a valuable indicator of cardiorespiratory fitness (1) and a strong predictor of death in patients with heart disease as well as in all-cause of deaths (2). This study aimed to assess the validity of predicting  $\dot{V}O_{2peak}$  from peak power output (POpeak) during arm cranking exercise using the equation described by the ACSM (i.e.,  $\dot{V}O_2 \text{ ml.kg}^{-1}.\text{min}^{-1} = 3 \times \text{work rate (kg.m.min}^{-1})/\text{body mass (kg)} + 3.5 \text{ ml.kg}^{-1}.\text{min}^{-1}$ ). Methods Thirteen able-bodied men ( $27.2 \pm 4.3$  y;  $174 \pm 5$  cm;  $74.5 \pm 11.8$  kg) and 13 paraplegic men ( $31.6 \pm 5.8$  y;  $170 \pm 6$  cm;  $63.7 \pm 11.1$  kg) took part in the study. Each participant completed an arm cranking graded exercise test (started at 30 W and increased by 15 W every 2 min) and a ramp exercise test (started at 0 W and increased by 15 W.min<sup>-1</sup>) designed to measure  $\dot{V}O_{2peak}$ . All exercise tests were performed on the same Lode arm ergometer. The midpoint of the ergometer was set at shoulder level and the distance was set to allow slight flexion in the elbow when the arm was extended. Participants were asked to keep the pedal cadence at 60 rpm. On-line respiratory gas analysis occurred every 10 s in both tests. Results Able-bodied and paraplegic participants achieved a higher POpeak during the ramp (136 cf. 106 W) compared to the GXT (118 cf. 92 W), respectively. For the GXT, there was no significant difference between measured  $\dot{V}O_{2peak}$  (34 cf. 31 ml.kg<sup>-1</sup>.min<sup>-1</sup>) and predicted  $\dot{V}O_{2peak}$  from POpeak (33 cf. 30 ml.kg<sup>-1</sup>.min<sup>-1</sup>) for able-bodied and paraplegic participants, respectively. However,  $\dot{V}O_{2peak}$  predicted from POpeak during the ramp test (38 cf. 34 ml.kg<sup>-1</sup>.min<sup>-1</sup>) was higher than measured  $\dot{V}O_{2peak}$  (33 cf. 29 ml.kg<sup>-1</sup>.min<sup>-1</sup>) for able-bodied and paraplegics, respectively. Discussion The higher POpeak values observed during the ramp exercise test may be attributed to the more frequent increase in the work rate compared to the GXT. The significantly higher predicted  $\dot{V}O_{2peak}$  from the ramp exercise test for both the able-bodied and paraplegic participants in this study is not surprising. The ACSM equations were derived during steady-state sub-maximal aerobic exercise. Thus, and as reported by the ACSM (2006), they are only appropriate for predicting the  $\dot{V}O_2$  during steady-state, sub-maximal aerobic exercise. The high  $\dot{V}O_{2peak}$  predicted from the ramp protocol, further confirms that the  $\dot{V}O_2$  is overestimated when it is based on non-steady-state exercise conditions, when the contribution from anaerobic metabolism is large (1). References 1.American College of Sports Medicine (2006). ACSM's Guidelines for Exercise Testing and Prescription. Lippincott Williams & Wilkins, Baltimore. 2.Kavanagh T, Mertens DJ, Hamm LF, Beyene J, Kennedy J, Corey P, Shephard RJ, (2002). 106, 666-671.

## LEARNING WITH THE NUDRIVE LEVER-PROPELLED WHEELCHAIR: THE EFFECTS OF 1 DAY LEARNING ON MECHANICAL EFFICIENCY AND PUSH FREQUENCY.

Jaspers, E.G., Hettinga, F.J., Monden, P., Van der Woude, L.H.V.

*University of Groningen*

Learning with the NuDrive lever-propelled wheelchair: the effects of 1 day learning on mechanical efficiency and push frequency. Jaspers EG, Hettinga FJ, Monden P, Van der Woude LHV Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen, The Netherlands Purpose: Previous research has shown that lever-propelled wheelchairs are more efficient but also less practical than hand-rim propelled wheelchairs (van der Woude et al., 2001). The NuDrive lever-system tried to make lever propulsion more practical by designing the levers lightweight and detachable. However experience shows that people need some time to get acquainted with the NuDrive. Therefore, the present study investigates 1 day of learning lever-propulsion with the NuDrive. Methods: 15 able-bodied participants (age: 24.1 (2.4) yr) were randomly assigned to an experimental (EXP, N=7) and control (CON, N=8) group. EXP performed 7 low-intensity NuDrive practice trials on a treadmill (0.22 W/Kg, 1.11 m/s). Each trial consisted of 2 blocks of 4 minutes with 2 minutes of rest in-between. Energy expenditure was calculated from oxygen uptake and respiratory exchange ratio (Garby L & Astrup A, 1987). Gross and net mechanical efficiency (GME and NME), push frequency, RPE and local perceived discomfort (LPD) were assessed during a pre- and post-test (0.22 W/Kg, 1.11 m/s) consisting of 3 blocks of 4 minutes with 2 minutes of rest in-between. Push frequency was measured using accelerometry. Groups were compared using a Repeated Measures Anova ( $p < 0.05$ ). Results: GME and NME improved in EXP compared to CON (GME EXP vs. CON pre: 4.00 (0.62) vs. 4.25 (0.68); post: 4.76 (0.60) vs. 4.15 (0.60); NME pre: 5.23 (1.00) vs. 5.45 (1.10); post: 6.60 (1.01) vs. 5.29 (0.92)). Push frequency (push/min) showed a small downwards trend in both EXP and CON (EXP vs. CON pre: 68.1 (25.6) vs. 77.8 (13.2); post: 55.7 (18.0) vs. 70.3 (14.5)). RPE and LPD did not differ between groups. Conclusions: The present study is the first that focuses on learning mechanisms in lever-propelled wheelchairs. Efficiency improves with practice, and a clear learning effect was present after 1 day of practice with the NuDrive. Decreasing push frequency might attribute to this learning mechanism. Based on the present results a proper learning period is advised before using or evaluating the NuDrive system as an alternative for hand-rim propulsion. References: van der Woude LHV, Dallmeijer AJ, Janssen TW, Veeger D. (2001). *American Journal of physical Medicine and Rehabilitation*, 80(10), 765-777 Garby L & Astrup A. (1987). *Acta Physiologica Scandinavica*, 129(3), 443-444

**THE EFFECTIVENESS OF SWIMMING FOR BREAKING THE VICIOUS CYCLE OF DECONDITIONING IN CEREBRAL PALSY.**

Declerck, M., Daly, D., Verheul, M., Sanders, R.H.

*University of Edinburgh*

THE EFFECTIVENESS OF SWIMMING FOR BREAKING THE VICIOUS CYCLE OF DECONDITIONING IN CEREBRAL PALSY. Declerck, M.1, Daly, D.2, Verheul, M.1, Sanders, R.H.1 1: University of Edinburgh (Edinburgh, UK), 2: KULeuven (Leuven, Belgium) Introduction Youth with Cerebral Palsy (CP) are considerably less active and have lower physical fitness than their able-bodied peers. This leads to a cycle of deconditioning resulting in deterioration of health and physical function and subsequently more inactivity. Influencing and contributing to this vicious cycle are different factors of the International Classification of Functioning, Disability and Health (ICF) such as pain, coordination, walking, fatigue, quality of life (QoL), self-esteem and functional independence. The implementation of community-based exercise and sport programs into the therapy program can be a solution for breaking and reversing this cycle. Swimming is a community-based activity that can be introduced at a young age. Therefore, the aim of this study was to investigate the effect of a swimming intervention on the factors contributing to the vicious cycle of deconditioning of youth with CP. Methods Fifteen children aged 7 to 17 years and diagnosed with CP participated in a randomized controlled trial comparing a swimming intervention (10 weeks, 2/wk, 30 to 60 minutes) to no extra therapy. The primary outcome measures were pain, fatigue, walking capacity and coordination. Secondary outcome measures were functional independence, self-esteem, QoL and swimming skills. All measurements were taken prior to and after the intervention and after a five week follow-up period. Results A pilot study (n=7) showed a significant improvement ( $p < 0.0001$ ) of 7% in swimming skills after a 6-week intervention with a participation level of 89%. Non-significant increases were found in walking speed (11%), manual performance speed of the dominant (9%) and non-dominant (14%) hand, gross motor function (2%). A non-significant decrease of pain (6%) was also noted. The main intervention was in progress at the time of abstract submission. Results will be presented at the ECSS conference. Participation level to the program was 95%. Discussion The results of the pilot study suggest that the 10-week swimming intervention may have positive effects on various aspects of functioning in children with Cerebral Palsy. If the 10-week swimming intervention improves different contributing factors of the vicious cycle, it can encourage specialists, physiotherapists and parents to promote participation in physical activities in the community and it could potentially replace part of the tiresome intensive therapy program with swimming in order to increase adherence to therapy and physical activity in adolescence and adulthood.

**SURFACE ELECTROMYOGRAPHIC ACTIVITY OF VASTUS INTERMEDIUS MUSCLE DURING QUADRICEPS SETTING AND KNEE EXTENSION EXERCISE**

KAGAYA, Y., Nakada, T., Endo, H.

*Showa University*

Introduction The vastus intermedius (VI) muscle is important for the knee extensor mechanism, but its activation remains unclear because it is located deep in the rectus femoris (RF) muscle region, making activity recording using surface electromyography (EMG) nearly impossible. Watanabe & Akima (2010, 2011) recently developed a technique to record VI muscle activation using surface EMG. The aim of this study was to determine VI activation during quadriceps setting and knee extension exercises. Methods Thirteen healthy male volunteers participated in this study. Their mean age was  $21.8 \pm 1.1$  years, and their height and weight were  $171.9 \pm 4.6$  cm and  $61.6 \pm 4.7$  kg, respectively. The subjects performed quadriceps setting in three different positions (supine, long sitting, and standing). Surface EMG data was recorded for VI, vastus medialis (VM), vastus lateralis (VL), and RF muscles. In addition, subjects performed maximal voluntary contractions (MVC) at two hip and three knee joint angles during isometric knee extensions. The two hip joint angles were  $90^\circ$  and  $30^\circ$ , and the three knee joint angles were  $75^\circ$ ,  $45^\circ$ , and  $15^\circ$ . Each surface EMG recording was found via integration over a 2-second time period and was indicated as %MVC. Results During quadriceps setting, VI activity while in the supine position and standing was significantly higher than that while long sitting ( $p < 0.05$ , and  $p < 0.01$ , respectively). VM and VL activity while standing was significantly higher than that while long sitting and in the supine position ( $p < 0.05$ , and  $p < 0.01$ , respectively). During isometric knee extension, VI activity while a knee joint angle of  $75^\circ$  was significantly higher than that at  $45^\circ$  and  $15^\circ$  for both hip joint angles ( $p < 0.05$ , and  $p < 0.01$ , respectively). RF activity at a hip joint angle of  $90^\circ$  was significantly higher than at  $30^\circ$  for knee joint angles of  $75^\circ$  and  $45^\circ$  ( $p < 0.05$ , and  $p < 0.01$ , respectively). Discussion The important finding in this study is that VI muscle activity over various knee and hip joint angles is not consistent with that of quadriceps femoris muscle groups. Thus, suggesting that RF activity as a two-joint muscle depends on the hip joint angle, and VI activity as a one-joint muscle depends on the knee joint angle. VI activity at the flexed knee position was higher than that at the extended knee position, and thus differed from other quadriceps femoris muscle groups. The results of our study may help in designing a rehabilitation and exercise program for patients with knee dysfunction. References Watanabe K, Akima H. (2010). *J Electromyogr Kinesiol*, 20, 661-666. Watanabe K, Akima H. (2011). *Scand J Med Sci Sports*, 21, 412-420.

**EFFECTS OF LOWER LIMB STRENGTHENING ON BALANCE AND FUNCTION IN PERSONS WHO SUFFERED A STROKE**

Fernandes, B.1, Batista, F.2, Beckert, P.2, Evangelista, I.2, Ferreira, M.J.2, Prates, L., Sérgio, J.S.1

1: *ESTeSL (Lisbon, Portugal)*, 2: *HFF (Amadora, Portugal)*

Introduction Postural control dysfunctions are one of the most common and devastating consequences of a stroke interfering with function and autonomy (Shumway-Cook & Woollacott, 2011). Neurological physiotherapy plays a central role in the recovery of movement and posture, however it is necessary to study the efficacy of techniques that physiotherapists use to treat these problems (Pollock et al., 2005). The aim of this study was to investigate the effects of a physiotherapy intervention program, based on oriented tasks and strengthening of the affected lower limb, in balance and functionality of individuals who have suffered a stroke. Methods The participants were 16 male subjects, aged 50 to 65 years, who suffered a single stroke, in the middle cerebral artery territory, during the month prior to the enrollment in the study. Subjects were randomly allocated to one of two groups: experimental group (N=9) or control group (N=7). Experimental group performed an intervention program based on oriented tasks plus strengthening of the affected lower limb. Control group followed a program based on oriented tasks only. Outcome measures were Berg Balance Scale, Modified Barthel Index and Modified Ashworth Scale. Both groups completed 4 treatment sessions per week, during 12 weeks. Results At the end of 12 weeks the experimental group had significantly greater increases in balance compared with the control group. Both groups improved function levels, muscle tone did not increase in any of the groups and there was a strong positive correlation between balance and function. Discussion The results suggest that the physiotherapy intervention program with oriented tasks and strengthening of the affected lower limb, seems to be more effective in increasing balance than a program based on oriented tasks only. It is important to point out that these individuals

did not show increase in muscle tone in the affected lower limb. Function levels also show an increase, however it is not significantly different from the increase produced by the control program. Positive correlation between balance and functionality suggests the importance of early starting of physiotherapy intervention programs, focused on treating balance dysfunctions after stroke, in order to promote autonomy and functional independence. References Pollock, A., Baer, G., Pomeroy, V., & Langhorne, P. (2005). Physiotherapy treatment for the recovery of postural control and lower limb function following stroke. Cochrane Review. The Cochrane Collaboration. John Wiley & Sons Shumway-Cook, A. & Woollacott, M. (2007). Motor control: translating research into clinical practice. 4th ed. Philadelphia: Lippincott Williams & Wilkins.

### MEASURING SWEAT SODIUM CONCENTRATION USING THE REGIONAL ABSORBENT PATCH METHOD: A ROBUST FIELD TEST

Dziedzic, C.E.1,2, Ross, M.L.1,3, Dunn, P.2, Slater, G.2, Burke, L.M.1

1: Australian Institute of Sport (Canberra, Australia), 2: The University of the Sunshine Coast (Maroochydore, Australia), 3: Edith Cowan University (Joondalup, Australia)

**Introduction** It has been suggested that sodium be included in individualized hydration plans (Maughan & Shirreffs, 2008). While more precisely measured by whole-body washdown technique (Shirreffs & Maughan, 1997), the regional absorbent patch method (RAPM) provides a practical approach to undertaking sweat testing in the field. The aim of this study was to investigate the variability of measurements of sweat sodium concentration considering potential differences in RAPM protocols. **Methods** The RAPM (Tegaderm+Pad) was used to collect sweat samples from the forearms, chest, scapula and thigh of 12 trained cyclists during four standardised cycling time trials. The sweat collection protocol was employed to allow site selection, including estimation of results [left and right forearm average or weighted four-site equation (Patterson et al., 2000)] and application time (30 vs. 60 min) to be investigated in either hot (32°C, 30-40% r.h.) or thermoneutral (TN) (21°C, 50-60% r.h.) conditions. Single measure analysis of sodium concentration was conducted immediately by ion-selective electrode method (Hitachi, Model 911). **Results** A repeated measures analysis of variance revealed no significant effect of application time ( $p=0.24$ ) or environmental testing conditions ( $p=0.11$ ) on sweat sodium concentration results (TN30 min:  $59 \pm 24$  vs. TN60 min:  $61 \pm 22$  mmol/L; Hot30 min:  $64 \pm 24$  vs. Hot60 min:  $67 \pm 26$  mmol/L). No interaction was detected between application time and environmental condition ( $p=0.77$ ). A paired t-test highlighted a significant difference ( $p<0.05$ ) in estimates of sweat sodium concentration when calculated from forearms alone ( $66 \pm 24$  mmol/L) compared to using a four-site equation ( $71 \pm 21$  mmol/L). **Discussion** This study shows a significant difference in the estimation of sweat sodium concentrations depending on the number of sites included in result interpretation. Nevertheless, RAPM appears to be a robust field test, withstanding protocol variations in relation to sweat rates (achieved via changes in thermal load in different environmental conditions) and sweat collection time. Care should be taken when deciding on which sites to include in testing, as the sampling protocol will determine which estimation of sweat sodium concentration can be made (i.e. forearm average or four-site equation). **References** Maughan R, Shirreffs S. (2008). IJNEM, 18,457-472. Patterson MJ, Galloway, SDR, Nimmo, MA (2000). Exp Physiol, 85(6),869-875. Shirreffs S, Maughan R. (1997). JAP, 82,336-341.

### INFLUENCE OF FITNESS HABITS ON THE PHYSIOLOGICAL CONDITION OF FACIAL SKIN

Aoki, R., Suwabe, K., Hyodo, K., Soya, H.

UNIVERSITY OF TSUKUBA

**Introduction** In modern society, stress is inevitable. A recent report indicated that chronic stress may increase the risk of developing various psychosomatic diseases, including acne vulgaris on the face. Since most women care about cosmetic problems, it is interesting to study how fitness habits affect the physiological condition of facial skin. Sebaceous hyperplasia is one of the main causes which form acne vulgaris. The stress regulation which brain function mediated involves sebaceous secretion. Recent studies have suggested that a person with a lot of sebum secretions showed that the right prefrontal cortex dominates the regulation of the stress response system, including the hypothalamic-pituitary-adrenal axis. And, it is thought that exercise may have a positive effect on skin health. Therefore, we hypothesized that people with good fitness habits are more stress-resistant than those who are sedentary, and that they also have better skin condition. The purpose of this study was to examine the influence of different fitness habits on physiological skin conditions. We especially focused on lipid metabolism and moisture conditions of facial skin as reflections of chronic stress response. **Methods** A total of 79 healthy female college students were investigated. We divided subjects into three groups, high fitness group, medium fitness group, and sedentary group, by using the International Physical Activity Questionnaire (IPAQ). The experimental environment was air-conditioned and the temperature and humidity were maintained at approximately 22 degrees celsius and 50%, respectively. After washing each subject's face, the sebum level, moisture level, pH, and trans-epidermal water loss (TEWL) were measured by Vapometer **Results** The amount of physical effort was revealed to be intensity-dependent ( $p < 0.001$ ). For sebum, the high fitness group was significantly lower than other two groups ( $p < 0.05$ ). Both fitness habit groups had lower pH values than did the sedentary group, and the medium fitness group had the lowest value. **Discussion** These results demonstrate that subjects with high-intensity fitness habits have better skin condition compared with the other groups, since both sebum and pH were lowered in high-intensity fitness compared to those of sedentary group. The mechanism behind it is uncertain, although the small amount of sebum in hi-intensity fitness might be due to their higher stress resistance; animals underwent chronic intense exercise training have been shown to be resistive to any of psychological stress (Watanabe et al., 1992). Thus, the amount of sebum secretion could be controlled with certain exercise regimen. Collectively, it appears that skin condition improves with high-intensity training and this may shed light on possibilities for new beauty regimens. 1992) **References** Tanida M, Katsuyama M, Sakatani K. (2007). Brain Research, 1186:210-216 Murase N, Katsumura T, Ueda C, Inoue S, Shimomitsu T. (2002). Index of welfare, Vol.49, No.11

### SMOKING HABITS OF BRITISH ARMY TRAINEES AND THE INFLUENCE OF SMOKING ON PHYSICAL FITNESS PARAMETERS

Siddall, A., Bilzon, J., Thompson, D., Greeves, J., Stokes, K.

University of Bath

Smoking habits of British Army trainees and the influence of smoking on physical fitness parameters Siddall, A.1, Bilzon, J.1, Thompson, D.1, Greeves, J.2, Stokes, K.1. 1: Department for Health, University of Bath, BA2 7AY, UK. 2: Department of Occupational Medicine, Army Recruiting and Training Division, SN9 6BE, UK Cigarette smoking adversely effects long-term health and is associated with reduced cardiorespiratory fitness. Smoking has also been reported to impair physical performance adaptations and increase injury risk during military

training. Despite this, smoking prevalence in military populations has typically been observed to be higher than in the general population. This study aimed to examine smoking characteristics of British Army infantry trainees and the potential effect of habitual smoking on physical fitness parameters. A validated lifestyle questionnaire was administered to trainees (aged 18-33) at entry to training (n=2087) to determine smoking characteristics. In a sub-sample (n=1182), measures of physical fitness routinely conducted in weeks 1, 14 and 24 of training were also obtained. A linear mixed model was used to identify any differences over time between habitual smokers (S) and non-smokers (NS) in 2.4 km run time, and the number of press-ups and sit-ups performed in two minutes. At entry to training the population comprised habitual smokers (48%), occasional smokers (5%), former smokers (9%) and non-smokers (37%) (1% non-responders). The sub-sample used in physical performance analysis was comprised solely of habitual smokers (58%) and non-smokers (42%). Estimated marginal means for weeks 1, 14 and 24 of training showed that NS performed significantly better than S in press ups (NS: 48 (0.6), 55 (0.6), 57 (0.7); S: 44 (0.5), 52 (0.5), 55 (0.6);  $P < 0.001$ ), sit ups (NS: 57 (0.5), 62 (0.6), 66 (0.6); S: 54 (0.4), 61 (0.5), 63 (0.5);  $P < 0.001$ ) and 2.4 km run time (NS: 612 (2), 579 (2), 567 (2) s; S: 621 (2), 586 (2), 571 (2) s;  $P < 0.01$ ). Physical performance improved significantly as a result of training irrespective of smoking group ( $P < 0.001$ ) but no interaction effects were evident ( $P > 0.05$ ). Smoking prevalence in British infantry trainees is substantially higher than both the British general public and values typically reported in similar non-infantry military populations. Twenty-four weeks of military training resulted in similar significant improvements in physical fitness parameters irrespective of smoking status. However, habitual smokers were significantly less physically fit than non-smokers, both at entry and throughout infantry training. Ultimately, poorer physical fitness might hinder performance in future occupational tasks.

## WORK INTENSITY AND ENERGY EXPENDITURE OF ENDURO- CYCLING RACE IN RECREATIONAL CYCLISTS

Nakagata, T., Murade, S., Fukao, K., Katamoto, S., Naito, H.

*Juntendo University*

**Introduction** Recently, the enduro-cycling race has become increasingly popular in Japan. Previous studies have estimated the work intensity and energy expenditure (EE) during competitive road race in professional cyclists based on heart rate (HR). However, the available data on the work intensity and EE during enduro-cycling race in recreational cyclists are very few. Therefore, we aimed to clarify the work intensity and EE during enduro-cycling race. **Methods** Ten healthy Japanese male recreational cyclists (age: 25-63 y-o, height: 172.4 ± 5.4 cm, mass: 63.4 ± 6.1, Vo<sub>2</sub>max: 52.9 ± 6.8 ml/kg/min) participated in this study. They had trained 2-3 days/wk, and cycled over 120-240 km/wk. Each subject raced over 2-4 hrs in an enduro-cycling race held in a circuit course. Blood lactate (LA) and glucose levels were measured before and after the race, and HR was continuously recorded (Polar) throughout the race. The EE during the race was calculated from the HR-Vo<sub>2</sub> relationship pre-determined in a laboratory before the race. **Results** The mean total distance covered and cycling speed were 126.7 ± 40.7 km and 36.3 ± 3.2 km/h, respectively. The mean HR during the race was 158.9 ± 10.6 bpm corresponding to a work intensity of 83.3 ± 6.1 % Vo<sub>2</sub>max. The estimated EE during the race was 2880.6 ± 1037.8 kcal, ranging between 1509-4125 kcal depending on the total distance covered. The energy cost was 0.36 ± 0.04 kcal/kg/km, which was relatively consistent regardless of distance covered. LA and glucose levels after the race increased slightly from 1.8 to 2.2 mmol/L and 108.4 to 118.3 mg/dl, respectively. However, the increases from the pre-race values were not significant, and were not related to the total distance covered. This result was not agreed by Costill (1970), who reported an inverse relationship between LA and distance covered during an open-distance running). **Discussion** A previous study estimated that work intensity during a road cycling race was approximately 70 % Vo<sub>2</sub>max for professional cyclists<sup>2</sup>). In the present study however, the work intensity recorded during enduro-cycling race for recreational cyclists was 83.3 % Vo<sub>2</sub>max. This variation could be attributed to the difference in race profile and cycling skills, and imply that enduro-cycling race in recreational cyclists might impose a higher relative load on their cardiorespiratory functions than that imposed during a competitive road race in professional cyclists **Conclusion** Work intensity of enduro-cycling race in Japanese recreational cyclists were estimated to be 83.3 % Vo<sub>2</sub>max. The energy expenditure varied between 1509-4125 kcal depending on total distance covered. **Reference** 1) Costill DL, J Appl Physiol, 1970 2) Benjamin FZ, Med Sci Sports Exer. 1999

**13:45 - 14:45**

## Poster presentations

### PP-PM07 Training & Testing 1

#### INDIVIDUAL VARIABILITY IN HEART RATE RECOVERY AFTER STANDARDIZED SUB MAXIMAL EXERCISE

van der Does, H.T.D.

*Hanze University of Applied Sciences*

**Individual variability in heart rate recovery after standardized sub maximal exercise** Does, H.T.D van der<sup>1,2</sup>, Brink M.S.<sup>1,2</sup>, Visscher, C.2& Lemmink K.A.P.M.<sup>1,2</sup> **1**School of sport studies, Hanze University of Applied Sciences (Groningen, Netherlands)**2**Center for Human Movement Sciences, UMCG (Groningen, Netherlands) **Introduction** To optimize performance, coaches and athletes are always looking for the right balance between training load and recovery. Therefore, closely monitoring of athletes is important. Heart rate recovery (HRR) after standardized sub maximal exercise has been proposed as a useful variable to monitor (Lamberts et al., 2004). However, it is well known that heart rate, next to biological variability, is influenced by several factors such as training load and psychosocial stress. So, the purpose was to look at individual variability in HRR from one week to another using the heart rate interval monitoring system (HIMS). **Methods** Eight elite Dutch female indoor hockey players (age: 23.9±3.91yr, length: 155.0±7.01cm, weight: 56.6±6.16kg) completed the HIMS two weeks in a row (Lamberts et al., 2004). The heart rate at the end of the last stage (HREnd) was determined and the HRR was calculated one minute after the end of the last stage. Furthermore, training load and psychosocial stress and recovery were monitored using the Foster-method (1998) and the RESTQ-Sport (Nederhof et al., 2008), respectively. **Results** A strong correlation was found between the HREnd from one week to the other ( $r=0.984$   $p < 0.01$ ). No correlation was found for the HRR after one minute between the first and second week. Comparison of the means of HREnd and HRR revealed a significant ( $p < 0.01$ ) difference between the mean HRR of the first week ( $M= 57.24$ ,  $SD=14.05$ ) compared to the second week ( $M=54.43$ ,  $SD=11.12$ ). Different individual patterns were also found for training load and psychosocial stress and recovery in these weeks. **Discussion** HREnd shows no difference over the two weeks, illustrating that athletes reach the same intensity at the end of the test each time. However, in contrast to earlier research (Borresen et al., 2007), HRR in our study shows

clear differences over two weeks. Individual differences in training load and psychosocial stress and recovery may explain these differences. So, when using the HRR regularly to monitor athletes, it is important to take training load and psychosocial stress and recovery into account before interpretation. References Borresen J, Lambert M (2007). *Eur J Appl Physiol*,101(4):503-11. Foster C (1998) *Med Sci Sports Exerc*,30(7):1164-8. Lamberts R, Lemmink K, Durandt J, Lambert M.(2004). *J Strength Cond Res*,18(3):641-5. Nederhof E, Brink M, Lemmink K (2008). *Int J Sport Psychol*,39(4),301-311

## EVALUATION OF A 2.000 M PERFORMANCE PREDICTION MODEL FOR ELITE ROWERS BASED ON ANAEROBIC THRESHOLD AND MAXIMUM SPRINT POWER

Falke, A.K., Hanakam, F., Grabow, V., Ferrauti, A.

*Ruhr-Universität Bochum*

EVALUATION OF A 2.000 M PERFORMANCE PREDICTION MODEL FOR ELITE ROWERS BASED ON ANAEROBIC THRESHOLD AND MAXIMUM SPRINT POWER Falke, AK.1, Hanakam, F.1, Grabow, V.2, Ferrauti, A.1. Ruhr-University Bochum, Department of Coaching Science (Bochum, Germany), 2. Technical University Dortmund, Department of Sport and Sport Science (Dortmund, Germany) Introduction In elite rowing a 2.000 m maximum test performed on a rowing ergometer is generally used for monitoring individual physical abilities and team selection. Due to the high physical and psychological load and lactate accumulation of such tests a regular examination isn't recommendable. Different performance prediction models based on various anthropometric and metabolic parameters have been proposed (Mäestu et al. 1999, Ingham et al. 2002, Riechman et al. 2002). Aim of the study was the development and evaluation of a 2.000 m performance prediction model for elite rowers based on anaerobic threshold and maximum sprint power. Methods 18 male and 7 female elite rowers performed each a 2·8 min submaximal incremental test for the determination of power at 4 mmol·l<sup>-1</sup> blood lactate level (P4mmol·l<sup>-1</sup>) and a 20 s sprint for the determination of maximum sprint power (P20s) and maximal lactate formation rate (VLamax). The 2.000 m race simulation time (T2.000) was measured separately in the course of a team selection competition. Using linear (multiple) regression analysis various combinations of parameters (also for gender specific subgroups) were tested for the prediction of T2.000. Results The prediction model based on the parameter combinations P4mmol·l<sup>-1</sup> and P20s and the combination P4mmol·l<sup>-1</sup>, P20s and VLamax revealed the most precise predictions of T2.000 (with R<sup>2</sup> = 0.97 and R<sup>2</sup> = 0.98, respectively). The standard deviation SD of residuals for both prediction models was 4.6 s and 3.8 s, respectively, for the entire group. Gender specific subgroups revealed a standard deviation SD of 4.7 s and 3.2 s, respectively, for the male and 2.7 s in both models for the female subjects. The distribution of residuals for both prediction models considering the entire group displayed a Gaussian distribution with a standard deviation  $\sigma$  of 3.5 s for the parameter combination P4mmol·l<sup>-1</sup> and P20s and  $\sigma$  of 3.8 s for the combination P4mmol·l<sup>-1</sup>, P20s and VLamax. Discussion The combination of a submaximal incremental test and a maximum sprint test allows for a precise prediction of the individuals 2.000m race time. We recommend the test procedure of our prediction model for regular examination of the athlete's ability. To further improve the prediction quality or enable a gender-specific model additional investigations with a larger and more diverse sample are needed. References Ingham SA, Whyte, GP, Jones K, Nevill AM (2002). *Eur J Appl Physiol*, 88, 243-246 Mäestu J, Jürimäe J, Jürimäe T (1999). *Acta Kinesiol Univ Tartu*, 4, 199-208. Riechman SE, Zoellner RF, Balasekaran G, Goss, FL, Robertson RJ (2002). *J Sports Sci*, 20, 681-687.

## THE INFLUENCE OF ANTHROPOMETRIC AND FITNESS COMPONENTS ON YOYO INTERMITTENT RECOVERY TEST 2 RESULTS

Schwindling, S.1, Faude, O.1,2, Görgen, C.1, Kraushaar, J.1, Meyer, T.1

*1: Saarland University, 2: University of Basel*

The YoYo intermittent recovery test 2 (YYIRT2) has been developed to determine the ability to recover from repeated anaerobic exercise in soccer players (Bangsbo et al., 2008). In this regard, the YYIRT2 may give additional information beyond typical tests of aerobic capacity. The present study aimed at analyzing the degree by which the YYIRT2 result can be predicted from anthropometric parameters and basic fitness components in amateur soccer players. 43 youth and amateur soccer players (19.4±3.2y, 177.6±7.8cm, 71.4±10.6kg) were tested on three occasions separated by one week. On the first (familiarization) and the last test day, the subjects conducted the YYIRT2 and one hour later a repeated sprint ability test (RSA, 10x30m with 30s active rest). On the second test day players carried out a 30m sprint (3 repetitions, 2 min rest in between), vertical jump tests (counter movement jumps, drop jumps), an agility test (20 m with 6 sharp turns), and an incremental running test (MAX, starting at 10 km/h, increase 2 km/h every 3 min) to determine the individual anaerobic threshold (IAT) and the maximal running velocity (vmax). For RSA the fatigue index (FI) and the percentage decrement score (Sdec, Girard et al., 2011) were calculated. Subjects ran on average 652±173m during the YYIRT2 and had a vmax of 17.4±1.0 km/h in MAX. A significant correlation of YYIRT2 distance was found with body fat (r=0.38), sprint (0-30m: r=-0.47, 0-10m: r=-0.41, 10-30m: r=-0.49), RSA (0-30m: r=-0.42, 10-30m: r=-0.51), IAT (r=0.57) and vmax (r=0.61). For all other parameters no significant correlation (-0.30<r<="" p=""></r

## TETHERED SWIMMING AS AN ESTIMATOR OF ANAEROBIC CAPACITY

Morouco, P.1,2, Neiva, H.2, Marinho, D.2,3, Marques, M.C.2,3

*1: IPL-CIMH (Leiria, Portugal), 2: CIDESD (Portugal), 3: UBI (Covilhã, Portugal)*

Introduction Relationships between tethered swimming (TS) and swimming performance have been previously studied. Nevertheless, most of these approaches studied heterogeneous groups. West et al. (2005) stated that to remain stationary, the swimmer relies mostly on fast glycolytic muscle fibers increasing the production of lactic acid. This was not verified in a recent study, reinforcing the importance of more studies under this scope. Methods 3 homogeneous groups (variation of Personal Best 100-m Free < 2.5%) of 8 male swimmers (G1: 13.0±0.7y-of-age, 54.5±3.9kg, 164.8±6.8cm; G2: 14.9±0.6y-of-age, 60.7±6.9kg, 172.1±6.6cm; G3: 19.9±1.7y-of-age, 75.6±7.6kg, 180.6±10.4cm) took part in the study. Maximum 30-s front crawl TS assessed maximum (Fmax) and mean force (Fmean). One day after, subjects performed 2 maximal front crawl swims (FS) with an underwater start (100- and 50-m) to obtain swimming velocity (v100 and v50). Blood samples from earlobe were taken after warm-up and at the terminus of the tests allowing the estimation of  $\delta$ [La<sup>-</sup>]. After Shapiro-Wilk normality test, parametric procedures were applied. The statistical significance was set at p<0.05. Results TS variables were higher in G3 than G2, than G1 (Fmax - 316.7±27.3N > 260.7±27.4N > 221.8±19.9N, p<0.05; Fmean - 126.6±10.9N > 102.9±11.3N > 93.9±12.1N, p<0.001). In  $\delta$ [La<sup>-</sup>] higher differences were obtained between TS with 100-m (p<0.0001) than with 50-m FS (p<0.05). Fmax presented a high correlation with v50 in G3 (r=0.87, p<0.001). In G2 relationships were observed between v50 with Fmax (r=0.77, p<0.001) and Fmean (r=0.73, p<0.05). Fmean correlated significantly with v50 (r=0.63, p<0.05) and v100 (r=0.68, p<0.05) for G1.  $\delta$ [La<sup>-</sup>] presented moderate to high (r=0.55-0.86) correlations both with TS values and FS velocities. Discussion As expected upper level swim-

mers presented superior values of force exerted in water, corroborating the validity of the methodology used. In groups alike,  $\delta[La-]$  in TS did not exceed the values of FS, contrasting the statement of West et al. (2005). For the different groups, correlations between force parameters and performance were estimated and differ according to age, force parameter and distance swam. These data could corroborate the idea that TS may be useful to discern between "sprinters" and "distance" swimmers profiles. The associations between  $\delta[La-]$  with force exerted in water and swimming velocities support the idea that the capacity to obtain higher values of force production and swimming velocities, is related with an enhanced production of energy through the glycolytic system. Our data suggest that TS may be useful to monitor and evaluate anaerobic training. References West S, Drummond M, VanNess J., Ciccolella M. (2005). J. Strength Cond. Res, 19(4),772-776.

### VALIDITY OF A REPEATED-SPRINT ABILITY TEST DERIVED FROM MATCH TIME-MOTION ANALYSIS IN YOUNG SOCCER PLAYERS

Jabes, M.1, Chamari, K.2, Wong, D.P.3, Dellal, A.4, Castagna, C.5, Ahmaidi, S.1

1:PJVU (Amiens, France), NCMSS (Tunis, Tunisia), HKIE (Hong Kong), OLSO (Lyon, France), FTBL (Florence, Italy)

Introduction It has been shown in soccer that the repeated sprint ability (RSA) is essential in the physical performance of soccer (Dellal et al. 2010). The literature, however, reports little field researches on the RSA in young soccer players reflecting the absence of a reference standardized protocol to assess their ability to repeat sprints (Girard et al. 2011). Therefore, the aim of this study was to develop and validate an RSA test protocol in young soccer players and examine its reliability in this context. It was hypothesized that an RSA protocol with a logical validity based on match time-motion analysis with seven 15-meter sprints and 25 seconds of active recovery between sprints would be appropriate for the assessment of the ability to repeat sprints in young soccer players. Methods Seventeen Under-15 soccer players participated in the study. All subjects have performed in random order 3 RSA tests: 2 seven 15-meter test with 25 sec of active recovery and a six 40-meter (20-meter/20-meter shuffle) with 20 seconds of passive recovery. Results Measurements of the mean total time, best time and rating of perceived exertion of each test showed high reliability in terms of ICC (RSA mean: 0.93, RSA best: 0.80, and RPE: 0.83), low CV (RSA mean: 1.18, RSA best: 1.97, and RPE: 1.14) and the small effect size for the test/retest of 7x15m RSA testing trials (RSA mean: 0.08, RSA best: 1.17, and RPE: -0.06). Furthermore, the RSA test's construct validity was confirmed by its ability to discriminate between goalkeepers and field players (RSA mean:  $p=0.03$  and RSA best:  $p=0.02$ ). Discussion Reliability results showed that the mean total time, best sprint time and the RPE were highly reliable. The sprint decrement, mean heart rate, and blood lactate measures showed lower reliability. The low reliability of fatigue through RSA dec measurements is probably related to the fact that rather than being measured, fatigue is derived from data that have their own inherent variability. In the present study we focused (for construct validity) on differentiation according to the players' field positions. Indeed, analyses of the mean total time and best time in the present protocol were able to discriminate between field players and goalkeepers which support the construct validity of this RSA protocol in young soccer players. The correlation between the total mean times in the 7x15m and 6x40m tests was moderate and not statistically significant. This lack of correlation may be due to the sprinting distance/time, sprint's form or the difference in the nature of recovery. In conclusion, the RSA test with logical validity developed here has also a construct validity and showed sufficient reliability to assess the repeated-sprint ability in young soccer players. REFERENCES Dellal A, Chamari K, Wong DP, Ahmaidi S, Keller, Carling C (2010) Comparison of physical and technical performance in European professional soccer match-play: The FA Premier League and La LIGA. Eur J Sport Sci ahead to print Girard O, Mendez-Villanueva A, Bishop D (2011) Repeated-sprint ability-part I: factors contributing to fatigue. Sports Med 41(8):673-94

### ONLINE VIDEO-BASED RESISTANCE TRAINING IMPROVES THE PHYSICAL CAPACITY OF JUNIOR BASKETBALL ATHLETES

Klusemann, M.J.1,2,3, Pyne, D.B.2, Fay, T.4, Drinkwater, E.J.3

1:Basketball Australia (Sydney, Australia), 2:Australian Institute of Sport (Canberra, Australia), 3:Charles Sturt University (Bathurst, Australia), 4:University of Jyväskylä (Finland)

Introduction Junior basketball athletes require a well-designed resistance training program to improve their physical development. Lack of expert supervision and resistance training in junior development pathways may be overcome by implementing an online video-based program. The aim of this study was to compare the magnitude of improvement in physical performance, strength and functional movement patterns of junior basketball athletes employing either a fully supervised, or an online video-based resistance training program. Methods Thirty-eight junior basketball athletes (males  $n=17$ ; age  $14\pm 1$ y; height  $1.8\pm 0.1$ m; mass  $67\pm 12$ kg; females  $n=21$ ; age  $15\pm 1$ y; height  $1.7\pm 0.1$ m; mass  $62\pm 8$ kg; mean  $\pm$  SD) were assigned into a supervised resistance training group (SG,  $n=13$ ), video training group (VG,  $n=13$ ) or control group (CG,  $n=12$ ) and participated in a six week controlled experimental trial. Pre- and post-testing included measures of physical performance (20 m sprint, step-in vertical jump, agility, sit and reach, line drill, Yo-Yo intermittent recovery level 1), strength (15 s push up and pull up) and functional movement screening (FMS). Results Training logs revealed 96% compliance from the supervised group and 77% compliance from the video group. Both SG and VG achieved 3-5%  $\pm$  2-4% (mean  $\pm$  90% confidence limits) greater improvements in several physical performance measures (vertical jump height, 20 m sprint and Yo-Yo endurance performance) and a 28  $\pm$  21% greater improvement in push up strength compared to the CG. The SG attained substantially larger gains in FMS scores than both the VG (12  $\pm$  10%) and CG (13  $\pm$  8%). Discussion Both short-term supervised and online video-based resistance training were effective in improving physical performance measures and strength. Supervised training remains the best method of program delivery to achieve maximum compliance, improvements in physical performance and functional movement patterns. In circumstances where supervised training is not available, online video-based training could be used to elicit substantial improvements in physical performance and strength in junior basketball athletes. This form of media-based training is a cost-effective and practical solution to apply resistance training to a large and/or remote athlete group. Sporting bodies could utilise this strategy to educate coaches and athletes on how to implement resistance training exercises into their daily training environment and enhance the short-term physical development of junior athletes.

### EVALUATION OF AN EYE-HAND COORDINATION TEST TO DISCRIMINATE BETWEEN TALENTS AND NON-TALENTS

Faber, I.R., Nijhuis-van der Sanden, M.W.G., Oosterveld, F.G.J.

Saxion University of Applied Science

Introduction Motor tests to assess specific sport skills which are proposed key-predictors for success are often included in talent identification programs (TID) (Régner et al., 1993). A valid test for a TID can discriminate talented from non-talented athletes and predict at least to some extent success. The test should contain tasks which are comparable to, but not exactly the same as the specific sport skills, to

diminish the influence of training-experience on the measurement outcomes. In this study, an eye-hand coordination test was examined on its capacity to discriminate between talented and non-talented athletes from different sports. TID for e.g. racket sports, handball, volleyball or basketball could use such a valid test for eye-hand coordination, because this is considered to be a necessary trait in these sports. Methods In total 231 young talented and non-talented athletes (age 7-14 years) from handball (n=38), tennis (n=28), gymnastics (n=36), soccer (n=49), volleyball (n=37) and table tennis (n=43) were tested. The children were instructed to throw a table tennis ball to a vertical positioned table tennis table with one hand and to catch the ball correctly with the other hand as frequently as possible in 30 s. The best of two attempts was registered as final score. The distance to the table tennis table was 1 m. An unpaired t-test was used to test if the test could discriminate between talented and non-talented athletes for each sport separately. A one-way ANOVA and post-hoc tests (Bonferroni) were used to compare only the talented athletes from all sports. Results The means of the talented athletes (T) was significantly higher ( $p < 0.001$ ) than that of the non-talents (N) for handball ( $T=24(SD4.5)$ ,  $N=16(SD4.8)$ ), tennis ( $T=27(SD5.3)$ ,  $N=3(SD3.5)$ ), soccer ( $T=26(4.7)$ ,  $N=17(SD4.3)$ ), volleyball ( $T=24(SD6.7)$ ,  $N=15(5.4)$ ) and table tennis ( $T=24(SD5.5)$ ,  $N=14(SD5.4)$ ). No significance difference was found for talents and non-talents in gymnastics ( $T=13(SD7.3)$ ,  $N=14(SD6.9)$ ;  $p=0.544$ ). Only the talented gymnasts scored significantly lower than talents from other sports ( $p < 0.001$ ). Discussion The test was able to discriminate between talented and non-talented athletes for handball, tennis, soccer, volleyball and table tennis. Implementation in a test battery for motor skills in a TID for these sports seems legitimate. Further research is desirable to obtain evidence about the predictive value and individual interpretation of test scores. References R gnier G, Salmela JH, and Russell SJ (1993). A Handbook of Research on Sports Psychology; 290-313. New York: Macmillan

### **FAST START STRATEGY INDUCES DIFFERENT INDIVIDUAL RESPONSES IN VELOCITY REGULATION DURING A 10KM RACE.**

Carmo, E.C.1, Gil, S.1, Kobal, R.1, Roschel, H.1, Ugrinowich, C.1, Bertuzzi, R.1, Tricoli, V.1

*University of S o Paulo*

Introduction The pacing regulation has an important impact on running performance. The fast start strategy (FS) has been frequently observed in 10km racing; but if this strategy is advantageous for performance is still controversial. Pacing regulation occurs with the purpose of protecting the body from harmful changes in homeostasis and a FS may induce premature fatigue subsequently hampering runner's performance. It seems that the RPE may be an efficient way to monitor pacing regulation (Abiss and Laursen, 2008). Thus, the aim of this study was to verify the regulation of pacing strategy and the associated RPE when a FS was applied. Methods Fifteen runners participated in two simulated 10km races. Running velocity (GPS Polar, RS800CX, Finland) and RPE (Borg 6-20) were measured every 400m. The pacing strategy was evaluated by the velocity-distance curve. The first race was a free pacing (FP) running (runners were instructed to complete the race as fast as possible) and in the 2nd race a FS was applied (runners performed the 1st km 6% faster than the FP). Results There was no difference in 10 km performance between strategies ( $45.0 \pm 4.1$  vs  $45.2 \pm 4.8$  min). In the FP running the first 400m were faster than rest of the race ( $p < 0.001$ ). In the FS velocity was higher in initial 1000m ( $p < 0.001$ ). Afterwards there was no difference in velocity between groups. The FS presented a higher RPE in the first 1600m when compared to FP ( $10.5 \pm 1.8$  vs  $12.3 \pm 1.8$ ,  $p < 0.04$ ). Seven runners improved performance in 2.4% using FS ( $43.9 \pm 2.9$  vs  $42.9 \pm 2.4$ ,  $p < 0.01$ ) while the other eight showed a 3.2% decrement ( $46.2 \pm 5.2$  vs  $47.8 \pm 5.6$ ,  $p < 0.001$ ). Discussion We found that the regulation of the pacing strategy was not affected by the use of FS. There was no difference in performance between FP and FS. However, dividing the subjects into positive (PR) and negative responsive (NR) we observed that the PR group ran faster than the NR group during the FS race. Interestingly, the 10km RPE was similar between groups. During running the momentary RPE is compared to the runners' expected RPE which is affected by their previous experience and the remaining running distance (Tucker, 2009). Thus, it seems that individual differences in pacing regulation cannot be monitored by the RPE. References Abiss C, Laursen PB (2008). Sports Med, 38 (3). Tucker R (2009). Br J Sports Med, 43.

### **DIFFERENT CONTROL STRATEGIES IN THE TIMING OF RAPID INTERCEPTION TASK IN WHICH MULTIPLE TIME-TO-CONTACT IS ANTICIPATED**

Ijiri, T., Shinya, M., Nakazawa, K.

*The University of Tokyo*

Introduction In a rapid interception task such as hitting in baseball, ideal time to contact is not necessarily anticipated (e.g. actual ball speeds of a pitcher are not always the same but highly variable in baseball). It may be important for good performance to be able to adjust interception timing accurately in the conditions that multiple ball speeds are anticipated. Interception timing is conceived to be controlled by changing swing onset and/or swing duration. The purpose of this study was to investigate whether interception strategies are different between single-speed conditions and multiple-speed conditions. Methods Twenty-six young males participated in the study. The participants were asked to intercept a moving virtual ball on a computer screen with a virtual arm controlled by real movement of their left elbow joint. There were three different ball speeds for which ideal times to contact were 410 (F: fast), 540 (M: medium) or 670 ms (S: slow). The experiment consisted of single-speed conditions (S, M and F) and two paired-speed conditions (SM and MF) in which ball speed varied between trials. In single-speed conditions, we calculated Pearson product moment correlation coefficient within each participant between swing onset and constant timing error. In paired-speed conditions we calculated the difference in swing onset between the faster and slower ball speeds. Results In single-speed conditions there were significant correlations between swing onset and constant timing error (S:  $r = 0.81 \pm 0.21$ , M:  $r = 0.86 \pm 0.11$ , F:  $r = 0.85 \pm 0.22$ ). In two paired-speed conditions, the distribution of the difference was bimodal especially in SM (-22.1-41.4, 76.4-111.1 ms), so we divided participants into two subgroups. Then, we calculated absolute timing error as an index of performance. The absolute timing error were smaller in the group which had larger difference in swing onset (SM:  $59.4 \pm 4.2$  vs  $75.9 \pm 6.1$ , MF:  $65.6 \pm 7.2$  vs  $82.4 \pm 14.4$  ms), suggesting that those who controlled interception timing mainly by changing swing onset outperformed those by changing swing duration. Discussion In single-speed conditions almost all participants used the same strategy changing swing onsets. On the other hand, in paired-speed conditions interception strategies were divided into two types between which the temporal accuracy was different. This result suggests that some factors such as ability to detect the difference in ball speeds earlier play an important role in the choice of the control strategies and the performance of the rapid interception task. Our future study will investigate the factors of highly skilled baseball players.



## SOMATOTYPE AND BODY COMPOSITION OF UNDER-19 WOMEN BRAZILIAN BEACH VOLLEYBALL PLAYERS IN RELATION TO PLAYING FUNCTION

Araripe Medeiros, A.

*Universidade do Porto - Faculdade de Desporto*

Somatotype and body composition of under-19 women Brazilian Beach Volleyball players in relation to playing function Medeiros, A.1; Lopes, R.2; Silva, F. T.2; Mesquita, I.1; Afonso, J.1; Palao J.M.3 1: University of Porto – Faculty of Sport - Portugal 2: Integrated Faculty of Ceara - Brazil 3: University of Murcia – Faculty of Sport Science - Spain Introduction The athletes' anthropometric and physical characteristics may be a determining factor for success in any sport (GUALDI-RUSSO e ZACCAGNI, 2001). However, so far most studies available in specialized literature concerning beach volleyball have focused in adult categories. Therefore, the purpose of this study was to compare body composition and somatotype of under-19 women beach volleyball players according to their playing function (blocker versus defender). Methods Twenty-two under-19 women Brazilian beach volleyball players were analyzed. Ten were blockers (aged 17.4±0.7 years) and twelve were defenders (aged 17.2±0.6 years). The players were compared according to their playing position, contrasting the blocker and defender specialists. Measures included height, obtained by a stadiometer (Sanny) with an accuracy of 0.1cm, and body mass, recorded by a portable scale (G-TECH), accurate to 100g. Percentage body fat was assessed using skinfold measures of seven sites applying Cescorf skinfold callipers and the Mcardle et al. (1998) skinfold equation. Somatotypes were calculated using the Heath-Carter method (CARTER e HEATH, 1990). Descriptive statistics were calculated and Mann-Whitney test was used to determine differences between groups (blockers and defenders). SPSS version 19.0 was used for all analyses. Results Blockers were significantly taller (1.73±3.9 m versus 1.65±4.5 m) and heavier (63.1±7.6 kg versus 58.4±7.5 kg) than defenders ( $p \leq 0.05$ ). As for body composition, no significant differences were found between blockers (20.0±3.6 %) and defenders (19.1±2.8 %). Blockers and defenders were classified according to somatotype as being mesomorph-endomorph (4.8-5.7-3.3 and 4.9-5.8-2.3 respectively). Blockers were significantly more ectomorph than defenders (3.3 and 2.6 respectively). Conclusion Blockers were significantly taller and heavier than the defenders. Blockers and defenders tend to be endomorph-mesomorph. These results indicate that anthropometric characteristics may be an important tool in the process of talent selection. References CARTER, J.; HEATH, H. Somatotyping: development and applications. Cambridge: Cambridge University Press, 1990. GUALDI-RUSSO, E.; ZACCAGNI, L. Somatotype, role and performance in elite volleyball players. The Journal of Sports Medicine and Physical Fitness [S.l.], v. 41, n. 2, p. 256-262, 2001. MCARDLE, W. D.; KATCH, F.; KATCH, V. Exercise physiology: Energy, Nutrition and Human Performance Rio de Janeiro: Guanabara Koogan, 1998.

## HEART RATE, BLOOD LACTATE AND PERCEIVED EXERTION IN SYNCHRONIZED SWIMMING ROUTINES DURING COMPETITION

Rodríguez Zamora, L.1, Iglesias, X.1, Barrero, A.1, Chaverri, D.1, Erola, P.2, Rodríguez, F.A.1

*1: INEFC-Barcelona Sport Sciences Research Group, University of Barcelona (Barcelona, Spain), 2: DEIM, Universitat Rovira i Virgili (Tarragona, Spain)*

Introduction In modern synchronized swimming (SS) athletes need to combine sets of technically, physically, and esthetically very demanding exercises, lasting about 2 to 5 minutes, both breathing freely and holding breath (BH) for almost 50% of the time (Homma, 1994). In each program, swimmers competing above junior level must perform both a technical and a free routine. This study aims to describe selected physiological responses during an official competition. Methods 34 high-level senior (21.4 ± 3.6) and junior (15.9 ± 1.0 years) synchronized swimmers were monitored while performing a total of 96 routines during an official national championship in the technical solo (TS), free solo (FS), technical duet (TD), free duet (FD), technical team (TT), and free team (FT) programs. Heart rate (HR) was continuously monitored. Peak blood lactate (Lapeak) was obtained from serial capillary samples during recovery (minutes 3, 5, 7, and 10). Post-exercise rate of perceived exertion (RPE) was assessed using the CR10 Borg's scale. Total competition scores (TCS) were obtained from official records. Mixed model MANOVA and Bonferroni post-hoc tests were used for comparisons. Results Senior swimmers attained higher TCS than juniors (87.0 ± 4.7 vs. 79.1 ± 3.4 points). Pre-exercise mean HR (beats•min<sup>-1</sup>) was 129.1 ± 13.2, and quickly increased during the exercise to attain mean peak values of 192.0 ± 8.6, with frequent interspersed bradycardic events down to 88.8 ± 28.3. Lapeak (mmol•L<sup>-1</sup>) was highest in the FS (8.5 ± 2.1) and FD (7.6 ± 1.8) and lowest in the FT routines (6.2 ± 1.9). Mean RPE (0-10+) was higher in the junior (7.8 ± 0.9) than in the senior group (7.1 ± 1.4). Discussion Cardiovascular demands of competitive routines are remarkably high and are characterized by intense anticipatory HR pre-activation and rapidly developing exercise tachycardia, with interspersed periods of marked bradycardia during the exercise bouts performed at apnea. Autonomic neural cardiovascular response to BH and face immersion (i.e. bradycardia) was powerful enough to counteract exercise tachycardia during the apneic phases of intense exercise (Andersson et al., 2002). Moderate Lapeak suggests a minor role of the glycolytic anaerobic metabolism. Competitive routines are perceived as very to extremely intense, particularly in the FS and FD, and less so in the technical and team programs. The role of BH and diving during very intense dynamic exercise needs to be further investigated. References Homma M. (1994). Med Sport Sci 39, 149-154. Andersson J.P, Lin r Mats H, Elisabeth R, Schagatay E (2002). J. Appl. Physiol, 93(3), 882-886.

## A LONGITUDINAL ANALYSIS OF GROWTH AND PERFORMANCE IN SELECTED AND NON-SELECTED YOUTH RUGBY LEAGUE PLAYERS

Waldron, M., Worsfold, P., Twist, C., Lamb, K.

*University of Chester*

Introduction Talent in team sport is often identified using longitudinal assessments of players' functional performances and anthropometric variables during adolescence. As little data exist in the sport of rugby league, there is scope to examine the factors that characterise higher ability, thus discriminating between selected and non-selected players at the youth level. Therefore, the purpose of the current study was to: (i) monitor the changes in anthropometric and performance measures in selected players over a three-season period, and (ii) identify the factors that differentiate between selected and non-selected players. Method Following ethical approval, 28 under-15, -16 and -17 year-old elite youth rugby league players were assessed over three seasons of competition. The players, who were either coach-selected or coach-non-selected at the end of each season, were annually tested for aerobic capacity, jump height, 10-30 m sprinting (velocity, acceleration, force and power) and anthropometric variables. Nine of the original sample were retained and played for the club at each age group. Results A step-wise discriminant function analysis identified the selected players by 30 m sprinting force at under-15 ( $P=0.001$ ) and squat jump height at under-16 ( $P=0.009$ ). No factors characterised the selected players at under-17. Analysis of variance identified developments ( $P < 0.05$ ) in 10 m speed ( $\Delta=6.3\%$ ), 10 m ( $\Delta=13.9\%$ ) and 30 m force ( $\Delta=10.8\%$ ), 10 m ( $\Delta=19.9\%$ ) and 30 m power

( $\Delta=14.5\%$ ), and concomitant changes in maturity ( $\Delta=32\%$  and  $\Delta=25\%$ ) and stature ( $\Delta=0.36\%$  and  $\Delta=0.12\%$ ) between the under-15 and under-16 seasons. Improvements ( $\Delta=8.2\%$ ) in predicted VO<sub>2</sub>max between the under-16 and under-17 seasons were also evident alongside developments in quadriceps muscle cross-sectional area ( $\Delta=16.3\%$ ) and lean mass ( $\Delta=3.2\%$ ). Discussion The results show the relative importance of force generation and explosive movements, such as vertical jumping, in identifying players of higher ability in the under 15 and 16 age groups which become less discriminative at the under 17 group. The results also show expected developments in physical size and aspects of performance in the under 15s to 16s group, which become limited to muscular growth at later stages. Practitioners should use the current results as a guide for developmental norms and consider the measurement of such performance characteristics to contribute to the identification of higher ability players, which will vary according to the age group. Given the disparity between players of the under 17 age group and adult populations, future research should evaluate the rate of development in growth and performance at more advanced age groups.

**13:45 - 14:45**

## Poster presentations

### PP-SH01 Psychology 1

#### **A LONGITUDINAL INVESTIGATION OF COACH PSYCHOLOGICAL HEALTH AND INTERPERSONAL BEHAVIOUR: THE MODERATING EFFECTS OF GENDER AND SPORT TYPE.**

Stebbings, J., Taylor, I.M., Spray, C.M.

*Loughborough University*

A longitudinal investigation of coach psychological health and interpersonal behaviour: The moderating effects of gender and sport type. Introduction. Within a self-determination theory (Deci & Ryan, 2000) framework, the effects of coaches' interpersonal behaviours on various athlete outcomes (e.g., need satisfaction, motivation, well-being) are well researched (Amorose, 2007). The antecedents of such behaviours, however, have scarcely been examined. In a cross-sectional study, Stebbings, Taylor and Spray (2011) demonstrated that coaches' psychological well-being was positively associated with autonomy supportive behaviours, and negatively associated with controlling behaviours. The current study expanded this line of inquiry by longitudinally exploring these relationships and exploring ill-being as an additional predictor of interpersonal behaviour. In addition, we aimed to assess the moderating effects of gender and sport type (individual versus team sports). Method. At three time points across an 11-month period, 195 coaches (79% male) from a variety of sports completed measures of positive and negative affect, and autonomy supportive and controlling interpersonal styles. Results. Multi-level modelling demonstrated a significant positive relationship between coaches' positive affect and autonomy supportive behaviours, and this relationship was stronger for females ( $b = .73$ ,  $p < .001$ ), compared to males ( $b = .43$ ,  $p < .001$ ). The significant positive relationship between coaches' negative affect and their controlling behaviours was stronger for males (males,  $b = .47$ ; females,  $b = .25$ ;  $p < .001$ ) and coaches of team sports (individual,  $b = .28$ , team,  $b = .54$ ;  $p < .001$ ). Discussion. The results extend previous research by discriminating between psychological well-being (positive affect) and ill-being (negative affect) in the prediction of coach autonomy supportive and controlling behaviours. The results also highlight the value of assessing the differences in these relationships across various demographic variables. In particular, females may be more prone to an autonomy supportive style when experiencing positive affect, whereas males and team sport coaches may be more likely to exhibit controlling behaviours when experiencing negative affect. Overall this study highlights the importance of coaching contexts that facilitate coaches' well-being, thereby increasing the likelihood of adaptive coaching styles. A particular focus on reducing negative affect in male and team sport coaches may be warranted to diminish maladaptive coach interpersonal behaviours towards athletes. References. Amorose, A.J. (2007). In M. Hagger & N. Chatzisarantis (Eds.), *Intrinsic motivation and self-determination in exercise and sport* (pp. 209-226). Champaign, IL: Human Kinetics. Deci, E.L. & Ryan, R.M. (2000). Psychological Inquiry, 11, 227-268. Stebbings, J., Taylor, I.M., & Spray, C.M. (2011). *Journal of Sport & Exercise Psychology*, 33, 255-272.

#### **DIFFERENCES IN THE COACH-CREATED PSYCHOLOGICAL ENVIRONMENT ACROSS TRAINING AND COMPETITION IN YOUTH SPORT**

Smith, N., Quested, E., Appleton, P., Duda, J.

*University of Birmingham (UK)*

Introduction According to achievement goal theory (AGT; Nicholls, 1989) and self-determination theory (SDT; Deci and Ryan, 2000), the psychological environment created by a coach can impact upon the quality of an athlete's motivation and experience in sport. When the environment is more task-involving, relatedness supportive and autonomy supportive and less ego-involving, relatedness thwarting and controlling, adaptive outcomes are expected to follow. However, past work suggests that under pressure situations, leaders are more likely to adopt an interpersonal style higher in ego-involving and controlling characteristics (Mageau and Vallerand, 2003). Extending previous research, this study used an observational methodology (which captured aspects of the environment emphasised in AGT and SDT) to examine whether there were any differences in the objective psychological environment created by coaches across competitive contexts (i.e., training and matches). Method Participants were 22 grassroots football coaches (21 males and 1 female). Coaches were filmed during a training session and match during the first 8 weeks of the season. Trained coders independently rated filmed footage in continuous 5-minute intervals, in terms of the extent to which the coach's interpersonal style was autonomy supportive, controlling, task- and ego-involving, and relatedness supportive and thwarting. Results Preliminary analyses suggest that during training, coaches adopt an interpersonal style that is significantly more autonomy supportive ( $M = 1.07$ ,  $SD = 0.66$ ) than controlling ( $M = 0.40$ ,  $SD = 0.37$ ),  $t(9) = 2.34$ ,  $p = .044$ , and significantly more task-involving ( $M = 1.22$ ,  $SD = 0.65$ ) than ego-involving ( $M = 0.39$ ,  $SD = 0.44$ ),  $t(9) = 3.78$ ,  $p = .004$ . Coach-emphasised autonomy support is significantly lower in matches ( $M = 0.32$ ,  $SD = 0.23$ ) than in training ( $M = 1.20$ ,  $SD = 0.69$ ),  $t(6) = 2.94$ ,  $p = .026$ . There was a trend for controlling strategies to be emphasised more during matches ( $M = 1.31$ ,  $SD = 0.70$ ) than in training ( $M = 0.48$ ,  $SD = 0.038$ ),  $t(6) = 2.33$ ,  $p = .058$ . Discussion These findings suggest that competition may lead coaches to withdraw their support for autonomy, and adopt a more controlling and coercive interpersonal style. This holds negative implications for athlete motivation and has been shown to lead to more maladaptive psychosocial outcomes. To ensure children are getting the most out of sport and

developing optimally, coaches should be educated to create adaptive psychological environments in training sessions and in matches. References Deci EL, Ryan RM. (2000). *Psych Inquiry*, 11(4), 227-268. Mageau GA, Vallerand RJ. (2003). *J of Sports Sciences*, 21(11), 883-904. Nicholls JG. (1989). *The competitive ethos and democratic education*. Harvard University Press, Cambridge.

### THE EFFECT OF SUPPORT TYPE AND SUPPORT VISIBILITY ON PERFORMANCE IN A FOOTBALL AIMING TASK: EVIDENCE FROM TWO EXPERIMENTAL STUDIES

Moll, T., Rees, T., Freeman, P.

*University of Exeter*

**Introduction** Prior to matches, football players often receive final words of encouragement and/or advice from coaches or fellow players. Though this is presumed to help, the effects of provided support are frequently mixed (Uchino, 2009). Providing support might alleviate distress and enhance problem-solving but may also come across as pressuring and threaten a recipient's sense of efficacy and autonomy (Bolger & Amarel, 2007). Recent research suggests that both the type of support (e.g., esteem or informational) and the way support is delivered (visibly or invisibly) may influence the effectiveness of support (Bolger & Amarel, 2007). We explore the effect of support type and support visibility in a performance setting. **Method** In two experiments (study one,  $n = 68$ , study two,  $n = 84$ ), we examined the effects of support type and support visibility on a football aiming task. Type of support was manipulated by changing the content (esteem or informational support) of the supportive message. Visibility was manipulated by addressing the support directly (visible) to the participant or indirectly by addressing the support to one of the experimenters (invisible). Experienced football players were randomly assigned to one of four support conditions: informational-visible, informational-invisible, esteem-visible, and esteem-invisible support. The players were told that an expert in penalty taking would be watching the task. In reality, this expert was a confederate scripted to provide one of the four support manipulations. Following the support manipulation, the players performed ten kicks towards a target. Performance was assessed as the average distance from the target. **Results** Two-way ANOVAs revealed a significant main effect for type of support on kicking performance (Study 1,  $F(3,64) = 12.72, p < .01$ ; Study 2,  $F(3,80) = 7.48, p < .01$ ). There were no significant main effects for support visibility and no interaction effects ( $p > .05$ ). **Discussion** The results suggest that, regardless of support visibility, participants in the informational support conditions outperformed those in the esteem support conditions. That is, giving advice (in a visible or invisible manner) prior to a kicking task appears to be more effective than giving encouragement. It may be that in a sports environment athletes are used to receiving (and expect to receive) advice from coaches. Furthermore, the quality of the informational advice ('Focus on the target') may have aided performance and not come across as pressuring or threatening; conversely, the esteem encouragement ('I'm sure you can do well') may have led to pressure and poorer performance. Bolger, N, Amarel, D (2007). *J Pers Soc Psy*, 92, 458-475 Uchino, BN (2009). *Pers in Psy Sci Psy*, 4, 236-255

### SOCIAL-PSYCHOLOGICAL DETERMINANTS OF PERFORMER'S IMMUNE RESPONSES: A SELF-DETERMINATION THEORY APPROACH

Quested, E.I, Bosch, J.A.2, Burns, V.E.1, Cumming, J.1, Duda, J.L.1

1. *University of Birmingham, UK*; 2. *University of Amsterdam, The Netherlands*

**Introduction** Research grounded in self-determination theory (SDT; Deci & Ryan, 2000) has implicated basic need satisfaction as a determinant of dancers' hormonal stress responses during performance (Quested et al, 2011). The current study extends this focus to include motivation-related determinants of immune function. The immune factor salivary S-IgA is a reliable predictor of susceptibility to upper respiratory tract infections (Gleeson, 2000) and is amenable to psychological influence (Bosch et al, 2002). To have a better understanding of the determinants of health, this study will also consider the social environment as a predictor of need satisfaction, as well as vocational dancer's reasons for engaging in dance (i.e., their motivation regulations), as determinants of S-IgA in anticipation of an important performance. **Method** One month prior to a ballet solo performance, 51 dancers (18 male, 1 unreported; M age = 19.00 SD = 1.93 yrs) completed questionnaires measuring their perceptions of autonomy support provision, need satisfaction, and motivation regulations for dance, in terms of their "typical" experiences in school. 60 or 15 minutes prior to the solo, saliva samples were collected using salivettes. Path analyses tested the fit of the data to the hypothesized model: 'Autonomy support-need satisfaction-motivation regulations- S-IgA'. **Results** The path model (controlling for S-IgA sampling time) showed a good fit to the data ( $\chi^2(6) = 8.50, CFI = .96, RMSEA = .09$ ). Perceived autonomy support positively predicted dancers' need satisfaction ( $\beta = .75, p = < .001$ ). Need satisfaction predicted the degree to which dance motivation was self-determined ( $\beta = .50, p = < .001$ ), which in turn predicted levels of S-IgA ( $\beta = .31, p = < .05$ ). Need satisfaction mediated the relationship between perceived autonomy support and self-determined motivation. **Discussion** Findings support the application of SDT as a framework to examine social-psychological predictors of immune function. Dancers with less self-determined (more controlled) motivation for training have alterations in immune function that may increase risk of infections. Present results suggest that autonomy supportive teaching may facilitate performers' need satisfaction and resulting self-determined motivation which in turn may have downstream effects on physical health. References Bosch JA, Ring C, de Geus EJ, Veerman EC, Amerongen AV. (2002) *Int Rev Neurobiol*, 52:213-53. Deci, EL., & Ryan, RM. (2000). *Psych Inquiry*, 11(4), 227-268. Gleeson, M. (2000). *Int J Sport Med*, 21, S33-S43. Quested, E, Bosch, JA, Burns, VE, Cumming, J, Ntoumanis, N, & Duda, JL. (2011). *J Sport Ex Psych*, 33, 828-846.

### COACHES HEALTH PROMOTION PERCEPTIONS IN SPORT CLUBS: WHAT IS DONE, WHAT IS EXPECTED AND DOES IT IMPACT THEIR MOTIVATION FOR COACHING?

Van Hoya, A., Heuze, J.P., Sarrazin, P.

*Université Joseph Fourier*

Sports clubs could be recognized as health promoting organization, regarding the psychological, social and physical benefits of physical activity practices. As the Ottawa Charter (1986) has proposed a shift from individual health behavior to institutional development of health promotion (HP), sports clubs can influence healthy behaviors, as the « Setting in Health Promotion » Model has shown in schools, hospitals and cities (Whitelaw, Baxendale, Bryce, Machardy, Young, & Witney, 2001). Grounded on this model, Kokko et al. (2009) developed the Health Promotion in Sport Clubs scale (HPSC) to assess 4 dimensions: policy, practices, environment and ideology. In a sample of Finnish sport clubs, respective score of 56%, 42%, 64% and 80% were found. This study extends this line of research, by (1) measuring both coaches' perceptions (i.e., what is made in my club) and expectations (i.e., what my club should make) of the HP in their club, and (2) examining the links between these perceptions and their motivation for coaching. Based on the self-determination theory (Deci & Ryan, 2002), we presumed that the more the coach perceived HP in his club, the more his motivation would be self-determined because his

psychological needs are more satisfied. 125 French coaches have completed a questionnaire containing an adapted version of the HPSC and a scale assessing their motivation to coach. Results showed that in comparison to hospital (Lin & Lin, 2010) scores were lower, specifically for policies (75% vs. 36%) and practices (72% vs. 32%). Moreover, ideology scored higher (0.80 for perceptions and 0.91 for expectations), before environment (0.76 and 0.87), policy (0.36 and 0.66), practices (0.32 and 0.63) and partnership (0.20 and 0.50). Coaches' perceptions were lower than their expectations, the mean differences were 0.31, 0.30, 0.30, 0.11, 0.11 ( $t_s < .01$ ), for practices, policy, partnerships, ideology and environment respectively. In other words, coaches of this sample consider there is a need for HP improvement in their club. Finally, confirming our hypothesis, HPSC score was related to self-determined motivation ( $r = .30$ ,  $p < .01$ ), and with policies, practices and environment ( $r_s = .32$ ,  $.23$ ,  $.22$ ,  $p_s < .01$ , respectively). There is a need for development to understand the discrepancies between coaches' representations and expectations. Deci, E. L. & Ryan, R. M. (2002). *The Handbook of Self-Determination research*. Rochester, NY: University of Rochester Press. Kokko, S., Kannas, L., & Villberg, J. (2009). *Health Prom Int*, 24, 26-35. Lin, Y.-W. & Lin, Y.-Y. (2010). *Health Prom Int*, 26, 362-374. Whitelaw, S., Baxendale, A., Bryce, C., Machardy, L., Young, I., & Witney, E. (2001). *Health Prom Int*, 16, 339-351.

## **TRANSFORMATIONAL LEADERSHIP AND LEADER INSPIRED EXTRA EFFORT: THE MEDIATING ROLE OF COACH AND ATHLETE RELATIONSHIP IN FOOTBALL PLAYERS**

Gorgulu, R.

*Hacettepe University*

**Introduction** In early stage, transformational leadership researchers have begun to examine the mechanisms by which transformational leadership exerts its impact on followers (Charbonneau et al., 2001). Recent years, it has emphasized that the type of leadership behaviours displayed by the coach play an important role in successful sporting performance (e.g., Gould, Greenleaf, Chung, & Guinan, 2002). However, there is no research that has been conducted within sporting domain to discern any mediational role between the transformational leadership and athletic effort at the current time. Therefore, the purpose of the present study was to examine the relationship between transformational leadership and leader inspired extra effort and the potential mediating role of the coach-athlete relationship in football players. **Methods** The participants were 124 male professional football players from the UK (mean age = 22.9,  $SD = 5.0$  years) completed the Differentiated Transformational Leadership Inventory (DTLI; Callow et al., 2009) the Coach and athlete Relationship Questionnaire (CART-Q; Jowett & Ntoumanis, 2004) and indices of follower effort. Results Most of the alpha coefficients for the transformational leadership sub-components ranged from .70 to .91 and were deemed to be internally reliable based on criterion of .70 set for the psychological domain (Raykow & Marcoulides, 2010). Overall the findings show that regression analysis failed to support mediation for any of the relationships examined except the direct effects between transformational leadership and leader inspired extra effort ( $\beta = .550^{**}$ ,  $SE = .131$ ,  $p < 0.01$ ). **Discussion** In conclusion, the results demonstrated that transformational leadership was positively associated with leader-inspired extra effort in a sport context and support the calls from Arthur et al., (2011). Based on this, it is essential that coaches may want to consider that the full extent of transformational behaviours has an impact on the athletic performance. However, effectiveness of transformational leader behaviours was not mediated by the coach and athlete relationship in the current study. Due to lack of research of the transformational leadership in sport, future research should seek to investigate underlying explanatory process of this relationship. **References** 1. Arthur, C.A., Woodman, T., Ong W. C., Hardy, L., & Ntoumanis, N., (2011). *Journal of Sport & Exercise Psychology*, 33, 3-19, Human Kinetics. 2. Callow, N., Smith, M., Hardy, L., Arthur, C.A., & Hardy, J. (2009). *Journal of Applied Sport Psychology*, 21, 395-412. 3. Charbonneau, D., Barling, J., & Kelloway, K. E. (2001). *Journal of Applied Social Psychology*, 31, 1521-1534. 4. Gould, D., Greenleaf, C., Chung, Y., & Guinan, D. (2002). *Research Quarterly for Exercise & Sport*, 73, 175-186. 5. Jowett, S., & Ntoumanis, N. (2004). *Scandinavian Journal of Medicine & Science in Sports*, 14, 245-257. 6. Raykow, T., & Marcoulides, G. A. (2010). *Introduction to Psychometric Theory*, New York: Routledge.

## **TO LEAD OR NOT TO LEAD? IDENTIFYING ATHLETE LEADERSHIP ROLES IN SPORT TEAMS.**

Fransen, K., Vanbeselaere, N., Vande Broek, G., De Cuyper, B., Boen, F.

*KU Leuven (University of Leuven)*

**Introduction** Research in sport leadership has mainly focused on the leadership of the coach. However, players within the team can also occupy leadership roles and become crucial for an optimal team functioning. The few studies that did examine the different roles of athlete leaders have distinguished between three leadership roles; task leader, social leader, and external leader (Loughead, Hardy, & Eys, 2006). However, these athlete leadership roles and their characteristics have not yet been thoroughly elaborated. Further investigation in this emerging area is needed considering the possible overlap between the different leadership roles as well as their relative influence on team outcomes. **Aims** In this study, we want to extend the current research knowledge on two points. First, we want to extend the previous categorization of leadership roles by exploring the existence of an additional leadership role, namely the motivational leader on the field. In our opinion, consideration of this motivational role can enhance our understanding of the complex nature of athlete leadership. In this study, the occurrence of the four athlete leadership roles within sport teams will be tested. We predict that the team captain overlaps with the social leader at the recreational level, but with the task leader at the highest performance level. In addition, we assume that the influence of the team captain is overrated and that other players within the team will occupy equally important leadership roles. Second, we will examine athlete leadership in a broader framework. In analogy with models of coach leadership, we will evaluate the qualities of the four leader roles on three domains: (a) personal characteristics (e.g. experience, competence), (b) behaviours (e.g. communicating, encouraging) and (c) athlete outcomes (e.g. collective efficacy). In particular, we expect that the motivational leader has the strongest influence on the collective efficacy beliefs of his/her teammates. **Method** The database of the Flemish Trainer School's (VTS) was used to contact 4500 qualified coaches of all the different team sports in Flanders (Belgium). These coaches were also asked to motivate their players to participate by referring them to the player-specific on-line version of the questionnaire. Data collection will be finished by March 2012, after which the data will be analyzed by correlational and regression analyses. **Discussion** Good athlete leaders are crucial for an optimal team functioning. Knowledge about athlete leaders' characteristics and the different roles that they occupy can be used to identify and guide athlete leaders in a sport team. **References** Loughead, T. M., Hardy, J., & Eys, M. A. (2006). The nature of athlete leadership. *Journal of Sport Behavior*, 29, 142-158.

### OPERATIONAL DECISION MAKING IN SPORTS: WHAT DETERMINES WHETHER A VOLLEYBALL PLAYER GOES FOR A SET OR A DIG?

Ntoloopoulou, M., Bootsma, R.J.

*ISM-AMU (Marseille, France)*

**Introduction** Often a particular situation offers multiple operational possibilities. For instance, a volleyball player may choose to play a ball using a set or a dig technique. In this research project we seek to identify the constraints harnessing the operational choices made by expert players. To this end, we confront them with a range of situations in order to determine to what extent the choices made are systematically related to the situations encountered, as is predicted by an affordance-based account of behaviour (Fajen, Riley, & Turvey, 2008). After having identified the particular constraints (e.g., time available, distance to covered) that separate the solutions adopted, we examine the relations between the visual information used to guide the movement toward the point of interception (Michaels & Oudejans, 1992) and the players' action capabilities in order to pinpoint the informational support for operational decisions making. **Method** Tested separately, six top-level French volleyball players attempted to play machine-launched balls into a circular goal positioned at the passer's position near the net. Each trial had the player start from one of 5 different initial positions (between 2 and 8 m from the net) and play one of 4 different balls trajectories (varying in landing position for a constant flight time of 1.9 s). Each player performed 80 trials (5 initial positions x 4 ball trajectories x 4 repetitions). For each trial, the action mode chosen (set or dig) was recorded. When a given ball trajectory gave rise to a change in action mode as a function of the player's initial position, motion of the ball and player was analysed from video recordings using the SIMI motion system operating at 25Hz. Data processing is currently underway. **References** Fajen, B. R., Riley, M. A., & Truvey, M. T. (2008). Information, affordances, and the control of action in sport. *International Journal of Sport Psychology*, 40, 79-107. Michaels, C. F. & Oudejans, R. R. D. (1992). The optics and actions of catching fly balls: Zeroing out optical acceleration. *Ecological Psychology*, 4, 199-222.

### STRATEGIES FOR DEFENDING DRIBBLER: DEFENDER AND DRIBBLER INTERACTION DURING A 1-ON-1 BASKETBALL SITUATION

Fujii, K.1,2, Yamashita, D.1,2, Yoshioka, S.3, Kouzaki, M.1

*1. Kyoto University (Kyoto, Japan), 2. Japan Society for the Promotion of Science (Japan), 3. Ritsumeikan University, (Shiga, Japan).*

**Introduction** Defenders in 1-on-1 basketball situation anticipate the dribbler's motion and react to stop the advance. In recent years, researchers have focused on the anticipation in replicated ball game situations by using video clips; however, two problems have been revealed with regard to defending the dribbler: (1) the dribbler's decision making and (2) the defender's skilled reaction movement. In the former case, both dribbler and defender should be captured in a real time 1-on-1 situation, instead of on video. In the latter case, split step (Uzu et al., 2009), a preliminary action in which both feet are unweighted, can be one of the skillful reaction movements. The purpose of this study was to reveal how a defender can defend a dribbler in a 1-on-1 basketball situation. **Methods** Six basketball players participated in this study as 12 dyads of dribblers and defenders. They played a real-time 1-on-1 game according to the rules of basketball. Three dimensional coordinates of the markers attached on bony landmarks of each player were obtained with a motion capture system. We then calculated for argument as order parameter by using their centre of mass (CoM) medio-lateral displacement, which represents the state of the dyad system, and categorised successful attack trials and effective defence trials. After the categorization, both the dribbler's and the defender's peak velocities, time to peak velocities and launch time were obtained by using their CoM medio-lateral velocity and acceleration data. **Results & Discussion** The differences in launch time and peak velocity between the dribbler and the defender for the effective defence trials were smaller than that for the successful attack trials. This means that both anticipation and reaction skill are important to effectively defend the dribbler. Additional categorisation of effective defence trials reinforced this idea. After the additional categorisation on the basis of the launch time and peak velocity, we found 'good anticipation' trials, 'split step (good reaction)' trials and 'dribbler's stop' trials. The results suggest that there were three defending strategies and that one strategy would be insufficient, because the defender's skilled reaction movement and the dribbler's decision making should be taken into account. In real basketball situations, even if the defender's anticipation fails, doing a split step may make it possible to defend the dribbler. The dribbler may also stop for many reasons, such as bad ball handling or failure in the dribbler's decision making. **Reference** Uzu, R., Shinya, M., & Oda, S. (2009). *J Sports Sci*, 27(12), 1233-1240.

### EFFECT OF TASK DURATION ON SUSTAINED ATTENTION, AN ELECTROPHYSIOLOGICAL STUDY

Fontenelle, V.1, Knaepen, K.1, Fernandez, H.1,2, Pattyn, N.1,2, Nagels, G.1,3, Meeusen, R.1

*1. VUB (Brussels - Belgium) 2. Royal Military Academy (Brussels - Belgium) 3. NMSC (Melsbroek - Belgium)*

**Introduction** Impairments of sustained attention (or vigilance) may have dramatic consequences in our daily life. Little is known about the mechanisms underlying vigilance decrement. Vigilance impairment due to task duration is commonly described as a result of mental fatigue. Recently, a new hypothesis has emerged suggesting that vigilance impairment related to underload task is due to boredom instead of mental fatigue. **Purposes** The main purpose was to study the effects of time-on-task on sustained attention using oddball event-related potentials. We also investigated if vigilance decrement was due to boredom or mental fatigue. **Material and Methods** Subjects performed a one-hour 3-visual stimuli oddball paradigm. The Go- and Nogo-ERPs referred respectively to the target and to the distracter. Mental task engagement was calculated using the engagement index ( $EI = 20 \times \beta / (\alpha + \theta)$ ). **Results** VAS scores for fatigue and reaction time significantly increased over time. Nogo-P300 amplitude significantly decreased with time-on-task, whereas Go-P300, Go- and Nogo-N2 amplitudes, as EI were not modulated. **Discussion** Evidences of engagement index values demonstrated that subjects experienced mental fatigue. **Conclusion** One-hour oddball paradigm increases subjective feeling of fatigue, impairs behavioral performance and affects attentional resources related to the distracter. Supported by Merck Serono Grant.

13:45 - 14:45

## Poster presentations

## PP-PM08 Sports Medicine 2

**KINKING OF THE EXTERNAL ILIAC ARTERY IMPAIRS ENDURANCE CYCLING PERFORMANCE BUT NOT PEAK POWER OUTPUT: A CASE STUDY**

Lamberts, R.P.1, Noakes, T.D.1

*1: UCT/MRC Research Unit for Exercise Science and Sports Medicine, Department of Human Biology, University of Cape Town, South Africa.*

**Introduction** Kinking of the common or external iliac artery is most commonly seen in professional cyclists, who spend a substantial amount of their training time in an aerodynamic position and flexing their hips as much as 8 million times per year (Schep et al., 2002), which causes limited blood flow to the lower extremity resulting in underperformance and complains about pain and powerlessness. It is unknown however if this pathology mainly restrict endurance cycling capacity or also peak power output (PPO). **Methods** A 32 year old professional cyclist (460 W; 6.1 W•kg<sup>-1</sup>) and participated in a monitoring/observation study, was diagnosed with kinking of both the left and right external iliac artery, after underperforming and complaining about painful/powerless legs. During the monitoring period the cyclists performed two PPO tests, including respiratory gas analysis (VO<sub>2</sub>max), and two 40km time trials (40km TT). Before all performance tests, the cyclists performed the LSCT, a submaximal cycle test which is able to predict cycling performance (Lamberts et al., 2009). After surgery of both left and right external iliac artery and a rehabilitation period, a third PPO and 40km TT test, including the LSCT, was performed. Actual performance and predicted performance of the cyclist was compared to normative data of 74 healthy cyclists (Lamberts et al., 2009) Results No meaningful differences were found between actual PPO (460W, 484W and 410W, respectively) and predicted PPO based on the LSCT (456W, 486W and 410W, respectively). No differences were also found between actual VO<sub>2</sub>max (5.4, 5.5, 4.7 l•min<sup>-1</sup>, respectively) and predicted VO<sub>2</sub>max (5.4, 5.7, 4.7 l•min<sup>-1</sup>, respectively). Meaningful differences (Lamberts et al., 2009) were found between actual and predicted 40km TT performance before surgery during which the cyclist under-performed by 3 minutes and 32 seconds and 4 minutes and 15 seconds, while after surgery no meaningful differences were found (9 seconds) **Discussion** The main finding of this case study is that meaningful discrepancies were found between actual and predicted 40km TT performance with kinking of the external iliac arteries in a professional cyclists. These finding suggest that kinking of the iliac artery mainly impairs endurance performance and not or less PPO and VO<sub>2</sub>max. Therefore additional measurements such as ankle systolic blood pressure measurements, echo doppler and magnetic-resonance imaging either with or without angiography (Schep et al., 2001, 2002), seem to be crucial for diagnosing kinking of the iliac artery within a PPO test. In addition this study shows that a discrepancy between predicted 40km TT performance, from the LSCT, and actual 40km TT performance can possibly be used as an early screenings tool. **References** Schep G, et al. (2002). *Lancet*. 359, 466-473 Lamberts RP (2009). Book (ISBN: 978-90-9024959-9), Enschede, The Netherlands, Ipskamp Drukkers Schep G, et al (2001). *Physiol Meas*. 22, 475-487

**TIMING AT PEAK LENGTHS AND FORCES OF HIP JOINT MUSCLES DURING SPRINT RUNNING**

Nagano, Y., Higashihara, A., Takahashi, K., Fukubashi, T.

*Niigata University of Health and Welfare*

**Introduction** The biceps femoris is the most commonly injured muscle among the hamstring muscles (Woods et al., 2004). Increased biceps femoris muscle-tendon force carries the risk of hamstring strain injury. Moreover, it is possible that other hip joint muscles influence biceps femoris mechanics. The opposite iliacus are suggested to influence the mechanics of biceps femoris (Riley et al., 2010). The purpose of this study is to investigate the relation of muscle lengths and muscle-tendon forces of hip joint muscles during sprint running and particularly, to examine the relationships with the peak of biceps femoris muscle-tendon force. **Methods** We obtained three-dimensional kinematics during 1 running cycle from 8 healthy sprinters sprinting at maximum speed. These data were used to drive musculoskeletal models by using nMotion musculous (NAC Image Technology, Inc.JAPAN). Muscle lengths and muscle-tendon forces were calculated for iliacus, rectus femoris, gluteus maximus, biceps femoris, opposite iliacus, and opposite rectus femoris. The time at muscle lengths and muscle-tendon force peaks as percent running cycle were measured and compared with muscle-tendon force peak of biceps femoris by using Bonferroni multiple comparison test. **Results** The peak muscle-tendon force of the biceps femoris occurred at 80.5 (2.9)% of the running cycle. It was significantly different from the peak muscle lengths of iliacus, rectus femoris, gluteus maximus, opposite iliacus, and opposite rectus femoris ( $p < 0.01$ , respectively) and the peak muscle-tendon forces of rectus femoris and opposite rectus femoris ( $p < 0.01$ , respectively). However, it was not significantly different from the peak muscle lengths of biceps femoris, peak muscle-tendon forces of opposite iliacus, and the second peak of iliacus and gluteus maximus. **Discussion** The results of this study showed that the peak muscle-tendon force of biceps femoris synchronised with the peak muscle-tendon forces of opposite iliacus and the second peak of iliacus and gluteus maximus. A previous study reported that muscles in the lumbo-pelvic region had great influence on hamstring stretch (Chumanov et al., 2007). It is possible that the contraction and flexibility of these muscles influence the mechanics and injury risk of biceps femoris. **References** Woods C, Hawkins RD, Maltby S, Hulse M, Thomas A, Hodson A. (2004). *Br J Sports Med*, 38(1), 36-41. Riley PO, Franz J, Dicharry J, Kerrigan DC, (2010). *Gait Posture*, 31(2), 279-283. Chumanov ES, Heiderscheit BC, Thelen DG, (2007). *J Biomech*, 40(16), 3555-3562.

**RELEVANCE OF BONE MASS, BONE MINERAL DENSITY AND BONE METABOLIC MARKERS IN LONG-DISTANCE RUNNERS**

Asano, S.1, Torii, S.2, Iida, Y.2, Iizuka, S.1

*1)Graduate School of Sport Sciences,Waseda University 2)Faculty of Sport Sciences,Waseda University.*

**Introduction** The osseous tissue is maintained through continuous formation and resorption. Many studies have reported that bone metabolism is altered in accordance with the type, intensity and frequency of the exercise. Recently, the usefulness of the bone metabolism markers evaluating bone turnover quantitatively attracts attention as screening tool for bone injury such as the stress fracture. How-

ever, few studies have analyzed the bone metabolism marker of the competitive athletes, continuously. We measured whole body bone mass, bone mineral density of the lumbar spine and bone metabolism markers in 16 male athletes belonging to a business group long-distance running team, longitudinally and cross-sectionally. Method We measured BAP as a bone formation marker and TRACP-5b as a bone resorption marker in serum, and whole body bone mass and bone mineral density of the lumbar using DXA (Delphi-A QDR). Result The levels of BAP and TRACP-5b in a few subjects exceeded beyond their normal range of young male. In addition, a negative correlation tendency was seen between bone mineral density of the lumbar and product of BAP multiplied by TRACP-5b, which expressed bone metabolism states. Discussion Uncoupling of the bone metabolism may exist in athletes performing high intensity exercise like a long-distance running continuously. These results showed that bone mineral density of the lumbar spine was low in athletes with high bone metabolic turnover, resulting in high frequency of stress fracture. We suggested that bone metabolism markers are useful from a point of view assessing bone states of athletes and preventing their bone injury.

### THE EFFECTS OF HYPERBARIC OXYGEN EXPOSURE ON RECOVERY AFTER HIGH-INTENSITY EXERCISE.

Horie, M.1, Shimoda, M.1, Imai, T.2, Watanabe, K.2, Enomoto, M.1, Miyakawa, S.2, Yagishita, K.1

*Institution: 1: Hyperbaric Medical Center, Tokyo Medical and Dental University Hospital, Japan. 2: Graduate School of Comprehensive Human Sciences, University of Tsukuba, Japan*

The Effects of Hyperbaric Oxygen Exposure on Recovery after High-intensity Exercise. Horie, M.1, Shimoda, M.1, Imai, T.2, Watanabe, K.2, Enomoto, M.1, Miyakawa, S.2, Yagishita, K.1 1: Hyperbaric Medical Center, Tokyo Medical and Dental University Hospital, Japan. 2: Graduate School of Comprehensive Human Sciences, University of Tsukuba, Japan. Introduction: Hyperbaric oxygen therapy (HBO), which can dissolve oxygen in serum in population to atomic pressure and transport oxygen to ischemic tissue, is an established therapy for treatment of several conditions, including decompression illness, carbon monoxide poisoning, and acute artery occlusion. Recently, it has become an increasingly popular treatment for athletes suffering from muscle or ligament injury. However, the effect of HBO is not clear on recovery from sports activities. The purpose of this study is to determine how HBO exposure effects on physiological responses and recovery after high-intensity exercise in athletes. Methods: Healthy male volunteer subjects (age:  $21.0 \pm 1.2$  years) were randomly divided into the two groups of the HBO group (n=11) and the non-HBO treatment (control; CT) group (n=11). All subjects underwent the high-intensity cycle exercise of 75% heart rate max for 60 minutes. After the exercise, the subjects of HBO group were placed in hyperbaric chamber with inhalation of 100% oxygen at 2.5 atmospheres absolute (ATA) for 60 min. The total duration of the procedure was 120 min (including compression and decompression). The subjects of CT group seated rest for 120 min. Subjective evaluation of fatigue after exercise was assessed using a visual analogue scale (VAS). In addition, blood counts, blood lactate, serum IL-6 concentration, natural killer cell (NK) activity, and oxidative stress markers (d-ROM, BAP) were measured at pre-, post-exercise and after HBO or non-treatment. Results: VAS value was significantly increased after exercise, and decreased after HBO or non-treatment. VAS values in HBO group were lower than that in CT group after the treatment. In the blood test, serum IL-6 concentration was significantly increased after exercise in both groups and then significantly decreased after HBO treatment compared with that before HBO treatment. Lymphocyte was significantly increased after HBO treatment in HBO groups, but not changed in CT group. There were no differences between HBO and CT groups in terms of NK cell activity value, d-ROM, BAP and lactate. Discussion: The HBO treatment did not only reduce high-intensity exercise-induced fatigue, but also showed anti-inflammation response and high level of lymphocytes in the blood. These findings indicate that HBO treatment was effective for recovery from High-intensity exercise. As a next step, we need to clarify the physiological mechanisms of these effects by HBO treatment.

### EFFECTS OF ACUPUNCTURE ON ISOMETRIC AND ISOTONIC EXERCISE OF ELBOW FLEXOR: A RANDOMIZED, CROS-OVER DESIGN

Kaneko, Y.1,2, Kime, R.1, Takagi, S.1, Murase, N.1, Osada, T.1, Katsumura, K.1, Kihira, A.2, Uehara, A.2, Furuya, E.2, Sakamoto, A.2

*1: Tokyo Medical University (Tokyo, Japan) 2: Kuretake College of Medical Arts & Sciences (Tokyo, Japan)*

Introduction Acupuncture is frequently used therapy for several musculoskeletal disorders in complementary and alternative medicine. In sports medicine, acupuncture may have beneficial effects for athletes not only to treat injury but also to keep better performance, such as relieving delayed onset muscle soreness (Hubscher et al. 2008, Kaneko et al. 2009), or improving maximum isometric voluntary force (Hubscher et al. 2010). However, it is not clear if acupuncture improve muscle function on isotonic voluntary contraction. The aim of this study was to examine the effects of acupuncture on maximum isometric voluntary contraction (MIVC) and muscle power (MP) with repeated isotonic voluntary contraction of elbow flexor. Method Ten healthy male were participated in this study (age  $30.2 \pm 4.7$  yrs; height  $173 \pm 4.1$ cm; weight  $70.5 \pm 7.9$ kg). MIVC of elbow flexor was measured prior to stimulation (MIVC1). Subjects received acupuncture (ACU) before the exercise on their biceps brachii, or no stimulation as control (CONT). Subjects were treated with ACU and CONT in randomized order in 1 week between trials. The acupuncture (0.25\*60mm) was inserted in the belly of biceps brachii into 1 cm depth for 5 min. MIVC2 was measured after the stimulation. The exercise protocol were 5 sets \* 10 repetitions of maximum isotonic voluntary contraction (0 – 90 deg) of elbow flexion at 50% MIVC1. After the exercise, MIVC3 was measured (MIVC3). MP of every repetition was measured. The changes in MIVC and MP between ACU and CONT were evaluated. Result For the mean MIVC, ACU changed from  $7.9 \pm 1.3$ kg to  $7.5 \pm 1.3$ kg and  $6.5 \pm 1.2$ kg. CONT changed from  $7.9 \pm 1.0$ kg to  $8.0 \pm 0.9$ kg and  $6.5 \pm 0.9$ kg (MIVC1, MIVC2, MIVC3, respectively). MIVC3 decreased compared to MIVC1 and MIVC2 ( $p < 0.01$ ) in both group. There was significant difference between ACU and CONT at MIVC2 ( $p < 0.05$ ). The mean MP was significantly higher at ACU than CONT (ACT:  $44.8 \pm 10.5$  W, CONT:  $43.2 \pm 8.4$  W,  $p < 0.01$ ). MP of latter repetitions (7th to 10th) of ACU were significantly higher than CONT ( $p < 0.05$ ). Discussion These results suggest that acupuncture stimulation may suppress the decrease of muscle power at repeated maximum isotonic voluntary contraction at 50%MIVC. On the other hand, MIVC was suppressed after acupuncture. Effect of acupuncture on muscle function varies and it could be beneficial or adverse for athletes. References Hubscher M et al. (2008). J Altern Complement Med 14(8):1011–1016 Hubscher M et al. (2010). Eur J Appl Physiol 110:353–358 Kaneko Y et al. (2009). The Journal of Acupuncture and Moxibustion 1: 12-21

## COOLING AND RECOVERY FROM INTENSE EXERCISE – A SYSTEMATIC REVIEW OF STUDIES WITH TRAINED ATHLETES

Poppendieck, W., Faude, O., Wegmann, M., Meyer, T.

Saarland University, Saarbrücken, Germany

Cooling and recovery from intense exercise – a systematic review of studies with trained athletes W. Poppendieck<sup>1,2</sup>, O. Faude<sup>1,3</sup>, M. Wegmann<sup>1</sup>, T. Meyer<sup>1</sup> 1 Institute of Sports and Preventive Medicine, Saarland University, Saarbrücken, Germany 2 Department Medical Engineering & Neuroprosthetics, Fraunhofer IBMT, St. Ingbert, Germany 3 Institute of Exercise and Health Sciences, University of Basel, Basel, Switzerland Introduction Cooling after exercise has been suggested as a method to improve recovery during intensive training periods or competitions lasting several days to weeks. It has been investigated in various studies and has also found its way into practice. However, many existing studies include untrained subjects to induce a higher degree of muscle soreness and fatigue due to a reduced fitness level. It is not clear if the results of those studies can be transferred to trained athletes. Although recent review articles on the topic of cooling and recovery exist, none of those has focused especially on trained athletes (Halson, 2011; Leeder et al., 2011). The purpose of this work was to fill this gap. Methods A literature search was conducted using the following databases: PubMed, ISI Web of Science, AMED and EMBASE. Inclusion criteria were: a) explicit analysis of trained subjects, b) cooling after exercise, c) performance measurement, d) existence of a control group or condition, e) performance evaluation at least 2 h after cooling to exclude potential pre-cooling effects. In total, 14 studies with 153 subjects were located and analyzed. For all studies, the effect of cooling on performance was determined, and effect sizes (Hedges'  $g$ ) were calculated. Results In order to determine under which circumstances cooling may be most beneficial, several parameters of the study design were more closely examined. Regarding performance measurement, the best effects were found for endurance parameters (3 studies/30 subjects, 3.7%,  $g=0.35$ ), while for jump (3/35, 3.4%,  $g=0.13$ ), strength (10/113, 2.4%,  $g=0.12$ ) and sprint performance (4/46, 2.7%,  $g=0.10$ ), effects were smaller. The effects were most pronounced when performance was evaluated 48 h after exercise (7/71, 5.0%,  $g=0.34$ ). With respect to the exercise which was used to induce fatigue, effects after strength training (4/39, 3.6%,  $g=0.18$ ) were slightly larger than after endurance-type exercise (10/114, 2.2%,  $g=0.16$ ). Cold water immersion (10/117, 2.9%,  $g=0.19$ ) and cryogenic chambers (2/18, 3.8%,  $g=0.14$ ) seemed to be more beneficial than cooling packs (2/18, 0.3%,  $g=0.00$ ). Discussion Overall, the effects of cooling on recovery were rather small (2.8%,  $g=0.17$ ). Under appropriate conditions, however, cooling after exercise may have relevant positive effects on performance recovery of trained athletes. Especially for the recovery of endurance performance, relevant beneficial changes were reported. Halson SL (2011) *Int J Sports Physiol Perform* 6: 147-59. Leeder J et al. (2011) *Br J Sports Med*, Epub ahead of print.

## PREDICTION OF A HALF MARATHON RACE TIME IN RECREATIONAL LONG DISTANCE RUNNERS

Alvero-Cruz, J.R.1, Trujillo Mamely, A.1, Fernández Vázquez, R.1, Fernández García, J.C.2, Correias Gómez, L.2, Carnero, E.A.2

1. Faculty of Medicine. University of Málaga. 2. University of Málaga.

Introduction Running is a popular sports discipline that can be performed over various distances. Different physiological, anthropometric and training characteristics seem to influence running performance (race time), which is dependent of distance race. The aim of this study was to analyze predictor variables as anthropometry, functional stress test and training test to predict a half marathon race time in male amateur distance runners Methods Thirty-two male recreational runners finishers in the same half marathon were studied (Age:  $41.6 \pm 7.4$  years, height:  $172.5 \pm 6.3$  cm, body mass:  $70.4 \pm 8.14$  kg,  $VO_{2max}$ :  $55.73 \pm 8.33$  ml/kg/min). They completed the race distance in a mean time of  $91.2 \pm 10$  min. Fat mass and skeletal muscle mass were calculated by anthropometry. A treadmill progressive exercise test (TT) was performed to assess maximal aerobic power, also the distance of a Cooper's Test (CT) was recorded in a different day. Stepwise multiple regression analyses were performed to obtain predictor variables (CT, TT and anthropometry). Results Stepwise multiple regression analysis showed that the distance of CT was the best predictor of the final race time. Race time in a half marathon might be predicted by the following equation. Race time (min) =  $214.34 - 0.03829$  (CT (m)) ( $R^2$ : 0.92, SEE: 3.04 min,  $p < 0.0001$ ). Other significant model included the maximal speed obtained on the TT and maximal oxygen uptake ( $VO_{2max}$ ) as significant predictors; Race time (min) =  $185.8341 - 3.7709$  (msTT) -  $0.4145$  ( $VO_{2max}$ ), ( $R^2$ : 0.79, SEE: 4.80 min,  $p < 0.001$ ) Discussion Our main finding was that a simple CT test is a good predictor of the final time in a half marathon, namely for amateur runners. This should be an important concern for coaches and athletes, so a simple test, which last only 12 minutes, can be used to regulate the pace during the race, in order to improve the final time. However, we may manage this equation cautiously since it was developed only with the time of one race. Future studies should be carried out to confirm our equation, which must be cross-validated with different runners and races. References Rüst CA, Knechtle B, Knechtle P, Barandun U, Lepers R, Rosemann T. (2011). *Open Access J Sports Medicine*, 2:113-119 Legaz A, Eston R. (2005), *Br J Sports Med*, 39:851-856 Alvero JR, Garcia J, Perez F, Berdugo C, De Diego AM. (2000). *Apunts Med Esport*, 134:21-24

## HAMSTRING MUSCLE KINEMATICS DURING THE ACCELERATION PHASE OF SPRINTING

Higashihara, A., Nagano, Y., Takahashi, K., Fukubayashi, T.

Waseda University

Introduction Recent video analysis of hamstring strains showed that many injuries involve trunk flexion while running at high speed, an action usually seen during acceleration (Orchard, 2002; Verrall et al., 2005). Based on this observation, trunk flexion during sprinting is therefore a risk for hamstring strain injury. However, thus far this hypothesis has not been scientifically validated. The purpose of this study was to investigate hamstring muscle kinematics during the acceleration phase of sprinting, and compare it with the maximum speed phase. Methods Eight male track and field athletes (age,  $18.6 \pm 7.9$  years) performed maximal sprint from 2 starting lines, set approximately 15 and 60 m from the center of the measurement area. A three-dimensional musculoskeletal model was used to compute muscle lengths and muscle-tendon forces of the biceps femoris (BF), semitendinosus (ST), and semimembranosus (SM) muscles during the sprinting gait cycle. Hip flexion, knee flexion, and pelvic anterior tilt angles were also calculated. Results Hip and knee flexion angles at foot strike were significantly greater during the acceleration phase than during the maximum speed phase ( $p < 0.001$ ). A similar trend was observed for the pelvic anterior tilt angle (foot strike,  $p < 0.01$ ; maximum,  $p < 0.001$ ). Hamstring muscle lengths peaked during the terminal swing of the gait cycle, and at foot strike, they were significantly greater during the acceleration phase than during the maximum speed phase (BF,  $p < 0.01$ ; ST and SM,  $p < 0.001$ ). The hamstring muscle-tendon forces showed no significant difference between the 2 phases. Peak muscle-tendon forces of the BF muscle and the ST and SM muscles occurred during the terminal swing and initial stage of the gait cycle, respectively. Discussion The results of this study showed that compared to the maximum speed phase of sprinting, sprinters tend to have more forward trunk lean during the acceleration phase, and this may cause stretching of the hamstring muscles at foot



strike. The results also showed that peak muscle-tendon forces of the BF muscle occurred during the terminal swing of the gait cycle, simultaneous with the maximal stretching of the BF muscle. The BF muscle, the most commonly injured among the hamstring muscles (Woods et al., 2004), is subjected to excessive loads during the terminal swing of the gait cycle when it is in its most elongated position. References Orchard J. (2002). *NZ J of Sports Med*, 30, 92-98. Verrall GM, Slavotinek JP, Barnes PG. (2005). *Br J Sports Med*, 39(6), 363-368. Woods C, Hawkins RD, Maltby S, Hulse M, Thomas A, Hodson A. (2004). *Br J Sports Med*, 38(1), 36-41.

## THE INFLUENCE OF CONTINUOUS 100 PITCHES ON EXTREMITIES AND TRUNK MOTIONS IN BASEBALL THROWING KINEMATICS

INOUE, N.1, WATANABE, H.2, TORII, S.3

*waseda university 1, kitasato university 2, waseda university 3*

**INTRODUCTIONS** Shoulder and elbow injuries in baseball players have been reported many previous studies. One of the causative factors of the injuries have been expressed by a large number of pitching in game or practice. The purpose of this study was to compare baseball throwing kinematics before and after continuous 100 pitches and to investigate correlation between kinematic variations of extremities and trunk motions. **METHODS** Ten collegiate baseball players (baseball history  $8.7 \pm 3.1$ y, ball speed  $103 \pm 7.3$  km/h, age  $21.5 \pm 1.1$ y, height  $175.6 \pm 5.2$ cm, weight  $70.8 \pm 9.8$ kg) participated in this study. At first, reflective markers were placed at 11 bony landmarks. Then, we collected 3D coordinates of the points during throwing motion by using a 4-high speed camera of 300Hz and 3D digitizing system (Frame-Dias IV) before and after continuous 100 pitches. From those data, angles and angular velocities of shoulder, elbow, trunk, pelvic and thigh from foot contact (FC) to ball release (BR) were calculated. A statistics analysis of variance ( $P < .05$ ) was used to compare the kinematic variables before and after continuous 100 pitches. **RESULTS** Significant increase was observed in maximum shoulder external rotation angle (MER-A), maximum shoulder internal rotation angular velocity (Max SIR-V) during acceleration phase (AC), elbow extension angle (EE-A) at MER and BR, and thigh horizontal angle (TH-A) at FC after continuous 100 pitches compared with before. Moreover, there was a significant decrease in shoulder external rotation angle (ER-A) at BR and maximum elbow extension angle velocity (Max EE-V) during AC. On the other hand, trunk and pelvic kinematic variables showed no significant differences. There was no significant correlation between TH-A at FC and the upper extremity variables, either. **DISCUSSIONS** The significant increase of MER-A, Max SIR-V during AC, and EE-A at MER and decrease of ER-A at BR passively induce higher throwing injury risk after continuous 100 pitches. Moreover, it is thought that the increase of TH-A at FC changed throwing motion to inside step. There was no significant correlation between TH-A at FC and the upper extremity variables, thus, TH-A at FC on inside had no influence on upper extremity motions as pelvic and trunk motions doesn't changes.

## EFFECT OF ELECTROACUPUNCTURE ON EXERCISE-INDUCED OXIDATIVE STRESS

Fujimoto, H., Hayashi, T., Hanaoka, Y., Sakai, T., Mukai, N., Ajisaka, R., Miyamoto, T.

*University of Tsukuba, Tokyo Ariake University of Medical and Health Sciences, Meiji University of Integrative Medicine*

**Introduction** Oxidative stress is induced by high-intensity exercise (Sen, 1995). Therefore, oxidative stress has been used to evaluate the physical condition of athletes (Schippering et al, 2009). In athletics it is important to prevent fatigue for peak performance. In Japan, acupuncture has been used for fatigue prevention of Japanese athletes (Akimoto et al 2003). However, there is little scientific evidence to prove the effect. The purpose of this study is to examine the effects of electroacupuncture (EA) on exercise-induced oxidative stress. **Methods** In this crossover study, the EA and control (CONT) groups each included 12 healthy male volunteers. EA at 2 Hz and optimum intensity was performed on each subject at both the SP10 (Xuehai) and SP11 (Jimen) locations for 10 min before exercise. Respiratory metabolism was recorded during bicycle ergometer exercise by ramp rate. Blood samples were collected from the fingertip of each subject before and after exercise. Plasma oxidized glutathione (GSSG) and total glutathione (tGSH) concentrations were biochemically determined as a marker of oxidative stress. The degree of fatigue before and after exercise was evaluated by the visual analogue scale (VAS). **Results** The ventilatory threshold (VT) and the respiratory compensation point (RC), parameters of respiratory metabolism during exercise, did not differ significantly between the EA and CONT groups. The level of oxidative stress (GSSG/tGSH) after exercise was significantly lower than that before exercise in the EA group. In contrast, this level did not change significantly in the CONT group. The VAS values increased significantly after exercise in both groups; however, the VAS value in EA group showed a low tendency in comparison with that in CONT group. **Discussion** VT and RC did not differ between the two groups, indicating that the level of exercise was nearly the same for both groups. The GSSG/tGSH and the VAS values after exercise were lower in the EA group than in the CONT group. The low GSSG/tGSH and VAS values indicated EA-mediated suppression of exercise-induced oxidative stress and exercise-induced fatigue, respectively. It has reported that acupuncture stimulation increases glutathione concentration in skeletal muscle (Toda 2009). In this study, EA was performed at a location where muscle fatigue was predicted to occur. Therefore, our results might suggest that EA-mediated suppression of oxidative stress bear some related to suppression of fatigue. We propose that EA might be useful for fatigue prevention. **References** Sen CK. (1995), *J Appl Physiol*, 79(3), 675-86. Schipperinger G, Fankhauser F, Abuja PM, et al. (2009), *Scand J Med Sci Sports*, 19(2), 206-12. Akimoto T, Nakahori C, Aizawa K, et al. (2003), *Med Sci Sports Exerc*, 35(8), 1296-302. Toda S. (2011), *Evid Based Complement Alternat Med*, Article ID 297130.

13:45 - 14:45

## Poster presentations

## PP-BN05 Coaching 1

**CURRENT COACH EDUCATION PROGRAMS FAIL TO FOSTER QUALITATIVE LEADERSHIP IN DUTCH YOUTH SPORT TEAMS**

Decroos, S., Ceux, T., Boen, F., De Backer, M., Vande Broek, G.

*KU Leuven*

Introduction In youth sports, coach education programs should aim at building leadership qualities, because it is not merely 'playing the game' that promotes positive trajectories (Fraser-Thomas, Côté, & Deakin, 2005). It is much more the quality of the coaches' leadership that yields positive and sustainable development of the players' autonomous motivation, performance, enjoyment and personal strengths (Larson & Rusk, 2011; MacDonald, Côté, Eys, & Deakin, 2011; Theokas, 2009). Since basic need support is currently seen as one of the most qualitative leadership behaviors, we examine in this study whether coaches of youth sport teams benefit from current education programs to be more need supportive and fine-tune their leadership behavior in favor of the players' autonomous motivation. Methods Youth handball, volleyball, basketball and football players (N=1050, M=12,54) completed multiple questionnaires assessing the quality of their motivation, their need satisfaction and the need support of their coaches. The coaches (N=126, M=33,15) reported their age, years of experience and highest sport education degree. Results Regression analysis revealed that neither the coaches' years of experience nor their sport education degree could predict their perceived need support by the players, players' need satisfaction or players' autonomous motivation. All standardized beta-coefficients ranged from -.083 to .039 (all p-values above .12). Discussion Our results reveal that current coach education programs fail to foster coaches' need supportive leadership. Therefore we argue to revise current curricula. Rather than building years of experience, coaches need new tools and revised education to regulate their leadership behavior in favor of the athletes' autonomous motivation, performance and overall thriving. References Fraser-Thomas, J. L., Côté, J., & Deakin, J. (2005). Youth sport programs: an avenue to foster positive youth development. *Physical Education and Sport Pedagogy*, 10(1), 19-40 Theokas, C. (2009). Youth Sport Participation - A View of the Issues: Introduction to the Special Section. *Developmental Psychology*, 45(2), 303-306 MacDonald, D.J., Côté, J., Eys, M., & Deakin, J. (2011). The Role of Enjoyment and Motivational Climate in Relation to the Personal Development of Team Sport Athletes. *The Sport Psychologist*, 25, 32-46 Larson, R. W., & Rusk, N. (2011). Intrinsic Motivation and Positive Development. In R. M. Lerner, J. V. Lerner, & J. B. Benson (Eds.), *Advances in Child Development and Behavior* (pp. 89-130). New York: Academic Press.

**FACTORS INFLUENCING ARTISTIC PERFORMANCE OF TRANSITIONS WITH SPATIAL VARIATION TO INDIVIDUAL WOMEN IN AEROBIC GYMNASTICS**

LIANG, Y.

*Waseda University*

Factors influencing artistic performance of Transitions with spatial variation to individual women in Aerobic Gymnastics Liang, Y.1, Tang, Hb.3, Kanosue, K.4 1: Graduate School of Sports Sciences, Waseda University (Saitama, Japan) 2: Faculty of Anhui Normal University (Wuhu, China) 3: Faculty of Beijing Union University (Bei Jing, China) 4: Faculty of Sports Sciences, Waseda University (Saitama, Japan) Introduction Aerobic Gymnastics requires the ability to perform complex and high intensity movement patterns to music. It originates from traditional aerobic exercise. (Aerobic Gymnastic Code of Points 2009-2012). The aim of this study was to give a quantitative description of one component of Aerobic Gymnastics, which is "Transitions" performed by the champion of the 11th Aerobic Gymnastics of World Championships, who won the highest artistic score ever in the category of Individual Women, and also was given high evaluation by many international judges. We especially focused on the special variation of her transitions. As a comparison we also analyzed the performance of the athlete who ranked eighth in the final of the same competition. Methods The video images of the routines of the two athletes were taken with a usual video camera at the frame rate of 30 Hz. The images were analyzed from three aspects; 1) duration, 2) work patterns and sequences, and 3) trajectory and location. Results The two players used similar duration for transition in their routine. The champion performed longer on difficulty elements and upward movements, while the eighth utilized more in jump and the downward movements. In addition, the two routines choreographed in almost the same sequences of Transitions. However, the routine of the champion was composed of more variety of movements, supporting points, and degrees of rotation around three axes, including the usage of compound axis. For trajectory of transitions, the champion performed circular, diagonal and anterior-posterior movements more, while the eighth tended to complete transitions at the same place. Likewise, the champion effectively mixed transitions with long and short trajectories, and also used all the zones evenly. In contrast, the eighth stayed in limited zones most of time and not using the left-top zone at all. Discussion The routine of the champion had more varieties in many aspects such as duration, movements, sequence, compounding axis, supporting point, trajectory and location. Of course, this may give an indication of the good physical ability of the champion. But present analysis showed that the choreography of the champion was excellent as well. Therefore, in conclusion, an excellent choreography of spatial variation in transition should be composed of varieties in all aspects. With this point of view, coaches would be able to make innovations in choreography, if it was correctly combined with the physical ability of players. References Federation International De Gymnastique. Aerobic Gymnastic Code of Points 2009-2012: 10

**AN EXAMINATION OF HOME-FIELD ADVANTAGE IN GAELIC FOOTBALL 2001-2010**

Carroll, R.1, Collins, D.K.2

*Toca Sports (Ireland)1, ITT Dublin (Ireland)2*

Introduction The existence of home-field advantage has been examined and established in a number of international sports (Clarke, 2005; Pollard, 2006). The aim of the current study was to examine if home-field advantage applied in Gaelic Football, both in the National League competition and All-Ireland Championship Qualifiers. Methods In total 1,393 (1,143 National League and 250 All-Ireland Championship Qualifiers) games were analysed, beginning from the 2001 season when the All-Ireland Championship qualifying system was

introduced. The study includes results from 34 teams. The teams, the result and the venue were listed for each game. The home team was identified in each game except where games took place in a neutral venue. The number of home wins, away wins, draws and neutral venues was then recorded. The approach of calculating home advantage using the percentage of games won by home teams throughout the competition was deemed a suitable statistical analysis (Nevill and Holder, 1999). Results The results from the National League competition (n=1143) from 2001-2010 show that presence of a home-field advantage (Home win: 56.62%; Away wins: 34.85%; Draw: 8.53%). The results from the All-Ireland Championship Qualifiers (n=250) from the same period does not support the presence of home-field advantage (Home wins: 47.17%; Away wins: 48.43%; Draw: 4.4%). Discussion The current study is the first to describe home-field advantage in Gaelic football. The study identified the presence of home-field advantage in the National League competition. The study was however inconclusive in regard of the All-Ireland Championship Qualifiers where teams are not segmented according to their standard of play unlike the National League competition. Due to variance in ability, the home-field advantage may not be a determining factor for success in the All-Ireland Championship Qualifiers. Future research should look at factors relating to success in the All-Ireland Championship. References Clarke, S.R. (2005) *J Sports Sci*, 23, 375-385. Nevill, A.M., Holder, R. (1999) *Sports Med*, 28, 221-236. Pollard, R. (2006) *J Sports Sci*, 24, 231-240.

### **A TEAM IS NOT ALWAYS A DREAM: HOW CAN COACHES REDUCE SOCIAL LOAFING IN TEAM SPORTS?**

De Backer, M.

*KULeuven*

A TEAM IS NOT ALWAYS A DREAM: HOW CAN COACHES REDUCE SOCIAL LOAFING IN TEAM SPORTS? De Backer, M. 1, Vande Broek, G. 1, De Cuyper, B. 1, Høigaard, R., 2, Boen, F. 1 1: KULeuven (Belgium), 2: University of Agder (Norway) Introduction Like managers, coaches have to distinguish between players in terms of functions, status, etc. This differentiation leads to concerns about a fair treatment, usually referred to as organizational justice. Studies in business contexts have continually demonstrated the power of justice judgments to shape people's thoughts, feelings, and actions. Consequently, this research aims at testing the relationship between coach-related justice and a behavior-related variable (i.e., social loafing) in elite sport teams. Social loafing has been defined as the reduction in motivation and effort when individuals work collectively, compared with when they work individually (Latané, 1979) and will usually result in a decreased team performance. However, we are not simply interested in the direct relation between coach characteristics and the individual behavior of athletes. The main purpose of this study is to develop a model that explains the effects of perceived justice of the coach on a series of intervening group-oriented variables (i.e., the motivational climate, team identification and team cohesion) leading to perceived and self-reported social loafing in interactive sport teams. Method Norwegian top level female handball players (N = 110; M = 22.8) filled in mail surveys assessing perceived justice, the motivational climate, team identification, team cohesion, and social loafing. Structural equation modeling (i.e., both confirmatory and exploratory) was used to investigate our research model. Results The confirmatory path analysis indicated a poor fit of the hypothesized model ( $\chi^2 = 64.52$ ,  $df = 22$ ,  $p = .00$ ; GFI = .90; AGFI = .80; CFI = .84; RMSEA = .14). Consequently, an exploratory path analysis was performed using structural equation modeling. Results of the revised model provided a good fit to the data ( $\chi^2 = 33.45$ ,  $df = 19$ ,  $p = .02$ ; GFI = .94; AGFI = .86; CFI = .95; RMSEA = .08). Discussion The revised model showed that the more the coach is perceived as fair, the more a mastery climate is experienced and the less an ego-oriented climate. A mastery climate in turn was positively related to athletes' team identification, while a performance climate was not significant related to it. Furthermore, our results confirmed that task and not social cohesion mediates the relation between team identification and both forms of social loafing in elite female sport teams. From a more practical standpoint, our results showed that the coach himself can guide the group processes and consequently reduce social loafing, even in world-class teams. References Latané, B., Williams, K., & Harkins, S. (1979). Many hands make light the work: The causes and consequences of social loafing. *Journal of Personality and Social Psychology*, 37, 822-832.

### **THE RELATIONSHIP OF A SEATED CHEST THROW TO A ONE REPETITION MAXIMUM BENCH PRESS**

Roberts, J., McCleary, S.

*Edinboro University of PA*

THE RELATIONSHIP OF A SEATED CHEST THROW TO A ONE REPETITION MAXIMUM BENCH PRESS Roberts Jr., J., McCleary, S.: Edinboro University of PA (Edinboro, PA, USA) Introduction Although the seated chest throw is a power measurement and the one repetition maximum bench press is a muscle strength measurement, there is little known about the relationship between the two tests. Other studies have compared the validity and reliability of a medicine ball throw with vertical jump power (Stockbrugger and Haennel, 2001) as well as the backward overhead medicine ball throw to vertical jump power production (Mayhew et al., 2005). However, the purpose of this study was to determine the strength of the relationship of a seated chest throw with a 12 pound and a 16 pound medicine ball to a one repetition maximum (1RM) bench press. Methods Data were collected from a sample of 55 participants; 30 males (age 19.73±2.03yr) and 25 females (age 17.08±2.34yr) between the ages of 14 and 24. Participants completed the 1RM bench press and the seated chest throws in randomized groups. In accordance with the procedures outlined by the American College of Sports Medicine, each participant completed 4 lifts of the bench press. Height and weight were measured using a calibrated Detecto® physician's scale and stadiometer. During the seated chest throw, participants threw a 12 pound and a 16 pound medicine ball at a force plate. The best of four trials for each ball was recorded. Descriptive data, Pearson's correlation and mean differences of the two tests were used to determine the strength of the relationship. Results With male subjects, correlations of  $r=0.612$  and  $r=0.614$  ( $p<0.001$ ) were found for the 1RM bench press as compared to a seated throw, as measured in ft. lbs, of a 12 pound and 16 pound medicine ball respectively. The female participants had stronger correlations for both of the chest throws ( $r=0.777$  and  $r=0.705$   $p<0.001$ ). Discussion With a randomized order of testing, the correlation of a 1RM bench press to the seated chest throw in young athletic males is moderately strong and significant. The correlation in young athletic females is equally significant with a stronger relationship than that observed in the male participants. In addition, these data suggest that females may elicit a stronger relationship to a 1RM bench press by using a 12 pound medicine ball while males could use either. References Mayhew J, Bird M, Cole M, Koch A, Jacques J, Ware J, Buford B, Fletcher K. (2005). *J Strength Cond Res*, 19, 514-518. Stockbrugger B, Haennel, R. (2001). *J Strength Cond Res*, 15, 431-438.

## DIFFERENCES IN BALL HANDLING PERFORMANCE, AMONG VARIOUS SIZES OF BALLS IN 13 AND 14 YEARS OLD BASKETBALL PLAYERS

Zacharakis, E.I, Apostolidis, N.I, Kostopoulos, N.I, Bolatoglou, T.I

*UNIVERSITY OF ATHENS*

DIFFERENCES IN BALL HANDLING PERFORMANCE, AMONG VARIOUS SIZES OF BALLS IN 13 AND 14 YEARS OLD BASKETBALL PLAYERS Zacharakis, E.I, Apostolidis, N.I, Kostopoulos, N.I, Bolatoglou, T.I 1: Faculty of Physical Education and Sport Science, Dpt of Games and Sports, University of Athens Introduction: The Comity International for Mini-basketball (CIM), proposes the use of small size ball (No5) for the facilitation of the young players (under 12 years old) ball-handling. On the other hand, the Federation International Basketball Association (FIBA) recommend for cadets (15-16y), juniors (17-18y) and men (>18y) the use of big size ball (No7), and for women the intermediate size (No6) (fibaeurope.com, 2010). These restrictions, force the cadet basketball players to conform the use of the big size of the ball, in a very short period. The aim of the present study was to investigate the possibility of the regular passage of the 13-14y players from the small to the big ball size, through the intermediate one (No6). Methods: A total sample of 105 basketball players 13 and 14 years old (n1=54, n2=51), volunteered to participate in the following tests: (a) speed dribble (28m) with both hands and both ball sizes, (b) obstacle dribble (A.A.H.P.E.R., 1984) with both hands and both ball sizes, (c) free throws shooting with both ball sizes and (d) speed spot shooting (A.A.H.P.E.R., 1984) with both ball sizes. For the data analyses six separate one sample t-tests were conducted, in order to investigate possible differences among the two ball sizes, for all of the skill tests. Statistical significance was accepted at  $p < .05$  level. Results: In none of the applied shooting skill tests revealed differences between the two ball sizes (No6 and No7). Reversely, it was revealed significant differences in the three of the four dribbling skill tests ( $p < .05$ ) Discussion/Conclusions: The results of the study revealed that in skill tests regarding shooting performance no differences were detected in the use of the 6 and 7 ball sizes. Reversely, in the dribble skill tests were detected differences in the three of the four trials with the two ball sizes and it was evident that the young players perform better ball-handling with the smaller ball. Conclusively, there are no sufficient findings that may justify the use of the intermediate (No6) basketball size, in the age of 13 and 14 years, so the young basketball players can pass strait from the use of the small basketball to the bigger one. References: American Alliance for Health, Physical Education, Recreation and Dance, (1984). Basketball for boys and Girls, Skill Test Manual. Reston, V A. fibaeurope.com/regulations/official basketball rules 2010 – basketball equipment/basketballs, p. 11-12.

## 2ND TO 4TH DIGIT RATIO AND PERFORMANCE IN SWISS YOUTH TRACK AND FIELD ATHLETES

Romann, M., Heyer, L., Fuchslocher, J.

*Swiss Federal Institute of Sport Magglingen*

Introduction The ratio of the second and fourth digit (2D:4D) is a biomarker for performance in various sports such as fencing, rugby, football, alpine skiing, sprinting, middle- and long-distance running (Hönekopp & Schuster, 2010; Manning & Hill, 2009). The underlying reason is a putative correlation between 2D:4D and prenatal testosterone. 2D:4D has been proposed as a predictor of performance and a helpful criterion for the talent identification (TID) process. The Swiss track and field federation (Swiss Athletics) uses a multidimensional TID-tool, but 2D:4D has to date not been taken into account. The aim of the present study was therefore to examine whether the 2D:4D of Swiss youth track and field athletes is related to the personal best performance exhibited during competition. Methods 180 track and field athletes (75 girls and 105 boys) were recruited during the annual Swiss Athletics talent selection day. The mean age of subjects was  $16.6 \pm 1.4$  years. The personal best performance was taken from the Swiss Athletics database. All performance data were transformed into points and adjusted for age according to Swiss Athletics standards. Second and fourth digit finger length was measured blind to performance data. Measurements were made from photocopies of the ventral surface of the right hand. Measurements were made to the nearest 0.1 mm from the midpoint of the finger crease proximal to the palm to the tip of the finger using steel vernier calipers. Results Mean 2D:4D was  $0.95 \pm 0.03$  for the whole sample,  $0.96 \pm 0.03$  for female and  $0.94 \pm 0.03$  for male athletes. Significant ( $p < 0.05$ ) negative correlations were observed between 2D:4D and performance in the whole sample ( $r = -0.24$ ) and significant ( $p < 0.05$ ) negative interclass correlations were found in female ( $r = -0.26$ ) and male ( $r = -0.25$ ) athletes. Effect sizes (ES) were small for both females and males. Subgroups of female middle-distance runners ( $r = -0.43$ ) as well as male sprinters ( $r = -0.61$ ) showed highest ES. Discussion Our data indicate that 2D:4D is a predictor of performance in track and field for both female and male athletes. This in turn suggests that fetal testosterone exposure has long-term effects on traits associated with physical performance in track and field. However it should be kept in mind that performance is closely related to maturity. Given that 2D:4D is fixed before birth and remains constant during life, 2D:4D might be used as a selection criterion in the TID process of female middle-distance runners and male sprinters. References: Hönekopp, J., & Schuster, M. (2010). A meta-analysis on 2D: 4D and athletic prowess. *Personality and Individual Differences*, 48, 4-10. Manning, J., & Hill, M. (2009). Digit ratio (2D: 4D) and sprinting speed in boys. *American Journal of Human Biology*, 21, 210-213.

## STEP ADJUSTMENT APPROACHING THE FIRST HURDLE

Smirniotou, A., Panteli, F., Argeitaki, A., Roussos, T., Katsikas, C.

*Kapodistrian University of Athens*

INTRODUCTION "Hurdling" involves running towards successive targets-hurdles placed at specific distances, which necessitate step adjustment using a visual control strategy (Smirniotou et al., 2010). During training hurdle's height is regulated to improve the approach run and hurdle's clearance stride. The purpose of this study was to examine if step pattern to the first hurdle changes 1. by modifying the height of the hurdle, 2. after a period of task-specific training. METHODS 11 students (M age  $18 \pm 0.8$  years) with no hurdling experience participated in the study. Pre- and post-tests were conducted. After the pre-test, participants attended 10 specific training sessions. In both tests they performed the approach phase to the first hurdle by sprinting 13m and striking a non-visible "target" (take-off point) prior to the hurdle. They completed 4 trials under each condition (A,B,C): A–run over hurdle (0.76m), B–run across flat mark, C–run over an upside-down hurdle. Trials were recorded using a panning camera (50Hz). Standard deviation (SD) of the Toe-Hurdle Distance (THD) for each step across trials for each participant was taken as a measure of footfall variability for a particular step. RESULTS Findings revealed an initial ascending footfall variability followed by a descending one as the participants approached the hurdle, suggesting the use of visual control. The onset of visual control (point of max SD of THD) occurred closer to the hurdle at the post-test (4th, 2nd, 4th support phase prior to the hurdle, for conditions A,B,C respectively) compared to the pre-test (6th, 4th, 5th support phase prior to the hurdle, for conditions A,B,C respectively). The mean max SD of THD recorded at post-test was lower compared to the pre-test, for all conditions (Pre-test: A:29.92cm, B:41.12cm, C:39.19cm. Post-test: A:25.37cm, B:15.12cm, C:14.39cm). DISCUSSION A visual control strategy seems to be applied during the approach phase to the first hurdle. In A and C vision was used for a greater distance compared to B, where partici-

pants commenced using visual control closer to the target probably due to its characteristics-height (Bradshaw & Sparrow, 2001). After a period of hurdles training visual control emerged closer to the hurdle for all conditions. The lower values of max SD of THD recorded in post-test indicate that even a small amount of task-specific training contribute to a more consistent run-up. The effect of running speed should be also examined in future research. REFERENCES Bradshaw, E.J. and Sparrow, W.A. (2001). Effects of approach velocity and foot-target characteristics on the visual regulation of step length. *Human Movement Science*, 20, 401-426. Smirniotou, A., Panteli, F., Argeitaki, P., Kesoglou, I. and Katsikas, C. (2010). Visual control of step length during the approach phase to the first hurdle. Abstracts, 15th ECSS Congress (p. 178).

### A STUDY OF IMAGING TIME OF PROFESSIONAL GOLFERS AND AMATEUR GOLFERS

Yoshihara, S., Ichikawa, D., Kita, T., John, S., Takahashi, M., Kawakami, T., Yamamoto, T., Kato, Z.

*Toyo university*

**Introduction** In order to have consistent performance in golf it is important to have a stable time between addressing the ball and the start of the swing (imaging time), and also between the start of the swing and impact on the ball (swing tempo). In order to realize the ideal ball flight that you want while playing on a golf course, you must have a complete image of the swing rotation, swing width, and power at impact before you begin the swing. It is considered that each individual has a relatively consistent time between the start of the swing and the top (top of swing time) and also between the top and impact (down swing time). However, it is considered that amateur golfers (AG) have a longer and more inconsistent imaging time compared to professional golfers (PG). The purpose of this study is to investigate difference in length of necessary imaging time of the tee shot, second shot, approach, and putting of PG and AG by measurement during an actual round of golf on a golf course. **Methods** The time between addressing the ball and ball impact (imaging time) of the tee shot, second shot, approach and putt of 2 PG and 1 AG was measured by taking video using a digital camera and measuring the time by inserting a time counter into the recorded video images. Putts of a distance less than 30cm were not included as they are considered a tap in for PG. Averages and standard deviations were calculated and the relationship between imaging time and golf performance evaluated. **Results** Table 1 shows the measured time of tee shot, second shot, approach and putting of PG and AG. Over 18 holes, the average tee shot time for PG was  $1.17 \pm 0.1s$  and for AG  $2.60 \pm 0.3s$ . For the 2nd shot it was  $1.19 \pm 0.1s$  for PG and  $2.74 \pm 0.4s$  for AG. For the approach shot it was  $0.90 \pm 0.2s$  for PG and  $3.06 \pm 0.4s$  for AG. For putting it was  $0.80 \pm 0.3s$  for PG and  $1.72 \pm 0.7s$  for AG. It was shown that in PG imaging time tended to decrease with each shot from the tee shot to putting but oppositely increased with each shot in AG. **Discussion** After comparing imaging time of PG and AG, the following trend was recognized. Over 18 holes, PG only need half the imaging time that is necessary for AG. The standard deviation for imaging time was also approximately half for PG compared to AG. Furthermore, a decrease in imaging time for each shot from the tee shot until putting was apparent in PG whereas in AG the imaging time for each shot from the tee shot to putting showed a tendency to increase. These results indicate that PG have already virtually completed their imaging by the time they actually address the ball resulting in a decrease in imaging time and a reduction in inconsistency of imaging time. It can therefore be deduced that imaging time for PG decreases as the distance from the place of the shot and the cup becomes closer, resulting in a reduction of the amount of psychological pressure on the golfer. Oppositely, it was recognized that AG require more time for various thoughts as the place of the shot becomes closer to the cup, reducing the potential for golf performance.

## 13:45 - 14:45

### Poster presentations

#### PP-SH03 Sport Management

#### JUDO AND SWIMMING TRAINING COACHES OPPORTUNITIES IN BRAZIL

Mazzei, L., Siva Filho, F., Böhme, M.T.

*Universidade Nove de Julho (University July Nine) - São Paulo/Brazil*

**Judo and Swimming Training Coaches Opportunities in Brazil** MAZZEI, L.1, SILVA FILHO, F.J.2, BÖHME, M.T.S.2 1: University July Nine (UNINOVE, São Paulo/Brazil); 2: Universidade de São Paulo (São Paulo/Brazil) **Introduction** For a country to achieve international sporting success, beyond financial investment, is necessary to develop some strategic points in national sport structure. The training of coaches is a strategic factor that can optimize the international sport results. (GRENN & OAKLEY, 2001; DE BOSSCHER et al 2006). According Erickson et al (2008) formal education of coaches is one of the possible ways of purchase knowledge. The aim of this study was to identify the training coaches opportunities in swimming and judo in Brazil. **Methods** A total of 18 elite sport coaches of São Paulo sport clubs (7 of judo and 11 of swimming) answered the following question: 'What is the entity's policy to training human resources for elite sport?' This paper is part of a research which is being conducted in São Paulo/Brazil. Data was obtained through personal interviews. Results were analyzed through "Group Character Speech Method" (GCS), as proposed by Lefèvre & Lefevre (2003). Results There was a similarity in some "Central Ideas" between judo and swimming, as the 'The club itself promotes actions' was cited by 66,6% of coaches. However, other "CI" were specific to each modality, how "no exist" (33.3%) for the judo coaches and 'is a coach responsibility' (16.6%) for swimming coaches. **Discussion** The results show that some clubs promote training coaches through their own actions, for example, study groups, guest speakers and subsidies for participation in international events. Another important point in the survey is that judo coaches reported that 'there is any one' policy or training coaches activities. In some countries with international success there are training programs for coaches in various forms, which are developed by a national sporting organization. **Conclusion** There is no proposed action related to the training of coaches in judo and swimming conducted by national bodies responsible for the organization of sport in Brazil. Clubs and coaches responsible for their own training **References** De Bosscher, V.; De Knop, P.; Van Bottenburg, M.; Shibli, S. (2006). A conceptual framework for analysing Sports Policy Factors Leading to international sporting success. *European Sport Management Quarterly*, 6, p. 185-215. Erickson, K., Bruner, M., MacDonald, D.; Côté, J. (2008) Gaining Insight into Actual and Preferred Sources of Coaching Knowledge. *International Journal of Sports Science & Coaching*, v. 33n. 4. p. 527-538. Green, M.; Oakley, B. (2001). Elite sport development systems and playing to win: uniformity and diversity in international approaches. *Leisure Studies* v. 20, p. 247-267. Lefèvre, F.; Lefèvre, A. (2003). O discurso do sujeito coletivo: um novo enfoque em pesquisa qualitativa. *Caxias do Sul: EDUCS*.

## THE DEVELOPMENT OF SUPPORTING THE ELITE ATHLETES IN THE UK: FROM ATHLETE AND CAREER EDUCATION PROGRAM TO PERFORMANCE LIFESTYLE

LEE, P., Jiang, R.

*National Taichung University of Education*

**Introduction** This discussion is about elite, or high performance, sport and primarily about how the UK provides life support for the elite athletes with a concern of major contributions of implementing ACE UK program in the 1999-2004 period and later the Performance Lifestyle program since 2004. **Methods** The documentary-based element takes the form of qualitative content analysis, which applied to the form of analysis of a number of British sport official reports, academic articles, and media commentaries. In total, 107 references were reviewed and 53 commentaries were identified to conduct this research. The data was subject to analysis and coding employing the NVivo 9 software package. **Results** In 1999 UK Sport, as the government agency with a remit for elite sport, administers an Athlete and Career Education (ACE UK) program based on a similar scheme that has been in place in Australia. ACE UK was set up to provide athletes with the skills to cope with the special demands of higher-level sport and to help them prepare for life after sport (UK Sport, 2001). Five major services were provided through the ACE UK program, namely, Personal Development Courses, Education Guidance, Career Planning, Olympic and Paralympic Employment Network (OPEN) (North & Lavallee, 2004). Since its inception in 1999, the ACE UK program has had a relatively high level of usage amongst the elite UK athlete population (UK Sport, 2001). In 2004, the ACE UK program has been replaced with the Performance Lifestyle program which covers the following three main areas: Lifestyle support, Careers and Employment Advice, and Education Guidance. Since 2009 the Performance Lifestyle service has been delivered through the English Institute of Sport. **Discussion** The above programs of lifestyle support and preparation for life after sport contain all or some of the following elements: career advice; educational support, along with personal finance; and media and presentation skills training (Green & Oakley, 2001, 262). This implies that Performance Lifestyle is a program designed to help athletes balance all other aspects of their life with their sport. And, the major contributions of the Performance Lifestyle are concluded as the followings: contributions to medals, athlete welfare, athlete focus, self-efficacy balance, and maybe transferable to other domains. **References** Green M, Oakley K. (2001). Elite sport development systems and playing to win: Uniformity and diversity in international approaches. *Leisure Studies*, 20, 247-267. North J, Lavallee D. (2004). An investigation of potential users of career transition services in the United Kingdom. *Psychology of Sport and Exercise*, 5, 77-84. UK Sport. (2001). *Athletes' lifestyles and ACE UK: A survey of athletes' experiences of sport, education and work, and the role of the ACE UK programme*. London: Author.

## THE COVERAGE OF HANDBALL NEWS IN TURKISH PRINT MEDIA

Celiksoy, S.

*Anadolu University*

Celiksoy, S, Argan, M., Celiksoy, M.A. *Anadolu University- Eskisehir/Turkey* **Introduction** Using the medium of television, Duncan and Brummet; identified three dimensions of spectating that pleasurable experiences are presumed to be derived from. These are the technological, discourse, and social dimensions (Duncan et al., 1998). The frequency of print media coverage of handball started to decrease after 1995. According to Celiksoy's research, some factors such as media, institutionalization, advertisements, and organizations are very important. There might be some ways to enlarge print media coverage of handball (Çeliksoy et al., 2008). The aim of the research is to analyze contents of 2008 print media coverage of handball in three national newspapers *Hürriyet*, *Milliyet* and *Sabah*. **Methods** A content analyze form, which has 20 subjects, has been used in the analyze and evaluation process. SPSS 15 program has been used. Frequency and percentage analyzes have been used in evaluation process. **Results** These newspapers are outstanding in respect to their selling and editions. The most coverage of handball is in *Hürriyet* with the rate of 52.4%. The coverage range on weekdays is 61.2% but at weekends it is 38.8%. The highest range in months is as follows; October (14.6%), November (18.4%), December (10.7%). The most coverage is on the sports page of the newspapers, 95.1%. According to range of the location of coverage, left bottom corner is 30.1%, mid page is 27.2%. The size of the coverage; 1-25 cm<sup>2</sup>. 45.6%, 26-41cm<sup>2</sup>. 39.8%. 61.2 % of the coverage of handball is on weekdays. The coverage of handball is only on sports page with the rate of 95.1%. Most of the coverage size is 10-41cm<sup>2</sup>, on the left bottom corner and it makes up of reports, teams, scores, neutral and positive news. **Discussion** The most coverage of handball is in *Hürriyet* with the rate of 52.4%. 61.2 % of the coverage of handball is on weekdays. Football has more coverage than other sports at the weekends. The coverage of handball is only on sports page with the rate of 95.1%, because teams weren't successful in 2008-2009 seasons championships. Most of the coverage size is 10-41cm<sup>2</sup>, on the left bottom corner and it makes up of reports, teams, scores, neutral and positive news. Besides, most of coverage consists of simple and short articles which have common headlines. The correlation between men-women national teams and men-women teams in leagues is nearly same. Men and women teams didn't success in the championships. Because of this reason, all the news usually appear under one headline on the page. **References** Duncan and Brummet, (1998). *Media Sport*, 7-8. Routledge 11 New Fetter Lane, London. Gamst,G; Sutherland,Y.N. and Evans, B.A. (1993). A Profile of Newspaper Sports Section Readers and Nonreaders, *Journal of Sport Behavior*, 8-9. Vol.16.

## THE RELATIONSHIP BETWEEN COACHING LEADERSHIP STYLE AND TEAM COHESION OF MALE AND FEMALE ATHLETES IN TEAM AND INDIVIDUAL SELECTED DISCIPLINES

Sarpira, M., Khodayari, A.

*Islamic Art University- Tabriz, Iran, Islamic Azad University, Karaj, Iran*

**Introduction** The present study aims to review the relationship between coaching leadership style and Team cohesion. **Method and Subjects** The subjects of the study were all the elite athletes of team and individual disciplines in Tabriz in 2011 that would be sent to the provincial championships. 250 athletes were randomly selected. The instruments for the research were: standard leadership scale for sport questionnaire (LSS) and Team cohesion questionnaire (TCQ). The questionnaires were reviewed and their validities were approved by 15 academic experts and professors. Using Cronbach's alpha coefficient, the researchers calculated the reliabilities of 95%, 90% respectively. This study is a descriptive -correlative one which is performed using field study method. Descriptive-Statistical method was used to present the information in tables and graphs and inferential statistical method (Spearman Correlation) was used to determine the relationship between coaching styles and Team cohesion and finally Mann-Whitney U test method was utilized to statistical comparison between coaches and male and female athletes in team and individual sports. **Results and Discussion** The results showed that there was a clear and significant positive relationship between all aspects of team cohesion and training and practice leadership, task-oriented leadership, and relationship-oriented leadership styles. But there is no significant positive relationship between team cohesion dimen-

sions and directive leadership style. The behavior of coaches in leadership style has a determining role in team cohesion, so coaches can improve the team cohesion by choosing an appropriate leadership style which consequently leads to success of athletes and achievement in competitions.

### **NATIONAL AND TRANSNATIONAL MODELS FOR DEVELOPMENT OF MARTIAL ARTS AND COMBAT SPORTS**

Zhuravlev, P.

*Russian Union of Martial Arts*

Introduction Martial arts (MA) and combat sports (CS) have always been popular. Millions of people practice MA and CS in the world. Because of the unprecedented growth of interest in traditional and modernized MA and CS and an increasing diversity by the almost daily creation of new disciplines there appear umbrella institutions which structure and guide the activities of various schools and federations. The aim of this study was to analyse national - oriented and transnational non-governmental institutions which focus their activities on general support for various MA and CS federations and organizations as well as on promotion of martial arts and combat sports as a whole. Methods The comparative analysis presented here is focused on national and transnational umbrella non-governmental organizations which serve for development of MA and CS on the regional or interregional level. Results In a modern global society whose various elements have become ever more interdependent MA and CS have been always the most instrumental means of fostering mutual understanding and friendly ties between the nations of the world. MA and CG world in all their diversity has enormous potential of educational and cultural values to contribute to social change and to youth development in the regions. National and transnational umbrella organisations are created to better face MA and CS' present challenges and to develop MA and CS as a whole like the following: - National level: Russian Union of Martial Arts (Russia), Organization of Eastern Combat Sports (Kyrgyzstan), Republic Union of Combat Sports (Estonia), Kazakhstan Union of Martial Arts (Kazakhstan), and others; - Transnational level: 1. Eurasia Convention of Martial Arts (that convenes nongovernmental umbrella organizations from 11 countries); 2. SportAccord (currently unites 14 both Olympic and non-Olympic International Federations of MA and CS); and others. Both national and transnational umbrella organizations organize nationwide or world-wide sporting, educational and cultural events which promote values of MA and CS. Discussion We'd like to discuss the following topics: 1. Similarities and diversities of the MA and CG umbrella organizations acting at the national and transnational levels. 2. Multi-sports games (like the SportAccord World Combat Games, and others) like a model for MA and CS development. References Collected articles, All-Russian scientific conference 'Martial Arts and Combat Sports: Modern Trends' (2011). Ekaterinburg, 21-25; Alexander Dolin. (2010). The Legacy of Martial Arts in the Globalizing World, Akita International University (Japan).

### **THE REPRESENTATION OF SPORTS IN TURKISH PRESS**

Katirci, H.

*Anadolu University*

Introduction Sports have become an important part of mass print media. Sports coverage has been increasing in recent years in the mass print media in Turkey. The aim of this study was to analyze the representation of sports in Turkish press. Methods The study sample consisted of national newspapers which are highest circulation in Turkey. Sport pages of these newspapers analyzed by the method of Content Analysis. The number of sports news, type of sports categories in news, distribution of reviews, comments and sports categories in sport pages, photos and their surface area are examined. Results Results showed that football is main sport branch (92% of content) in Turkish newspapers. Almost other sport branches are not covered by newspapers in Turkey. Discussion Without question one of the great passions of the twentieth century has been sport (Boyle and Hayne, 2009). Today's sports have relations with many industries. One of these industries is defined as media. The relationship between sport and the media as a commercial connection for both industries start at the beginning of the twenty-first century. The media has transformed sport from an amateur structure into a hyper-commercialized industry (Matthew, 2006). Sport and media relations are so important for developing sports industry and media coverage (Boyle, 2006). Because of this; sports media should include all sports in their structure. But in Turkey sport media, especially newspapers, located just football in their pages. References Boyle, R. (2006). Sport Journalism: Context and Issues. Los Angeles: Sage Publications. Boyle, R. and Hynes, R. (2009). Power Play: Sport, The Media and Popular Culture. Edinburg: Edinburg University Press Ltd. Matthew, N. (2007). Sport and The Media: Managing The Nexus. Amsterdam: Elsevier.

### **FUTSAL AND ITS RULES IN SPAIN. OPINION OF PLAYERS**

Cachón-Zagalaz, J., Torres-Luque, G., Lara-Sánchez, A.J., Zagalaz-Sánchez, M.L.

*University of Jaén*

Introduction Futsal in Spain has introduced some rules of FIFA rules. In such an attractive sport for the children and young women it is very important to know well the rules by which it is ruled and his differences and similarities with other countries (Totes-Luque et al., 2011). This adaptation has been produced since 2006. The new rules applied causes a negative influence on different aspects. This influence affects the people involved in the game and the loss of sight. Methods Undertake a descriptive whereby study is designed and applied an ad hoc closed the players found in Granada (Spain). Different groups of people will take part: coaches, players, managerial, referees... We intend to conduct a descriptive study. We designed a closed questionnaire. Then we applied this questionnaire to the groups involved. The questionnaire includes views on the rule change since 2006 (Calahorra et al., 2011). The distribution by professions is: 9 technicals; 67 players; 1 manager; 9 referees; 34 spectators; 2 physiotherapists; 6 journalists; total 128 subjects. Results The research subjects were 104 players of which 67 are surveyed. SPSS 15 statistical package for Windows was used for the analysis of quantitative data. The higher percentage of respondents is players. The subjects involved in the FS believe the change in the laws referring to misconduct, game harms the spectator sport. Discussion Also modification of rules and, especially, reduction strategies has slowed down it. The results also match values and qualities of the FS: passing, perfection, passion, possession, keys to the spectator sport, as he retires in the initial investigation (Cachón-Zagalaz et al., 2010). New rules are complex and make it more difficult to make decisions. The game is less dynamic and more limited strategies. Lost spectacle and mark fewer goals. References Cachón-Zagalaz, J. (2011). Análisis de la incidencia en el espectáculo deportivo del nuevo reglamento de fútbol sala (2006) en España. Tesis Doctoral. Servicio de Publicaciones de la Universidad de Jaén. Jaén (Spain). Cachón-Zagalaz, J., Zagalaz-Sánchez, M.L., Lara-Diéguez, S., Torres-Luque, L., Calahorra-Cañada, F. (2010). Influence of Change Rules <2006> in Soccer show room for sports in Spain. 15th Annual Congress of the European College of Sport Science. Antalia (Turkey), p. 184. Calahorra, F., Torres-Luque, G, Lara, A.J. y Zagalaz, M.L. (2011). Parameters related to the competition's physical training. Journal of Sport and Health Research, 3 (2): 113-128. FIFA FUTSAL (2008). Reglamento FIFA FUTSAL. Fútbol-Táctico. Revista profesional de

Fútbol y Fútbol Sala, 19, noviembre. Torres-Luque, G., Calahorra, F., Lara-Sánchez, A.J. y Zagalaz-Sánchez, M.L. (2001). Exigencia competitiva del jugador de fútbol infantil. *Ágora para la EF y el Deporte*, 13 (3) septiembre - diciembre 2011, 383-395.

### **MEASURING THE SUCCESS OF NATIONS IN JUDO: EVOLUTION AT OLYMPIC GAMES AND WORLD CHAMPIONSHIP IN PERIOD 2000 TO 2011**

Mazzei, L., Silva Neto, A., Vieira, D., Bastos, F., Böhme, M.T.

*Universidade Nove de Julho (University July Nine) - São Paulo/Brazil*

Measuring the Success of Nations in Judo: Evolution at Olympic Games and World Championship in period 2000 to 2011 MAZZEI, L.I.; SILVA NETO, A.; VIEIRA, D.; BASTOS, F. C2; BÖHME, M. T.2 1: University July Nine (UNINOVE, São Paulo, Brazil), 2: University of São Paulo (São Paulo, Brazil) Introduction Judo is a very popular sport. Around 200 countries are affiliated in the International Judo Federation. It's disputed in Olympics Games (OG) and has a adult World Championships (WC), suggesting a universalization of this sport. Therefore, Judo has been the target of investment by many nations that seek international elite sport success. The aim of this study is to analyze the concurrence of countries in greater international Judo events (OG and adult WC). Methods This study was conducted in the period 2000 to 2011. The following variables were analyzed: number of countries that have athletes in the top 8, in the top 4 (medalists) and the countries market share. To calculate the market share was used a points system according to De Bosscher et al (2008). Results There was an increase 18.5% of countries that have athletes ranked in top 8 in WC from 2001 to 2009, while the number of nations that have medalists increased 3.8%. In events of 2010 and 2011, there was a decrease in number of countries that have athletes ranked in top 8 and in medalists in WC (-31%, -16%). Already in OG, the increasing of countries that have athletes ranked in top 8 from 2000 to 2008 was 16%, while the number of nations have medalists has been stable. The market share analyses shows a great superiority of Japan (average of 23% and 21%) followed by France (10%; 7%), Cuba (7%; 9%), China (5%; 9%) and Korea (5%; 7%). Discussion There was a rise of concurrence in judo (VILLAMON et al, 2004), which explain the number of countries and the growing number of athletes in the top 8 in both events and in top 4 in WC. On the other hand, some changes in the competition rules caused a decrease in the number of athletes have possibility of a significant classification in WC. With respect to the market share, the results demonstrate that judo is a Japanese sport, followed at a distance by some countries. Although the difference has decreased, before the changes that occurred in competition rules. Conclusion Many countries seek the international success in judo, but the recent changes in the competition rules go against the real universalization in this sport. However, is an expectation to increase the market share of some countries in London 2012. References De Bosscher, V.; Shibli, J. B.; Van Bottenburg, M.; De Knop, P. (2008). The global Sporting Arms Race: An international comparative study on sports policy factors leading to international sporting success. Aachen: Meyer & Meyer. Villamón, M.; Brown, D.; Espartero, J.; Gutiérrez C. (2004). Reflexive Modernization and the Disembedding of Judo from 1946 to the 2000 Sydney Olympics. *International Review for the Sociology of Sport*, 39/2, 139-156.

### **MAXIMIZING ACHIEVEMENT IN SPORT ORGANIZATIONS: A MULTI-STYLE LEADERSHIP APPROACH**

Schneider, R.

*The College at Brockport, State University of New York*

ABSTRACT In consideration of adopting an approach to sport leadership that supports Andrew's (2009) recommendation of altering leadership behavior to meet the requirements of the organization and its members, this presentation will offer insights as to how sport leaders might effectively utilize various components of multiple leadership styles to maximize organizational efficiency. Varying forms of influence are at the disposal of the leader when dealing with the complexities and dynamic nature of organizations (Bolden, Petrov, & Gosling, 2008). The achievement of maximum outcomes from sport organization members calls for a multi-style approach to leadership. Successful leadership of sport organizations can and does take place in many forms. A multi-style approach to leadership incorporates components of all leadership styles as needed to achieve maximum organizational efficiency. Adopting a multi-style approach to sport leadership requires an understanding of the various approaches to leadership and the ability to implement specific components of leadership theories that are germane to varying objectives, circumstances, and missions of sport organizations. The extent to which sport leaders can identify and apply appropriate components of different leadership theories will help elevate the success of the organization. In the interest of effective leadership, Simplicio (2011) explored the benefits and detriments of incorporating specific leadership styles into one's management approach. Adopting selected components of various leadership styles also requires the ability of sport leaders to periodically assume a leadership style that may not be a natural "fit" with their personality traits. To that end, this presentation will also provide a structure, including examples, that supports the sport leader's utilization of various components of leadership theories when leading a sport organization. REFERENCES Andrew, D. S. (2009). The impact of leadership behavior on satisfaction of college tennis players: A test of the leadership behavior congruency hypothesis of the multidimensional model of leadership. *Journal Of Sport Behavior*, 32(3), 261-277. Bolden, R., Petrov, G., & Gosling, J. (2008). Developing collective leadership in higher education, Final report, Research and Development Series. UK: Leadership Foundation for Higher Education. Simplicio, J. (2011). It all starts at the top: Divergent leadership styles and their impact upon a university. *Education*, 132(1), 110-114.



13:45 - 14:45

## Poster presentations

### PP-SH04 Sport Statistics and Analysis I

#### THE VOLLEYBALL PERFORMANCE IN SIDE-OUT AND DEFENSE ACCORDING SCORING SKILL AND PLAYERS EFFECTIVENESS

João, P.V., Pires, P., Vaz, L.

*Research Center for Sports Sciences, Health and Human Development (CIDESD) UTAD - Vila Real, Portugal.*

THE VOLLEYBALL PERFORMANCE IN SIDE-OUT (KI) AND DEFENSE (KII) ACCORDING SCORING SKILL AND PLAYERS EFFECTIVENESS João, P.V.1, Pires, P. 2, Vaz, L. 1 1Research Center for Sports Sciences, Health and Human Development (CIDESD) UTAD - Vila Real, Portugal. 2University of Trás-os-Montes and Alto Douro. Introduction Match Analysis is a particular importance in the process team's preparation, to the extent to increase the chances of coach's success to enhance their knowledge on skills teams' performance. Thus and with respect to identify possible constraints assigned to the defensive game procedures (in KI and in KII) we have developed the present study. Methods The sample was composed of 743 actions of reception and by 482 defense actions, belonging to 5 games of Play-off of the National Championship 2009-2010. The dependent variables considered were the effectiveness of the reception and the defense effectiveness, while, the intervenient player at the reception, the service type, the reception area, the defense player intervenient, the defense area and the attack zone were the independent variables. The statistical procedures used were the descriptive statistics and the multinomial logistic regression to obtain the estimated probability of occurrence of the dependent variable, based on values of the independent variables. The reliability intra and inter-observer were cleared using the Cohen's kappa values. Results The results show that the player who has done more receptions which allow all the attack options was the priority reception player. The receptions that occur in the central zone distant are those which provide more situations with all the attack options and the floating jump service is allowing a higher percentage of receptions with all the attack options. Discussion The results showed that the player who has done more defenses that allow all the attack options was the Libero, proving its importance in the offensive organization of team in KII. The areas' most exploited by attacks opponents were the zones 1, 6 and 5 respectively. In this sense in the training process team, and to increase the effectiveness of defensive procedures (in KII), must be considered to be effective coordination of the line of teams receptions and priority reception player establish regularity routines of double function what they practice. To increase the levels of effectiveness of defensive procedures in KII, training routines must be established at the level of the block, which difficult the attack in zone 1, thus freeing the setter for the implementation of distribution action.

#### HEIGHT IS AN OVERRATED FACTOR IN ELITE LEVEL WOMEN'S VOLLEYBALL

Afonso, J., Medeiros, A., Mesquita, I.

*University of Porto - Faculty of Sport*

Height is considered a nuclear component for achieving success in sports such as basketball and volleyball. Therefore, it has been considered as one of the major factors to be included in any talent detection program applied to these sports. However, concerns have arisen as to how important height really is, and to what extent performers are able to play in elite-level national teams without being tall. We analyzed the height of women volleyball players who have participated in the FIVB World Grand Prix, editions 2004 to 2011. This competition gathers the best twelve national teams in women volleyball around the world (16 in 2011) and possesses high prestige. Data were collected directly from the FIVB online platform ([www.fivb.org](http://www.fivb.org)), including values from a total of 1708 participants across those years. Average height was  $182.61 \pm 7.57$ cm, ranging from  $181.92 \pm 8.04$ cm in 2011 to  $183.53 \pm 7.40$  in 2007, and has been diminishing consistently since 2007 until 2011. Relatively to the total number of participants, 7.96% of the players were under 170cm, while 17.27% were under 175cm. Per year, an average of 4 players under 165cm was registered. On the other end of the spectrum, an average of 6 players above 196cm were registered each year. When average team height was crossed with team ranking (1st to 4th ranked; 5th to 8th; 9th to 12th; the 13th to 16th ranked teams were excluded, since only the 2011 edition presented that many teams), significant differences emerged ( $F=7.064$ ,  $p=0.001$ ). Bonferroni pairwise comparisons revealed that the teams ranked in the top four spots presented superior height (184.16cm) compared to the teams ranked in the lower end of classification (181.22cm), with a mean difference of 3cm. In conclusion, even though height is an important factor for high-level volleyball, and still makes a difference between top-level teams and near top-level teams, there is wide space for shorter players to incorporate national teams participating in World-class competitions such as the FIVB World Grand Prix. Certain game functions, such as the libero and the setter, are less dependent on height than being a middle-attacker, for example. This might explain why almost 18% of the players registered in such competitions fall short of 175cm, but players under this height were also found for wing-spikers. Yet, many national teams for the youth and junior players stipulate a minimum value of 175cm as a cut value, under which the player is excluded of the process. If nothing else, these data should advise coaches that height is being overrated as a factor of selection in women's volleyball. Furthermore, average height in this World-class competition has been decreasing, suggesting that other factors are being privileged in making the team's rosters.

#### THE ROLE OF AGE IN PERFORMANCE IN ELITE LEVEL WOMEN VOLLEYBALL TEAMS

Afonso, J., Medeiros, A., Mesquita, I.

*University of Porto - Faculty of Sport*

Age is a core concept for achieving high performances. Foremost, age allows gathering experience and acquiring quality in performance. On the other hand, physical decrements may impair performance. Therefore, volleyball teams should balance their roster, mixing experienced, older players with younger players. Our purpose was to analyze the age of women volleyball teams who have participated in the FIVB World Grand Prix, from 2004 to 2011. This competition selects the best twelve national teams in women volleyball in the world (16 in 2011). Data were collected directly from the FIVB online platform ([www.fivb.org](http://www.fivb.org)), including values from a total of 1708 participants across those years. Average age was  $24.28 \pm 4.21$  years, ranging from  $23.64 \pm 3.41$  in 2005 to  $24.79 \pm 4.33$  in 2007. This is an evident evolution of age according to the Olympic cycle. Teams' age decreases in the year immediately following the Olympic Games, progres-

sively increases until the next Olympic Games, and again falls. Teams were further divided into three groups according to their ranking in the competition: 1st to 4th ranked teams, 5th to 8th, and 9th to 12th. Teams ranked 13th to 16th were excluded, since this situation happened only in the 2011 edition of this competition. There are significant differences between the teams according to their ranking ( $F=5.009$ ,  $p=0.009$ ). Bonferroni pairwise comparisons revealed that the teams ranked 1st to 4th were older (24.84 years) than the teams ranked 9th to 12th (23.63 years). Overall, World-class women volleyball teams present an average age varying from 23 to 25 years, mixing experienced players with younger, up and coming players. Age fluctuations accompanying the Olympic cycles reveal there is a concern in national teams to renew their roster, which then goes on acquiring experience until the next Olympic Games. Furthermore, the four best-ranked teams in each World Grand Prix are, in average, one year older than the worst four ranked teams. So, ideally, top-level women volleyball teams should present a mixture of experience and youth, but achieving the best four spots implies a trend towards experience. The renovation of teams following the Olympic cycles is evident in this sample.

## EVALUATION OF CERTAIN PHYSICAL FEATURES RELATED TO JUMPING ABILITY OF VOLLEYBALL PLAYERS OF NATIONAL VOLLEYBALL TEAMS OF AGE 16-19 YEARS, IN ALBANIA.

Lleshi, E.1, Kokoneci, G.2

*University of Sport, Tirana*

Introduction Albania's participation in Balkan Volleyball Cup 2011 for age group 16-19 is an important event in our country. The evaluation of physical features, especially jumping ability in the force platform (Ergo Jump System) has a special importance in the progress of these volleyball ages. Methods The research is focused in four teams: Junior Women 12 girls, Youth Girls 12 girls, Junior Men 12 boys, Youth Boys 12 boys. Based on or measurements, we calculated the average for each team: Birthday (AGE), Body Height (BH), Body Weight (BW), Body Mass Index (BMI), Jump Attack (JA), Jump Block (JB), Squat (SJ) and Counter movement Jump (CMJ), Repetitive Jump (RJ 15sec). The three tests for C. Bosco were performed in the Ergo Jump System platform. The difference in % of (CMJ-SJ) the calculation of the elasticity index. Elastic energy (CMJ-SJ) x 100 / CMJ the capacity for subsequent reuse of accumulated elastic energy resulting from the elastic stretch preceding muscular contraction. The average RJ 15sec / CMJ gives the resistance index of explosive force. Results The measurements showed the following results: Junior Women; Age 18.3, BH 179.8cm, BW 66.5kg, BMI 20.5, JA 288.2cm, JB 277.3cm, SJ 25.3cm, CMJ 30.6cm, Elasticity 17.3%, Resistance 0.8: Youth Girl; Age 16.5, BH 174cm, BW 61kg, BMI 20, JA 280.3cm, JB 266.9cm, SJ 26.9cm, CMJ 32.5, Elasticity 17.2%, Resistance 0.8: Junior Men; Age 18.5, BH 191cm, BW 79.8kg, BMI 21.8, JA 323.7cm, JB 305.3cm, SJ 43.3cm, CMJ 43.2cm, Elasticity 16.3%, Resistance 0.7: Youth Boys; Age 17.5, BH 190.8cm, BW 79kg, BMI 21.9, JA 322.5cm, JB 303.8cm, SJ 36.4cm, CMJ 43.2cm, Elasticity 15.7%, Resistance 0.8. Discussion The collected evidence presents the BMI of 16-19 females within the comparative parameters of references, whereas the BMI of males is >(10-20%) for the same age. The elasticity index deriving from the difference in % of CMJ-SJ as Reactive Strength Index is low in these volleyball players. (CMJ-SJ) x 100 / CMJ; the elasticity index is presented in % as an indicator of the accumulated energy capacity resulting from the elastic stretch preceding muscular contraction. This index shows unexploited reserves of muscle elastic energy in sportsmen. The mechanical strength during jumping RJ 15sec proved to be a very sensible functional parameter which individualizes the features and characteristics of alaktik anaerobe element pertinent to training. Capacity of reactive strength index CMJ (h15/h CMJ) in collective sports in teams, these values reach up to 0.90-0.95. This data suggests that the values of teams 16-19 years reach up to 0.8. The national volleyball teams of 16-19 years have a low capacity of reactive strength resistance, which derives from lack of their plyometric and power training. Reference C. Bosco Ph.D. "La forza muscolare" (Rome 2006) Capitolo IV-La Forza Esplosiva, Capitolo VIII-Applicazioni pratiche. D. Cometti; "La Pliometria" 2a edizione italiana (2009); Capitolo V; I TEST; Test di Bosco .

## ADOLESCENT MALE VOLLEYBALLERS' SERVE PROFICIENCY IN ESTONIAN CHAMPIONSHIPS IN 2005, 2006 AND 2008

Stamm, M., Stamm, R., Koskel, S.

*Tallinn University*

ADOLESCENT MALE VOLLEYBALLERS' (AGED 13-15, N=197) SERVE PROFICIENCY IN ESTONIAN CHAMPIONSHIPS IN 2005, 2006 AND 2008 Meelis Stamm<sup>1</sup>, Raini Stamm<sup>2</sup>, Säde Koskel<sup>3</sup> <sup>1</sup>Institute of Educational Sciences, Tallinn University, Tallinn, Estonia <sup>2</sup>Institute of Health Sciences and Sport, Tallinn University, Tallinn, Estonia <sup>3</sup>Centre for Physical Anthropology, Institute of Anatomy, Faculty of Medicine, University of Tartu, Tartu, Estonia Introduction The study analyses volleyballers' performance at Estonian championships for Class C (up to 16-year-olds) in three tournaments – Tartu 2005, Viljandi 2006 and Rakvere 2008. The participants were members of the eight best teams of Estonia at the moment. Methods To record the games an original computer program Game (Nõlvak, 1995) was used, which was first presented by R. Nõlvak (Stamm) in 1995 and has been introduced in the International Journal of Volleyball Research (Stamm et al, 2000). For simultaneous recording of the performance of two opposing teams, two computers equipped with the program Game were used. Parallel recordings were made by volleyball experts – Meelis Stamm and Raini Stamm. Twenty-eight indicators of proficiency in the game were registered, but in this study we focus only on the element of serve. Results From our results we can conclude that in 2005 there were 278 serves which earned a point at once (aces) in 2006 – 204 serves, and in 2008 – 309 serves. When we look at the mistakes during the serves, we can see that in 2005 there were 308, in 2006 were 197 and in 2008 were 246 mistakes during the serve. From these numbers we can summarize, that boys serving quality is increasing. The same thing is when we look the proficiency of serve during the different years. It has been changing from 0,38 to 0,45. As long as it is not a longitudinal study but cross sectional, then we can't say that the boys were getting better but we can say that the quality of coaching was improved. Discussion The serve is playing more important role in the game from year to year. The meaning of serve has been changed. It has become a real attacking element and it is not any more simply the element for beginning the ball rally. References Nõlvak R. (1995) A system for recording volleyball games. Papers on Anthropology VI. Proceedings of the 7th Tartu International Anthropological Conference 29 May – 2 June. Tartu 1995, 171-175. Stamm R., Stamm M., Oja A. (2000) A system of recording volleyball games and their analysis. Int J Volleyball Res, 2 (1), 18-22.

## THE DIFFERENCE IN SPORTIVE PERFORMANCES BETWEEN THE NATIONAL WOMEN'S VOLLEYBALL AND WOMEN'S BASKETBALL TEAMS IN ALBANIA.

Lleshi, E., Selencia, R.

*Sport of University of Tirana*

Introduction Women's National Volleyball and Basketball teams have a diverse performance from each others. Their specific training leads to the diversity of physical qualities and individual or team's sportive performance. Methods This study is concentrated on two teams: Women's Volleyball Team (V) and Women's Basketball Team (B) 12 members each, focusing on 24 subjects. We estimated the average of every team from data such as: Birthday (AGE), Body Height (BH), Body Weight (BW), Body mass (BMI), Body Fat (BF), Squat and Counter-movement Jump (SJ, CMJ), Repetitive Jump (RJ15sec). The C. Boscos tests (3) were performed on the ErgoJump system platform. From the data we were able to calculate the average differences between the two teams. The difference in percentage of (CMJ-SJ) the calculation of the coefficient of the reutilization of the elastic force.  $(CMJ-SJ) \times 100 / CMJ$  percentage of the capacity of reutilization of the accumulated energy as a result of the elastic retraction that proceeds the muscular contraction. The average RJ15sec/CMJ, that is the resistance coefficient of the explosive force. Results These are the results from the evaluations: The differences between Women's V Team with Women's B Team: Age 22.3 < 26.4, BH 180 < 180.2 cm, BW 68.4 > 68.3 kg, BMI 21.12 > 21.04, SJ 28.5 > 25.07 cm, CMJ 34.6 > 30.8 cm, % elasticity 17.71 < 21.54%, BF 25.10 < 26.37%. Average RJ15sec/CMJ = Volleyball is 0.9 and Basketball 0.7. Discussion The team members were tested and the results are displayed in pre designed tables and considered for the team's average estimation. The National teams do not have any differences in the general physical performance considering the parameters of BH, BW, BMI. The formula use in Body fat  $\% = (1.20 \times BMI) + (0.23 \times Age) - 10.8 \times gender - 5.4$  the gender female = 0 have difference. The formula  $(CMJ-SJ) \times 100 / CMJ$  indicates the coefficient of elasticity expressed in percentage of muscular contraction have difference between V and B. Mechanical strength during the jumping at RJ15 sec identifies the qualities and characteristic of aerobic power alaktacide with the adaption of the training. The capacity of resistance of speed power.  $CMJ / (h15 / hCMJ)$  in the case of sports that there is a team involvement reaches values at 0.90-0.95, so from the data we can see that values of these teams have differences between them. Nation Women's V Team 0.9 has relatively better capacity in resistance of speed power compared with nation Women's B Team 0.7. This comes as a consequence of the deficiency in Plyometric and Explosive force training. Still some of the team members are able to reach optimal results after have completed proper training phase. References C. Bosco Ph.D. "La forza muscolare" Aspetti Fisiologici ed Applicazioni Pratiche (Rome 2006) Capitolo IV-La Forza Esplosiva, Capitolo VIII-Applicazioni pratiche del test di Bosco; G. COMETTI, D. COMETTI, "La Pliometria" (origini, teorie, allenamento), 2a edizione italiana (Tivoli 2009); Capitolo V; TEST; Testo di Bosco.

## TACKLE CHARACTERISTICS THAT MAY INCREASE THE LIKELIHOOD OF A SUCCESSFUL TACKLE OUTCOME IN RUGBY UNION

Hendricks, S., Matthews, B., Rhode, B., Lambert, M.I.

*University of Cape Town*

Introduction The tackle in rugby union is a dynamic and high impact contact situation that occurs frequently during matches and exposes players to high risk of injury and muscle damage. Given the nature and frequency of the tackle situation, tackle contact skills are a prerequisite for participation in rugby union. Most techniques described in training manuals and injury prevention programs are based on anecdotal evidence. Retrospective analysis of the tackle has characterized common injury mechanisms for both the ball-carrier and tackler, and effective ball-carrying techniques. In spite of this, no retrospective analysis from a tackler perspective and its association with successful tackle outcomes in rugby union has been investigated to date. Aim The purpose of this study is to identify tackler characteristics that may increase the likelihood of a successful tackle outcome in rugby union. Methods Two thousand and ninety-two tackles from 18 matches of the 2010 Super 14 were analysed. Tackles were coded using characteristics and definitions described in previous research, and characteristics and definitions developed specifically for this study. Characteristics were divided into the three tackle phases i.e. pre-contact (0.5s preceding contact), contact and post contact. The outcomes of the contact event were divided into tackle outcome, possession, territorial change and result. Multinomial logistic regression was used to determine which tackler characteristics increased the likelihood of a successful outcome. Results Pre contact: Tracking decreased the tacklers' chances of a successful tackle (Relative Risk Ratio (RRR) 2.24, 95% CI 1.72-2.92,  $p < 0.001$ ) relative to an up and forward head position. Contact: Arm tackles (RRR 2.32, 95% CI 1.62-3.32,  $p < 0.001$ ), collision tackles (RRR 4.98, 95% CI 2.17-11.42,  $p < 0.001$ ) and jersey tackles (RRR 2.56, 95% CI 1.87-3.49,  $p < 0.001$ ), significantly reduced the chances of a successful result relative to shoulder tackles. Post-tackle: A moderate (RRR 0.36, 95% CI 0.26-0.50,  $p < 0.001$ ) or strong (RRR 0.39, 95% CI 0.11-1.35) leg drive by the tackler after contact increased the likelihood of a successful tackle. Using the arms for either pulling (RRR 0.30, 95% CI 0.21-0.43,  $p < 0.001$ ) or wrapping (RRR 0.19, 95% CI 0.13-0.27,  $p < 0.001$ ), improved tacklers' probability for success in contact. Discussion The characteristics identified in this study are comparable to most training manuals and injury prevention programs. Nonetheless, key characteristics that may require more attention than other characteristics have been identified. The authors of this study propose that coaches and players focus on these key characteristics in training to improve their tackle ability in matches.

## RELIABILITY OF TRUNK STABILITY MUSCLE REACTIONS IN THE CONTEXT OF NUMBER OF CONSECUTIVE TRIALS

Sarabon, N.

*University of Primorska*

Introduction Central lumbo-pelvic stability plays an important role in postural, locomotion and manipulation activities of all kinds. In order to evaluate neuromuscular functions of the LPSM two types of tests (i.e. motor tasks) are commonly used. First, quick voluntary movements of the limbs which involve anticipatory (Ramprasad et al., 2010) and second, sudden unexpected mechanical perturbations which evoke reactive automatic trunk muscles stabilisation actions (Pedersen et al., 2009). The aim of this study was to test intra-session repeatability of automatic neuromuscular responses of three muscles which are involved in lumbo-pelvic stability (LPSM). Methods Sixteen young healthy volunteers participated in the study. Each of them performed four consecutive trials of: (1) a test of self-initiated quick shoulder flexion to test the anticipatory pre-activation patterns of the LPSM, (2) a test of neuromuscular reaction of LPSM on unexpected loading, and (3) a test of neuromuscular reaction of LPSM on unexpected unloading of upper extremities. The latency of the neuromuscular responses (LAT) and the rate of LPSM increase in activation (RMS50) were analysed in all of the responses. The dependence of parameters' repeatability on the number of trials averaged was analysed using ANOVA, ICC, SEM, and CV. Results For all the three observed muscles and all the motor tasks ICCa values of the RMS50 was generally higher than that of LAT. Eighteen or more trials of the same task are needed to achieve acceptable ICCa values. Results of SEM and CV showed progressive decrease with the increasing number of the

trials being averaged. The most reduction in SEM and CV took place with averaging the first 10 consecutive trials. Discussion Based on our results we can conclude that averaging of 20 or more trials of the same lumbo-pelvic stability test will bring us a repeatable measure. However, in order to work with fewer trials also other methodological approaches such as signal averaging should be considered. References Pedersen MT, Randers MB, Skotte JH, Krstrup P. (2009). J Strength Cond Res, 9, 2621-6. Ramprasad M, Shenoy DS, Singh SJ, Sankara N, Joseley SRP. (2010). J Back Musculoskel Reha, 23, 77-86.

**13:45 - 14:45**

## Poster presentations

### PP-PM16 Rehabilitation 1

#### THE EFFECT OF AQUATIC EXERCISE ON THE PEAK TORQUE OF KNEE JOINT OF ELDERLY WOMEN

Dong-hyun, S., Gi Duck, P.

*Namseoul University*

**Introduction** The application of aquatic exercise for elderly persons does not require any special skills, and exercise on the ground can be used underwater as they are in most situations. Taekowndo Poomsae motions are composed of standing, steps for punching as well as kicking motions, and thus, they can improve lower extremity health related to physical strength and can be effective in preventing falling as they reduce balance sway. In this respect, this study is intended to examine the effects of Taekowndo Poomsae motions applied underwater on knee joint peak torque. **Methods** This study was conducted with 23 elderly women divided into an Aquatic Exercise Group(AEG, n=12) and a Control Group(CG, n=11). The knee joint Peak torque was assessed using an ISOMED 2000(D&R GmbH, Germany). The aquatic exercise program was implemented using a N Aquatic Rehabilitation Swimming Pool in Chonan, Korea. The aquatic exercises performed were Taekowndo motions, including Poomsae chapters 1-3, and basic kicks (front kick, side kick and back kick). **Result** With regards to changes in knee joint peak torque, the AEG showed significant differences between before and after the application in all items, including Right knee flexion, Right knee extension, Left knee flexion and Left knee extension( $p<0.05$ ), while the CG did not show any significant differences between before and after the application. **Discussion** When comprehensively considering the aforementioned previous studies, the results indicating that the application of aquatic exercise using Taekowndo Poomsae motions improved knee joint Peak torque is supported, suggesting the applicability of these exercises as a new exercise program for elderly women. **Reference** Maki, B. E., McLroy, W.E.(2006). Control of rapid limb movements for balance recovery: Age-related changes and implications for fall prevention. *Age Ageing*, 35: M126- M134. Masani K, Vette AH, Kouzaki M, et al.(2007). Larger center of pressure minus center of gravity in the elderly induces larger body acceleration during quiet standing. *Neuroscience Letters*, 422, 202-206.

#### SLOWED EXERCISE-ONSET VO<sub>2</sub> KINETICS DURING LOW-TO-MODERATE-INTENSITY ENDURANCE EXERCISE IN SUBJECTS WITH MULTIPLE SCLEROSIS

Hansen, D., Wens, I., Kosten, L., Verboven, K., Eijnde, B.O.

*Hasselt University*

**Background** In multiple sclerosis (MS) patients, a lowered skeletal muscle oxidative capacity is present. It might be relevant to be able to assess skeletal muscle oxidative capacity in MS patients without the need of invasive techniques and/or maximal exercise testing. For this purpose, the exercise-onset oxygen uptake (VO<sub>2</sub>) kinetics during endurance exercise is measured. The objective of this study was to assess exercise-onset VO<sub>2</sub> kinetics in MS patients vs healthy subjects. **Methods** From 38 MS patients and 17 healthy subjects, exercise-onset VO<sub>2</sub> kinetics (mean response time (MRT)) was determined during two subsequent 6-minute low-to-moderate-intensity exercise bouts. Blood lactate, heart rate, expiratory volume and Borg ratings of perceived exertion was assessed during exercise, and compared between groups. Relations between muscle strength, body composition, EDSS score, physical activity, and MRT were assessed in MS patients. **Results** During exercise blood lactate, heart rate, and expiratory volume were equal between groups ( $p>0.05$ ), but MRT was significantly slower in MS patients vs healthy subjects ( $p<0.05$ ). In total population, MRT was independently related to MS presence ( $p<0.05$ ). In MS patients, no independent relations were found between muscle strength, body composition, physical activity, EDSS score, and MRT ( $p>0.05$ ). **Discussion** Because of the observation of slowed exercise-onset VO<sub>2</sub> kinetics during endurance exercise in MS patients vs healthy subjects, and because no clinical parameters were related to exercise-onset VO<sub>2</sub> kinetics, these findings might suggest that MS patients suffer from molecular skeletal muscle dysfunctioning (such as lowered oxidative capacity) during endurance exercise. By applying such exercise tests, we are now capable of estimating (changes in) oxidative capacity of skeletal muscle in MS patients, without the need of maximal exercise tests or invasive procedures.

#### INDIVIDUALIZATION OF EXERCISE PRESCRIPTION BY THE USE OF THE PERCEIVED EXERTION RELATED TO THE CROSS-OVER POINT IN WOMEN WITH METABOLIC SYNDROME

Garcin, M.

*University Lille Nord de France*

**INDIVIDUALIZATION OF EXERCISE PRESCRIPTION BY THE USE OF THE PERCEIVED EXERTION RELATED TO THE CROSSOVER POINT IN WOMEN WITH METABOLIC SYNDROME** Garcin, M.1 2, Borel, B.1 2, Coquart, J.3, Matran, R.1 4, Delsart, P.5, Mounier-Vehier, C.5 1: Univ Lille Nord de France (Lille, France), 2: UDSL, EA4488 (Ronchin, France), 3: Univ Rouen, EA 3832 (Rouen, France), 4: Service des Explorations Fonctionnelles et Respiratoires, Hôpital Calmette, CHRU Lille (France), 5: Service de Médecine Vasculaire et Hypertension Artérielle, CHRU Lille (France) **Introduction** The use of indirect calorimetry in effort which allows to determine the crossover point of substrate utilization (COP) is used in order to individualize the prescription of exercise intensity (Brun et al., 2007). Furthermore, the use of a perceived exertion scale (RPE, Borg, 1970) can be proposed to prescribe the exercise intensity (Dunbar et al., 1992). The study's aim was to examine 1) the feasibility of the use of the RPE to prescribe a rehabilitation program individualized at COP, and 2) the effects of this program on the maximal work capacity and RPE in women with metabolic syndrome (MS). **Methods** Fifteen women with MS (age = 56.0 ± 8.2 yrs; mass =

87.7 ± 12.7 kg; height = 160 ± 6 cm) performed a test to exhaustion to estimate the peak of oxygen uptake (VO<sub>2</sub>peak) and the power output peak (Ppeak), and an indirect calorimetry test to determine COP and the related RPE. These women followed a rehabilitation program (3 sessions of 45 min.wk<sup>-1</sup> at the target RPE related to their COP on cycle ergometer during 12 wks). After the rehabilitation program, the tests were performed again. Results The target RPE was 11.8 ± 3.0 (i.e. light). The power adjusted was not significantly different from the target power (40 ± 15 vs 41 ± 17 W; p=0.60). For the same prescribed target RPE, the power output adjusted by the women increased with the rehabilitation duration (P<0.001). VO<sub>2</sub>peak and Ppeak were increased (17.3 ± 3.9 vs 18.5 ± 4.3ml.min<sup>-1</sup>.kg<sup>-1</sup>; 101 ± 25 vs 122 ± 29 W, respectively; p=0.01) whereas RPE was lower after the rehabilitation period during the indirect calorimetry test (p=0.006). Discussion These women did success to regulate the power output to COP from their target RPE. Moreover, the use of target RPE allowed these women to increase the power output during the rehabilitation program, and so to significantly improve their maximal work capacity. Both the increase of maximal work capacity and the decrease of RPE for a same relative power output after the rehabilitation program showed the beneficial effects of this program prescribed from RPE in these women with MS. References Borg GV. (1970) Scand J Rehabil Med, 2, 92-98. Brun JF, Jean E, Ghanassia E, Flavier S, Mercier J. (2007) Ann Readapt Med Phys 50, 528-534. Dunbar CC. (1993) Clin Sports Med, 16, 221-224.

## VALIDATION OF ACTIHEART ENERGY EXPENDITURE MEASUREMENT IN COPD PATIENTS

Oomen, J., Gosens, W., Brage, S., Borghouts, L.

*Fontys University of Applied Sciences*

Introduction Assessment of physical activity energy expenditure (PAEE) outside the standardised laboratory is complex. Thompson et al.1 showed that motion sensors do not provide an accurate estimation of PAEE whereas the combined motion and heart rate sensor Actiheart does. However, measurement of PAEE with Actiheart has never been evaluated in patients with COPD. Therefore this study examined the validity of the Actiheart against indirect calorimetry for PAEE measurement in patients with COPD. Methods 27 patients with COPD (FEV1/FVC <70%, age 58 ± 7 years) were selected for the study. Patients were asked to perform five simulated Activities of Daily Living (ADL) (Walking, Watering plants, Walking with a load, Stocking laundry and Cycling) for 8 minutes. These activities were selected from a study of Ainsworth et al 2 and expected to represent a range in PAEE. There was an 8 minutes resting period between activities. Energy expenditure was estimated during the activities using the Actiheart 3 with indirect calorimetry (Cosmed K4B2) as the reference measurement. Results PAEE measured with Cosmed was in a very small range (13,3 vs 16,3 kJ/min) and most activities did not differ significantly from each other in energy expenditure. Using the algorithms valid in healthy subjects, the Actiheart was not able to correctly estimate PAEE in the individual tasks (p < 0,001) and the protocol as a whole (P < 0,001). After manually 'tweaking' the algorithms there was no significant difference in PAEE between the Cosmed and the Actiheart in the individual activities (p > 0,4) and the protocol as a whole (total PAEE) (p > 0,9). Discussion Actiheart was not able to calculate PAEE in patients with COPD using the algorithms validated for healthy adults. After we adapted these, PAEE calculated from Actiheart did not differ from indirect calorimetry. However, the HR-range (HRmax symptom limited - HRrest) in which patients performed their activities was very small. Therefore, the PAEE range was also small. COPD patients are symptom limited due to shortness of breath and the use of medication (e.g. Beta blockers). As a result, all activities were performed at an intensity between Flex- and Transition heart rate. This may limit the use of branched algorithms in COPD. 1. Thompson D, Batterham AM, Bock S, Robson C, Stokes K. Assessment of low-to-moderate intensity physical activity thermogenesis in young adults using synchronized heart rate and accelerometry with branched-equation modeling. J Nutr 2006;136:1037-42. 2. Ainsworth, B.E., et al., Compendium of physical activities: classification of energy costs of human physical activities. Med Sci Sports Exerc, 1993. 25(1): p. 71-80. 3. Brage, S., et al., Branched equation modeling of simultaneous accelerometry and heart rate monitoring improves estimate of directly measured physical activity energy expenditure. J Appl Physiol, 2004. 96(1): p. 343-51.

## MECHANICAL EFFICIENCY IN COPD

Gosens, W., van 't Hul, A.J., Oomen, J.M., van Ranst Hesselink, M.K.C., Borghouts, L.B.

*Institute of Human Movement and Sports, Fontys University of Applied Sciences, Tilburg, The Netherlands & Maastricht University, Maastricht, The Netherlands.*

Mechanical efficiency in COPD Gosens, W.1,2, van 't Hul, A.J.3,4, Oomen, J.M.1, van Ranst D.3, Hesselink, M.K.C.2, Borghouts, L.B.1  
1Institute of Human Movement and Sports, Fontys University of Applied Sciences, Tilburg, The Netherlands 2Department of Human Movement Sciences, Maastricht University, Maastricht, The Netherlands 3Revant, Rehabilitation Centre, Breda, The Netherlands 4Department of Pulmonary Diseases, VU Medical Centre, Amsterdam, The Netherlands Introduction Chronic Obstructive Pulmonary Disease (COPD) is a disease clinically characterised by breathlessness on exertion, fatigue and exercise intolerance. The underlying mechanisms of symptoms and exercise intolerance are complex. Exercise tolerance decreases with increasing severity of the disease. Therefore, it can be hypothesised that ME declines with increasing severity of the disease and that indices of the severity of the disease are independent predictors for ME in COPD. However, absolute work rate explains about 90% of the gross ME in healthy subjects (Ettema et al., 2009). Therefore, the primary aims of this study were: 1) to evaluate whole body ME in a large group of COPD patients with a wide range of degree of illness, 2) to examine how ME in COPD is related to absolute work rate and indices of disease severity. Methods 569 patients (301 male, 268 female) with COPD (28 GOLD stage I; 166 GOLD stage II; 265 GOLD stage III and 110 GOLD stage IV) were included in the data-analysis. Body composition and pulmonary functions were determined according to recommended standards. Ventilatory and metabolic response parameters were collected during the constant work rate test at 75% Wmax. The gross mechanical efficiency was calculated from the ventilator parameters, using the abbreviated Weir formula. Results The mean whole body gross ME was 11.0 ± 3.5% at 75% peak power. The ME declined significantly (P<0.001) with increasing severity of the disease when measured at the same relative power. Log transformed absolute work rate (r = 0.87, p<0.001) was the strongest independent predictor of gross ME. Discussion This study demonstrates that when patients are compared at the same relative work load, gross mechanical efficiency (ME) seemingly declines with increasing severity of disease in COPD. However, when gross ME is expressed as a function of absolute work rate, there is no relation between gross ME and indices of disease severity. Conclusion Gross ME in COPD is largely predicted by the absolute work rate (r = 0.87, p<0.001) and indices of the severity of the disease do not predict ME in COPD. References Ettema G, Lorc's H (2009) Efficiency in cycling: a review. Eur J Appl Physiol 106(1):1-14

**MOVING FORWARD PROJECT: REHABILITATION OF HEART FAILURE PATIENTS IN A REGIONAL HOSPITAL.**

van Berkel, S., de Vries, S.T., Vegter, W.H., van 't Hof, A.J.W.

*Isala klinieken Zwolle*

Introduction Heart failure is an increasing problem in today's society because people are getting older, are surviving a heart attack, are obese and/or are diabetic. Therefore the number of people that develop heart failure is increasing. The prevalence is 3.0% at 65 to 74 years to 16.8% above 85 years(1). The first mortality is 40%(2). Physical inactivity is very common among heart failure patients and will lead to further decrease of physical condition and progression of heart failure. The goal of this study is to examine whether an early, both clinical and home-based, intensive rehabilitation program in a regional hospital has a positive effect on exercise capacity, quality of life and hospital admissions in heart failure patients. Methods Sixty-two patients were included in 2009 and 2010 in the "Moving Forward Project", a 12 month intensive rehabilitation program. The rehabilitation consisted of both endurance and weight training. The patients exercised 4 days per week at home and on two days per week at the hospital under supervision. Maximal oxygen uptake capacity was measured during a cycle ergometer test. Quality of life was measure with the Minnesota Living with Heart Failure questionnaire. The hospital admissions and other adverse events were registered. All measurements were performed at baseline and after 3, 6 and 12 months. Results The preliminary results show that maximal oxygen uptake capacity increased by 14% (= 2.2 ml/min/kg, n=41) after 3 months and by 26% (= 4.0 ml/min/kg, n=29) after 6 months. Quality of life did not improve after 3 months (41.8 to 39.7; n.s.), but did improve after 6 months (40.8 to 34.0; p=0.03). The average number of hospital admissions during the 12 months of the program was  $2.0 \pm 1.4$ . The primary reason for admission was heart failure (50%). Conclusion and discussion An intensive rehabilitation program in a regional hospital leads to improvement of physical condition and quality of life in heart failure patients. Whether this will also lead to a better long-term survival is a question that remains to be answered in future studies. 1 Cowie MR, Wood DA, Coats AJS, Thompson SG, Poole-Wilson PA, Suresh V & Sutton GC. Incidence and aetiology of heart failure. A population-based study. *European Heart Journal* 1999; 20: 421-428 2 Cowie MR, Wood DA, Coats AJS, Thompson SG, Suresh V, Poole-Wilson PA, Sutton GC. Survival of patients with a new diagnosis of heart failure: a population based study. *Heart* 2000; 83: 505-510

**PREVALENCE AND TRENDS OF OVERWEIGHT AND OBESITY IN YOUNG ITALIAN ATHLETES: DIFFERENCE BETWEEN YEARS OF COMPETITIVE SPORT PRACTICE**

Attisani, G., Attisani, I., Castagna, A.

*Centro Medico Fisios*

Objective: To provide current estimates of the prevalence and trends of overweight and obesity in Italian children and adolescents who play sports from a different amount of years. Research, Methods and Procedures: This was a cross-sectional study of 2344 athletes (M/F:1682/662) aged 12 to 18 years. Height and weight were measured in a Sport Medicine Clinics during the period between 2009 and 2006 (1017 subject, 69.5% male). To classify the athletes were used the International Obesity TaskForce cut-offs (IOTF)-2. The IOTF classify BMI in children as thin, normal weight, overweight or obese, depending on the child's age and sex, based on adult BMI cut-offs at 18 years. Normal weight or thin for BMI range at 18y <25, overweight for BMI range at 18y from 25 to 30 and obesity for BMI range at 18y >30. Then the athletes were divided into two groups. A: athletes at the first physical fitness examination for competitive sport; B: athletes who have made six consecutive annual visits. The data was obtained through a questionnaire and subsequent verification by medical records. The data of group A was compared with data of group B. A probability level of  $p < 0.05$  was used to indicate statistical significance. Results: The prevalence of overweight in group A was 24.3% (273) in male and 19.5% (93) in female. The prevalence of obesity in group A was 4.8% (54) in male and 5.1% (24) in female. The prevalence of overweight in group B was 20.3% (88) in male and 8.9% (33) in female. The prevalence of obesity in group B was 2.1% (9) in male and 1.7% (6) in female (Tab. 1). We observed a decrease of overweight of 4% in male ( $\chi^2$  Yates corrected=3.57;  $p=0.0590$ ; odds ratio=0.76) and of 10.6% in female ( $\chi^2$  Yates corrected=19.56;  $p=0.0000$ ; odds ratio=0.38); a decrease of obesity of 2.7% in male ( $\chi^2$  Yates corrected=6.18;  $p=0.0129$ ; odds ratio=0.39) and 3.4% in female ( $\chi^2$  Yates corrected=7.94;  $p=0.0048$ ; odds ratio=0.27) (Tab. 2). Conclusions: The prevalence of overweight and obesity in group B is less than the prevalence in group A. This proves that sport practiced continuously during the adolescent period is useful to maintain or gain normal weight. References: 1. Cole TJ, Bellizzi MC, Flegal KM and Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ* 2000;320:1240-3. 2. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut-offs to define thinness in children and adolescents. *BMJ* 2007;335:194-7.

**13:45 - 14:45****Poster presentations****PP-PM17 Physiotherapy****AGE-RELATED CHANGES IN TOE GRIP STRENGTH AS MEASURED BY A TOE GRIP DYNAMOMETER: RELATIONSHIPS BETWEEN TOE GRIP STRENGTH AND PHYSICAL FUNCTIONS**

Uritani, D., Fukumoto, T., Maeoka, H., Okada, Y., Matsumoto, D.

*Kio University*

Introduction Toe grip strength (TGS) is associated with physical functions such as balancing (Endo et al., 2002) and walking (Hughes et al., 1990), and TGS decreases with aging (Endo et al., 2002). However, a reference value for TGS is not clear because a standard method of measurement of TGS has not been developed. Thus, the relationships between TGS and physical functions are unclear. The aim of this study was to clarify age-related changes of TGS, to develop a prediction equation of TGS, and to investigate relationships between TGS and physical functions using a toe grip dynamometer developed by us. Methods Participants were 1194 subjects (mean (standard deviation) age, 56.2 (14.4) years; age range, 20-79 years; 437 males and 757 females). Outcome measures were TGS, hand grip strength (HGS), isometric knee extension strength (IKES), vertical jump, and functional reach. Participants were divided into three groups: young (Y) group (aged 20-39 years), middle age (M) group (aged 40-59), and old (O) group (aged 60-79 years). Correlations between TGS and

other outcomes with age, height and weight were examined using Pearson's correlation coefficient. Outcomes were compared among three groups using one-way ANOVA with post-hoc test by gender. A prediction equation of TGS was developed based on stepwise multiple-regression analysis including gender, age, height and weight as explanatory variables. The significance level was set at 5%. Results TGS was correlated with age ( $r = -0.48$ ), height ( $r = 0.56$ ), weight ( $r = 0.41$ ), HGS ( $r = 0.61$ ), IKES ( $r = 0.61$ ), vertical jump ( $r = 0.66$ ) and functional reach ( $r = 0.35$ ). In males, TGS of the O group (10.9 kg) was significantly lower than that of the Y group (16.6 kg) and M group (14.4 kg), and TGS of the M group was significantly lower than that of the Y group. In females, TGS of the O group (7.2 kg) was significantly lower than that of the Y group (10.5 kg) and M group (9.4 kg). Other outcome measures also decreased significantly with aging in both genders. A prediction equation was  $TGS = 0.688 - 2.587 \times \text{gender (male: 0, female: 1)} - 0.112 \times \text{age} + 0.097 \times \text{height} + 0.033 \times \text{weight}$  ( $R^2 = 0.42$ ). Discussion Our results showed that TGS decreased with aging, especially after 60 years of age. TGS was predicted by gender, age, height and weight. TGS was associated HGS and IKES, and may represent extremity muscle strength, as well as HGS and IKES. TGS was associated with not only balancing ability, but also jumping performance. References Endo M, Ashton-Miller JA, Alexander NB. (2002). *J Gerontol A Biol Sci Med Sci*, 57(6), M392-397. Hughes J, Clark P, Klenerman L. (1990). *J Bone Joint Surg*, 72B(2), 245-251.

### **SIGNIFICANCE OF THE ELDERLY LIVING IN THE COMMUNITY BEING ABLE TO STAND ON ONE LEG WITH EYES OPEN: A STUDY OF PHYSICAL, COGNITIVE, AND PSYCHOLOGICAL FUNCTIONS**

MURATA, S., KUBO, A., KAI, Y.

*Nishikyushu University*

**Introduction** The simplest form of balance function test is to measure the time of being able to stand on one leg. Although measurement of the time of being able to stand on one leg with eyes open is of significant convenience as a test of the balance function, few studies have been conducted to support the validity of the measurements as criteria for judgment, or examine their relationships with physical, cognitive, and psychological functions in a comprehensive manner. In this study, which is based on the criteria set by previous studies, we examined the significance of the elderly (with a mean age in the seventies) living in the community to be able to stand on one leg for fifteen seconds, focusing on their physical, cognitive, and psychological functions. **Methods** We categorized the subjects into two groups: 304 people who were able to stand on one leg with eyes open for fifteen seconds or longer and 203 people who were unable to do so. We conducted age-adjusted covariance analyses of physical (grip, quadriceps strengths, foot-grip strength, sit-ups test, sit-and-reach flexibility, walking speeds, 10-m obstacle walk, 6-minute walk, 3-m time up to go test), cognitive (Mini mental state examination, Trail making test), and psychological (Sense of health, Sense of satisfaction of life, Purpose of life) functions between the two groups. **Results** All scores for muscle strength and walking ability were markedly lower in the unable group. No significant difference in the cognitive functions was noted between the two groups. Scores for a subjective sense of well-being and the purpose of life were lower in the unable group. **Discussion** Thus, we concluded that the test to examine elderly people's ability to stand on one leg is a simple and effective method for identifying a decrease in their physical functions. It is also suggested that if an elderly person is unable to stand on one leg for fifteen seconds with eyes open, it might indicate a decrease in his/her psychological functions, such as a subjective sense of well-being and the purpose of life. It is important to conduct comprehensive assessment to examine the psychological as well as physical functions of the elderly in the "unable" group. The subjects of the study were elderly people who were living an independent life in the community. A study involving the fragile elderly should be conducted to examine whether the results are applicable to the case of physically weak elderly people. As this was a cross-sectional study, it is difficult to determine whether the time of being able to stand on one leg influenced the psychological functions or the time was affected by the functions. This point should be clarified by a longitudinal study.

### **A DISCUSSION ON DYNAMIC BALANCE DIFFERENCES UPON USAGE OF KINESIO TAPE AMONG COMMUNITY-DWELLING ELDERLS**

Lai, C.H., Lin, C.W., Chiang, Y.L., Chen, C.L.

*TZU-HUI INSTITUTE OF TECHNOLOGY (Pingtung, Taiwan)*

**Introduction** It had been shown that the ability to maintain balance could help to reduce the risk of falls in elders, which might be associated with activity limitation and have influences upon one's quality of life. Poor balance control could result in physical changes among elderly population. Hence, falling prevention should be taken into consideration along with joint stability and muscle strength. Kinesio taping method has been a preferred taping method by athletes, physical therapists and further medical practitioners. It provides applied area full range of motion, stability, and support. An appropriate kinesio taping method meant for improving dynamic balance control among community-dwelling elders was examined through this study as a result. **Methods** 20 active and healthy community-dwelling elders (10 men, 10 women, aged 65 and older) participated in this study. After completing a questionnaire of baseline characteristics, all participants were asked to view an instructional demonstration of SEBT. Each participant accomplished 6 trials on dominant leg in each of the 3 reach directions (anterior, posteromedial, and posterolateral) during the first day; followed by taking the same 3 pre-taping data trials and another 3 post-taping data trials with kinesio tape on the second day. Kinesio tapes were applied to stance leg by an experienced physical therapist in order to facilitate gluteus medius, vastus medialis and stability of ankle joints. Numbers noted of greatest reach distance upon each direction of pre- and post-taping were summed to analyze outcome efficacy of kinesio tape applying in related to dynamic balance of elderly people. Paired sample t-test was used to identify differences among pre-taping and post-taping trials. **Results** The mean reach distance (sum of the 3 reach distances in centimeters) of pre-taping trial is 171.6cm; along with the mean reach distance of post-taping trial is 174.9cm. Significantly greater mean reach distance was found between pre-taping and post-taping trials ( $p < .01$ ). **Discussion** This was the first study focused on using kinesio tape to enhance dynamic balance performance of elders. There was no control group in this study, therefore limb length measurements for normalization the reach distances were not required. Post-taping trials showed greater mean reach distance suggested positive assists in maintaining dynamic balance control. Further study is needed to observe if kinesio tape could reduce the threat of fall. We propose this easy-to-learn, easy to use as well as effective kinesio taping method to provide solutions for enhancing activity levels and living quality in support of older adults. References Norris B, Trudelle-Jackson E. (2011). *J Sport Rehabil*, 20(4), 428-41. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB. (2006). *J Orthop Sports Phys Ther*, 36(12), 911-9. King MB, Tinetti ME. (2005). *J Am Geriatr Soc*, 43(10), 1146-54.

## PHYSICAL ACTIVITY AND LOW BACK PAIN DURING PREGNANCY

Santos, P.C.1,2, Abreu, S.2, Lopes, D.3, Moreira, C.2, Couto, M.1, Ferreira, M.2, Alves, O.4, Santos, R.2, Vale, S.2, Marques, A.I.2, Moreira, P.2,5, Mota, J.2

1. *Escola Superior de Tecnologia da Saude do Porto\_IPP;2. FADEUP\_UP; 3 Clinical Practice; 4. ULSAM; 5. FCNA\_UP*

Background: Pregnancy-related low back pain is an increasingly reported condition, with substantial costs on health. Prevention of this condition is an explicit need, and physical activity during pregnancy may play an important role. Aim: To evaluate the proportion of non-specific pregnancy-related low back pain (NSPLBP) and its association with type and intensity level of PA during pregnancy. Methods: A longitudinal prospective cohort study was developed in a consecutive sample of 118 pregnant women with a mean age of  $28.8 \pm 4.85$ . Participants were evaluated in the first, second and third trimester. A questionnaire was used to collect socio-demographic data and lifestyle variables, and to determine the presence of NSPLBP. Type and intensity level of PA were evaluated using the Pregnancy Physical Activity Questionnaire (PPAQ). Chi-square test and Fisher's test were used to analyze the association between variables, using the Statistical Package for Social Sciences (SPSS®). Results: It was found a proportion of 40.7%, 52.2% and 66.7% for NSPLBP at first, second, and third trimester respectively and a prevalence of 76.3% NSPLBP at any time during pregnancy (period prevalence). Analyzing the incidence of NSPLBP, there were found 10, 28 and 24 new cases in the first, second and third trimester. Intensity and type of physical activity were not associated with this condition, except in household/caregiving activities where it was found statistically significant differences between the tertiles. In second trimester, women who were in third tertile had a lower prevalence of low back pain compared with the other tertiles (tercil1 40.0%; terci2 38.3; terci3 21.7,  $p=0.042$ ); in third trimester, in leisure except sport, there were statistically significant differences in the frequency of NSPLBP between tertiles, being the lowest frequency found in second tertile (tercil1 37.2% ; terci2 20.5; terci3 42.3,  $p=0.019$ ). Conclusion: Non-specific pregnancy-related low back pain represents a common condition among pregnant women and should thus be faced as a major public health issue. This condition was not associated with type and intensity of physical activity during pregnancy except in household/caregiving and leisure except sport in a specific period.

## DIFFERENTS ISOKINETICS BETWEEN INJURED AND UN-INJURED SEMI-PROFESSIONAL SOCCER PLAYERS

Marfínez-Ruiz, E.1, Esparza-Ros, F.1, Marfínez-Pardo, E.2, Rubio-Arias, J.A.2, Alcaraz, P.E.2

*Catholic University of San Antonio*

Introduction The muscle injuries are characterized by high injury and re-injury rate. Therefore, is necessary to improve understanding is necessary to improve our understanding about the functional modifications after muscle injuries, that would allow to developing more effective rehabilitation and prevention programs. So, the aim of this study was analyzed differences in the muscle strength isokinetic between injured and un-injured semi-professional soccer players. Methods Twenty-four male soccer players ( $26.08 \pm 4.71$  years,  $179.75 \pm 4.46$  cm and  $76 \pm 5.59$  kg) were tested at the same day, in January (mid-season). An isokinetic concentric test flex/extension knee at angular velocities of  $60^\circ/s$ ,  $180^\circ/s$  and  $270^\circ/s$ , obtaining the peak torque (Nm), coefficient of variation, hamstring/quadriceps ratio (H:Q ratio), acceleration time (m/s) and power (W). The muscle injuries of the players were monitored during the competitive season. This data was analyzed with Independent Samples T- Test, the priori level of statistical significance was set at  $p \leq 0.05$ . Results The injury players showed significantly higher values in the coefficient of variation for knee flexion at angular velocity of  $180^\circ/s$  that un-injured players. Not significative differences was found between groups of injured and un-injured subjects for the peak torque, H:Q ratio, acceleration time and power at angular velocities of  $60^\circ/s$ ,  $180^\circ/s$  and  $270^\circ/s$ . Discussion Our result suggest that the coefficient of variation for knee flexion at angular velocity of  $180^\circ/s$  could be related to muscle fatigue. This risk factor has been frequently suggested as a possible etiology of muscle injuries (Croisier, 2004; Devlin, 2000). Other isokinetic variables, as stated by Bennell et al. (1998), were no significant difference between injuries and un-injuries players. In summary, the isokinetic concentric test can be useful in the identification of subjects with muscle injuries. References Bennell, K., Wajswelner, H., Lew, P., Schall-Riaucour, A., Leslie, S., Plant, D., et al. (1998). Isokinetic strength testing does not predict hamstring injury in Australian Rules footballers. *Br J Sports Med*, 32(4), 309-314. Croisier, J. L. (2004). Factors associated with recurrent hamstring injuries. *Sports Med*, 34(10), 681-695. Devlin, L. (2000). Recurrent posterior thigh symptoms detrimental to performance in rugby union: predisposing factors. *Sports Med*, 29(4), 273-287.

## EFFECTIVENESS OF A THERAPEUTIC EXERCISE INTERVENTION COMBINING MCGILL PROTOCOL AND MOTOR-SENSORY EXERCISES ON BACK PAIN INTENSITY

Shalaj, I.1, Tishukaj, F.1, Gjaka, M.1, Tschan, H.2

1: *University of Prishtina, 2: University of Vienna*

Introduction Inadequate body posture may lead to the development of spine deformities and result in back pain which is highly prevalent in all age groups and presents an enormous socioeconomic burden. Purpose The aim of this study was to determine the relationship between the quality of body posture (based on spinal muscular imbalance) and back pain syndromes and to examine the effectiveness of a therapeutic exercise intervention on pain and postural control markers, respectively. Methods 43 patients (13 male and 30 female, respectively) aged 18-50 yrs suffering from back pain (stage 2 and 3 according to Oswestry Disability Index) were included and volunteered to participate in this exercise intervention study using the McGill protocol combined with motor-sensory exercises (12 weeks; 3 times per week; 40 min per session). To monitor treatment effectiveness the disability score the Oswestry Disability Index (ODI) was assessed before and after the intervention, as were balance parameters (MTF) and postural parameters (IDIAG, MediMouse). Descriptive and analytical procedures were performed using SPSS. Results Exercise treatment significant decreased pain intensity as assessed by ODI ( $p < 0.000$ ). Initially there had been 30 patients (69.8%) diagnosed with back pain stage 2, and 13 subjects (30.2%) with back pain stage 3, respectively. Following the exercise intervention 31 patients (72.1%) improved to stage 1 according to ODI, 9 (20.9%) improved to ODI stage 2, and only 3 patients (7%) did not improve and remained in stage 3 according to ODI. Body-stability and functional movement symmetry characteristics both improved significantly ( $p < 0.01$ ) following 12 weeks of exercise treatment. Conclusion Based on these results it appears that a therapeutic exercise intervention combining the McGill protocol combined with motor-sensory exercises is effective in reducing pain-related disability of individual activities of daily living and improve body posture parameters. These results allow speculating that spine muscle imbalances and weaknesses are causally related with the development of back pain.



**PAIN INHIBITION AND POSTEXERTIONAL MALAISE IN CHRONIC FATIGUE SYNDROME : AN EXPERIMENTAL STUDY**

Van Oosterwijck, J.1,2,3, Nijs, J.1,2,3, Meeus, M.1,2, Lefever, I.1, Huybrechts, L.2, Lambrecht, L.4, Paul, L.5

1:Vrije Universiteit Brussel (Belgium), 2:Artesis University College Antwerp (Belgium), 3: University Hospital Brussels (Belgium), 4:Private practice Ghent (Belgium), 5:University of Glasgow (UK)

**Introduction:** CFS patients show severe symptom and pain exacerbation following physical exercise [1-3]. It seems that the pain inhibitory systems in these patients do not respond to exercise as they do in healthy subjects and the underlying mechanisms of symptom exacerbation following exercise in CFS still remain unclear. Therefore this study aimed at examining 1) the efficacy of the pain inhibitory systems in CFS patients during 2 different types of exercise, 2) whether the (mal)functioning of pain inhibitory systems is associated with symptom increase following exercise. The knowledge can be used to steer the content of physical exercise programs used in the rehabilitation of CFS patients. **Methods:** Twenty-two women with CFS and 22 healthy sedentary controls performed a submaximal exercise test and a self-paced, physiologically limited exercise test on a cycle ergometer with continuous cardiorespiratory monitoring. Subjects their health status and pressure pain thresholds (PPTs) were assessed before and after each exercise bout. Activity levels were assessed using accelerometry. Possible changes in any of the outcome measures in response to exercise were compared using repeated measures ANOVA. **Results:** In CFS patients, pressure pain thresholds decreased following both types of exercise, whereas they increased in healthy subjects (between group differences p-value varying between .077 and .002). This was accompanied by a worsening of the CFS symptom complex post-exercise ( $p < .05$ ). Decreased pressure pain thresholds during submaximal exercise were associated with postexertional fatigue in the CFS group ( $r = .454; p = .034$ ). Although CFS patients reported increased fatigue post-exercise, their level of actual physical activity remained unchanged ( $F = .838; p = .365$ ). **Discussion:** These observations indicate the presence of abnormal central pain processing during exercise in CFS patients and demonstrate that both submaximal exercise and self-paced, physiologically limited exercise trigger postexertional malaise in these patients. These observations indicate the presence of abnormal central pain processing during exercise in CFS patients and demonstrate that both submaximal exercise and self-paced, physiologically limited exercise trigger postexertional malaise in these patients. Further study is required to identify specific modes and intensity of exercise that can be performed in people with CFS without exacerbating symptoms. These results highlight the fact that one should be cautious when evaluating exercise in people with CFS. Exercise programs should be individually tailored, keeping in mind that even minimal over-exertion may be counterproductive by increasing pain and symptoms, thus prolonging recovery. **References:** 1.Jammes et al. *J Intern Med* 2005;257:299-310. 2.Lapp CW. *Am J Med* 1997;103:83-84. 3.Bazelmans et al. *J Psychosom Res* 2005;59:201-208.

**THE EFFECT OF STRENGTH AND BALANCE TRAINING IN WOMEN WITH KNEE OSTEOARTHRITIS**

Gulsen, M., Koz, M.

*Baskent University*

The aim of this study is to investigate the effect of strength and balance training on muscle strength, balance and disability. The participants were 32 female between the ages of 45-70, who were graded II and III knee OA according to "Kellgren-Lawrence Scale". The participants were divided into four groups as each group had 8 participants: strength training, balance training, both strength and balance training and control groups. Sociodemographic features were recorded. Then their muscle strength tests (by isokinetic dynamometer (Cybex 770 Norm Lumex Inc, Ronkonkoma, NY, USA), balance tests (by SPORTKAT 3000 (LLCVista CA 92083)) and disability tests (by West Ontario and McMaster University Osteoarthritis index (WOMAC)) were applied. The participants in strength group performed 6 days in a week for 4 weeks strength training with a physical therapist observation. The participants in balance group performed 30 minutes, 6 days in a week for 4 weeks balance training with a physical therapist observation with KAT system. The participants in both strength and balance group performed both 6 days in a week for 4 weeks strength training and 6 days in a week for 4 weeks balance training with a physical therapist observation with KAT system. The participants in control group didn't take any training programme. After 4 weeks, the evaluations were repeated. According to strength training measurement results, better muscle strength improvements were found in both strength and balance group than balance and control groups, and in strength group than both strength and balance group, balance and control group ( $p < .05$ ). In balance group, no significant difference was found with other groups in strength training. According to balance training measurement results, in balance group better improvements observed than strength group, strength-balance group and control group, and in strength-balance group showed better improvements than strength and control groups ( $p < .05$ ). No significant difference was found in WOMAC values by strength-balance training, strength training, balance training ( $p > .05$ ). We think that appropriate physio-therapy program that is prepared for knee OA patients will contribute the improvements about protecting and improving knee muscle strength and correcting patients' balance according to this study.

**13:45 - 14:45**

**Poster presentations****PP-PM18 Nutrition 2****TAURINE SUPPLEMENTATION: EFFECTS ON ENERGY METABOLISM IN OBESE.**

Freitas, E.C., Rosa, F.T., Suen, V.M.M., Pfrimer, K., Ferrioli, E., Marchini, J.S.

*School Physical Education and Sport of Ribeirão Preto*

**Introduction:** Taurine is an amino acid present in large quantities in mammalian tissues. However, the studies showed that plasma levels of taurine are significantly lower in obese subjects. It is suggested that taurine supplementation increases the consumption of oxygen, thereby increasing energy expenditure. The purpose of the study was to investigate the concentration of taurine and changes in total energy expenditure (TEE) of obese women after taurine supplementation. **Methods:** A double-blind study was conducted with 16 obese sedentary women, BMI 48.2 (35-54) kg / m<sup>2</sup>. Participants were divided into two groups: placebo (PL) (3 g flour starch / day, n = 8) and taurine supplementation (TS) (3 g of taurine / day, n = 8). All women participated in the Nutrition Education Program. Nutritional assessment included weight, body mass index, composition of fat-free mass (FFM) and fat mass (FM) measured by the method of dilution of deuterium oxide. Taurine plasma was analyzed using quantitative and qualitative analysis of plasma amino acids, total energy expendi-

ture (TEE) by doubly labeled water (DLW) technique. All participants were evaluated before (baseline) and after 8 weeks of supplementation. The analysis of variance (ANOVA) followed by post hoc Bonferroni tests were applied to Statistical analysis. Results: The mean weight of each group was 120 (97 -135) and 126 kg (152-100). The mean weight loss in the TS and PL groups was 4 kg after 8 weeks. There was no significant difference between groups in weight loss after 8 weeks. Fat mass and fat-free mass was not significantly different between the groups after the supplementation period. The levels of plasma concentration of taurine were significantly different after the period of supplementation in group TS ( $p = 0.02$ ). Referring to TEE, there was no significant difference between groups, but when comparing the percentage change of data between the groups, results were significantly different ( $p = 0.05$ ). Conclusion: There were significant changes in plasma levels of taurine in the TS group after 8 weeks. Moreover, the results of TEE were no significant after supplementation of taurine, however, when the variations were made between groups was observed an increase of 34% in the group TS and 6% reduction in the PL group showing evidence of the involvement of taurine in energy metabolism. The number of study participants can be a limiting factor in the results, it is suggested that further studies are needed to elucidate the energy metabolism in obese patients. Key-words: supplementation taurine, energy metabolism, obesity, energy expenditure. Acknowledgments: This work received financial support by the Research Foundation of the State of Sao Paulo (FAPESP - process number: 08/53747-8)

### **SITTING TIME INCREASES THE RISK OF SUFFERING OVERWEIGHT AND OBESITY INDEPENDENTLY OF WALKING TIME IN NON-INSTITUTIONALIZED PEOPLE AGED 65 OR OVER FROM SPAIN: THE ELDERLY EXERNET MULTI-CENTER STUDY**

Gomez-Cabello, A., Pedrero, R., Olivares, P.R., Hernandez, R., Rodriguez, J.A., Mata, E., Aznar, S., Villa, J.G., Espino, L., Gusi, N., Gonzalez-Gros, M., Casajús, J.A., Ara, I., Vicente-Rodriguez, G.

*GENUD Research Group. University of Zaragoza*

Sitting time increases the risk of suffering overweight and obesity independently of walking time in non-institutionalized people aged 65 or over from Spain: The Elderly EXERNET Multi-center Study Gomez-Cabello A1,2, Pedrero-Chamizo R3, Olivares PR4, Hernandez-Perera R5, Rodriguez-Marroyo JA6, Mata E7, Aznar S8, Villa JG6, Espino L5, Gusi N4, Gonzalez-Gross M3, Casajús JA1,2, Ara I1,7, Vicente-Rodríguez G1,2 on behalf of EXERNET Study Group 1 GENUD Research Group, University of Zaragoza, Spain 2 Faculty of Health and Sport Science, Department of Psychiatry and Nursing, University of Zaragoza, Spain 3 ImFINE Research Group. Department of Health and Human Performance, Technical University of Madrid, Spain 4 Faculty of Sport Sciences, University of Extremadura, Spain 5 Unit of Sports Medicine, Cabildo of Gran Canaria, Spain 6 Institute of Biomedicine, University of León, Spain 7 GENUD Toledo Research Group, University of Castilla-La Mancha, Spain 8 PAFS Research Group, University of Castilla-La Mancha, Spain Introduction: obesity, defined as an excess of total body fat, is a matter of concern all over the world, and its prevalence is still increasing among elderly people (1). Aim: to examine whether a sedentary behaviour (hours sitting per day) is associated with higher risk of central obesity, overweight-obesity and overfat in a representative sample of non-institutionalized Spanish elderly population and if so, whether physical activity (hours walking per day) modified this association. Methods: a cross-sectional study was carried out in a sample of 3136 people  $\geq 65$  years of age. Anthropometric measurements were obtained using standardized techniques and equipment. Active and sedentary behaviors were recorded by means of a questionnaire. Binary logistic regression was used to test the association among overweight-obesity, central obesity and overfat and the sedentary independent variable (hours per day sitting) by sex. Results: for both men and women, the higher prevalence of overweight-obesity, central obesity and overfat was found in those who spent sitting more than 4 hours per day and walk less than 1 hour, compared with those who spent sitting less than 4 hours per day and walk more than 1 hour (all  $p < 0.001$ , except for central obesity in women). In men, more than 4 hours sitting per day was associated with 1.7-fold higher odds of having central obesity compared with those sitting less than 4 hours per day ( $p < 0.01$ ). In women, this sedentary behaviour increased the risk of overweight-obesity and overfat by 1.5 and 1.4, respectively ( $p < 0.01$ ). Age or time spent walking did not significantly change these results. Conclusion: sitting time increases the risk of overweight-obesity and overfat in women and the risk of central obesity in men, independently of walking time. References: 1. Gomez-Cabello A. et al. Prevalence of overweight and obesity in non-institutionalized people aged 65 or over from Spain: the elderly EXERNET multi-centre study. *Obes Rev* 2011.

### **RELATIONSHIPS BETWEEN EATING BEHAVIORS AND BODY COMPOSITION IN LEAN AND OBESE CHILDREN**

Martin-Garcia, M.1, Bryant, E.2, Plaza-Carmona, M.1, Fernandez-Rodriguez, M.3, Gonzalez-Vergaz, A.3, Mata, E.1, Garcia-Cuartero, B.3, Ara, I.1

*1 GENUD Toledo Research Group, Univ. of Castilla-La Mancha, Spain 2 Centre for Psychological Studies, Univ. of Bradford, UK 3 Pediatric Service, Hospital Severo Ochoa, Spain*

**INTRODUCTION** Recently, several studies have been trying to relate eating behaviors with the development of obesity in adults and children (Bryant et al., 2008; Vogels et al., 2006). Some studies have already shown that a positive correlation between disinhibited behaviors and increased levels of BMI and obesity are present in adults. However, these relationships have been less studied in children. Some data indicate that high scores of the dietary restraint factor (Cognitive Restraint) in children can predict high BMI and elevated percentage of body fat (%BF) (Vogels et al., 2006). **MATERIAL AND METHODS** Forty three boys ( $11.3 \pm 0.3$  yrs;  $49.1 \pm 3.1$  kg;  $151.8 \pm 1.8$  cm;  $20.6 \pm 0.9$  kg/m<sup>2</sup>) and 51 girls ( $11.5 \pm 0.3$  yrs;  $49.4 \pm 2.6$  kg;  $150.0 \pm 1.5$  cm;  $21.4 \pm 0.8$  kg/m<sup>2</sup>) participated in this study. Body composition was measured by dual-energy X-ray absorptiometry (Hologic, Serie Discovery QDR, Bedford, USA). An extended version of the Three Eating Factor Questionnaire (TFEQ-R21) was used in order to obtain information related to the children's eating behavior (Cappelleri et al., 2009). **RESULTS** Three 2-way independent groups ANOVAs were used to examine differences between the genders and weight status on TFEQ scores. Upon examination of TFEQ-UE (uncontrolled eating), a main effect of adiposity level was found whereby lean children had a higher score ( $p = 0.001$ ). Conversely, a main effect of obesity status on TFEQ-CR (cognitive restraint) demonstrated that those in the overweight/obese category had higher TFEQ-CR scores ( $p = 0.021$ ). No further main effects or interactions were found. TFEQ-UE was found to correlate negatively with age ( $r = -0.34$ ,  $p < 0.001$ ) and weight ( $r = -0.36$ ,  $p < 0.001$ ). Whereas, TFEQ-CR was found to correlate positively with weight ( $r = 0.25$ ,  $p = 0.014$ ), total fat mass ( $r = 0.24$ ,  $p = 0.02$ ), %BF ( $r = 0.38$ ,  $p < 0.001$ ) and trunk fat mass ( $r = 0.31$ ,  $p = 0.003$ ). After controlling for age and gender, only the correlations with TFEQ-CR remain. No correlations were found for TFEQ-EE (emotional eating). After controlling for sex, age, sleep hours and hours watching TV, a higher TFEQ-CR score was found to significantly predict a higher body weight, increased %BF and higher trunkal fat mass (all  $p < 0.001$ ). **DISCUSSION** Data for the present study seems to strongly suggest that increased cognitive restraint (CR) is related to an increased body weight, percentage of body fat and trunkal body fat in children. **REFERENCES** Bryant EJ, et al. (2008). *OR* 9:409-419. Vogels N et al. (2006). *AJCN* 84:717-24. Cappelleri JC, et al. (2009) *IJO* 33: 611-620.

### ENERGY BALANCE-RELATED BEHAVIOURS IN PRESCHOOLERS: FOCUS GROUPS WITH PARENTS AND TEACHERS

De Craemer, M., De Decker, E., De Bourdeaudhuij, I., Deforche, B., Vereecken, C., Duvinage, K., Grammatikaki, E., Iotova, V., Fernández-Alvira, J.M., Zych, K., Manios, Y., Cardon, G.

*Ghent University*

Introduction Qualitative research – and in particular the execution of focus groups – is a good way to collect ideas and strategies for future interventions. Focus groups with parents and teachers have already been executed to obtain information on preschoolers' physical activity levels and nutrition habits. However, no focus groups have ever been executed to investigate what these caregivers think about how these behaviours can be changed. Based on these insights, effective interventions could be developed. Methods Focus groups were carried out between October 2010 and January 2011 in six European countries: Belgium, Bulgaria, Germany, Greece, Poland and Spain. In total, 24 focus groups with 122 parents and 18 focus groups with 87 teachers were executed. Data were analyzed, using qualitative data analysis software. Results Both parents and teachers considered preschool children sufficiently active. They did not perceive the need to increase preschoolers' physical activity levels. Furthermore, parents did not think it is necessary to decrease the intake of sugared milk drinks and fruit juices. They consider them as healthy because of the vitamins/minerals these beverages contain. Discussion The European focus group results indicated misperceptions of caregivers on preschoolers' physical activity levels and nutrition habits. This resulted in low perceived needs to change these behaviours. Consequently, the awareness of parents and teachers has to be raised concerning the need to change these behaviours and regarding the shared responsibility of parents and teachers to promote these healthy behaviours in preschoolers. Providing teachers with ready-to-use classroom material, and involving parents in preschoolers' school activities, are perceived as promising ways in trying to change the behaviours of preschool children. References Huybrechts I, De Henauw S. (2007). *Br J Nutr*, 98(3), 600-610. Kranz S, Siego-Riz AM, Herring AH. (2004). *Am J Public Health*, 94(9), 1525-1530. Oliver M, Schofield GM, Kolt GS. (2007). *Sports Med*, 37(12), 1045-1070.

### COMPARATIVE STUDY OF BLOOD LEVELS IN RATS UNDERGOING RESISTANCE TRAINING COMBINED WITH HIGH PROTEIN DIET AND HIGH CARBOHYDRATE DIET

Furukawa, M., Neiva, C.M., Peinado, A.B., Romero, B., Zapico, A.G.

*Universidad Politécnica de Madrid*

Comparative study of blood levels in rats undergoing resistance training combined with high protein diet and high carbohydrate diet Furukawa, M1; Neiva, CM2; Peinado, AB1; Romero, B1; Zapico, AG3 1: Universidad Politécnica de Madrid, Spain; 2: UNESP – Rio Claro, Brazil; 3: Universidad Complutense de Madrid, Spain Introduction Resistance training (RT) has been known as the best method to promote hypertrophy in synergistically involved muscles [1]. Combined with this technique, high protein diets (HPD) have shown positive effects on muscle hypertrophy and strength [2]. While high carbohydrate diets (HCD) present similar results [3], both diets may change negatively or positively the blood levels of certain lipids, carbohydrates and proteins. The aim of this study was to show the changes in blood levels in rats after a HPD and HCD combined with RT. Methods Forty-two male rats (Wistar), 75 days old and with an initial weight of 192±17g were separated into six groups: trained and HPD (THP), trained and HCD (THC), trained control (TC), sedentary HPD (SHP), sedentary HCD (SHC) and sedentary control (SC). All of the trained groups had to perform two weeks of adaptation swimming training followed by 5 weeks of RT. Blood samples were collected before and after the intervention. Glucose, cholesterol, triglycerides and urea were analyzed in this study. One way ANOVA with repeated measures was used to study the differences between pre-post values. Probability level for statistical significance was set at  $\alpha=0.05$ . Results Significant changes occurred in glucose levels in the groups THC (149% of change measured as final value - initial value/initial value\*100), TC (155%), SHP (180%), SHC (121%) and SC (200%). There was no change in the THP group ( $p>0.05$ ). Changes in urea occurred in groups THP (55%), THC (-24%), SHP (19%), SHC (-28%) and SC (11%) ( $p<0.05$ ). Triglyceride levels changed in groups THP (67%), THC (70%) and SHC (129%) ( $p<0.05$ ). No changes in cholesterol were found ( $p>0.05$ ). Discussion Diets enriched with proteins and carbohydrates significantly increase levels of glucose, urea and triglycerides in rats trained in a RT, although the THC and SHC groups presented significant reduction of urea. This can be explained by the fact that HCD has the lower quantity of protein in its composition [4]. The HCD groups presented values significantly higher on glucose levels and these findings suggest that a HCD may be harmful according to metabolic risk factors[5]. References 1. Drummond MJ, et al. *J Appl Physiol*. 2008; 104(5): 1452-61. 2. Kato Y, et al. *J Nutr Sci Vitaminol (Tokyo)*. 2011; 57(3): 233-8. 3. Jeukendrup AE and McLaughlin J. *Nestle Nutr Inst Workshop Ser*. 2011; 69: 1-17. 4. Al Banchaabouchi M, et al. *Amino Acids*. 2001; 21(4): 401-15. 5. Wu X, et al. *Clin Endocrinol (Oxf)*. 2012. Epub ahead of print.

### EFFECT OF FISH OIL SUPPLEMENTATION ON LIPID PROFILE IN PARAPLEGIC ATHLETES BEFORE AND AFTER BASKETBALL PLAY

Cury-Boaventura, M.F., Marques, C.G., Santos, V.C., Levada-Pires, A.C., Pithon-Curi, T.C., Gorjao, R.

*Institute of Physical Activity and Sports Sciences, Cruzeiro do Sul University*

EFFECT OF FISH OIL SUPPLEMENTATION ON LIPID PROFILE IN PARAPLEGIC ATHLETES BEFORE AND AFTER BASKETBALL PLAY Introduction: Spinal cord injury causes metabolic disorders such as dyslipidemia. The engaging of paraplegics in sports programs combined with an adequate food plan can minimize the risk of related diseases. Evidence suggests that fish oil rich in n-3 polyunsaturated fatty acids (n-3 PUFA) has a beneficial effect on lipid profile. We investigated the effect of fish oil supplementation on lipid profile in athletes with spinal cord injuries at rest and after basketball play. Methods: Eleven paraplegic athletes were supplemented with 3g of fish oil per day (FO group) and three paraplegic athletes were supplemented with 3 g of soy lecithin (PL group). The athlete's blood samples were collected on rest and immediately after basketball play (60 minutes) before and after supplementation. The following determinations were carried out: total cholesterol, triglycerides, HDL-c and LDL-c. Results: There was no significant difference in age, height, body mass and % of fat mass between the groups. We observed no significant differences on total cholesterol, triglycerides, HDL-c, LDL-c plasma concentration in the PL and FO group. However, FO group showed a trend to decrease total cholesterol ( $\Delta C = 25$  to  $-17$  mg/dL and  $8$  to  $-36$  mg/dL, respectively) and LDL-c ( $\Delta C = 25$  to  $-34$  mg/dL and  $-7$  to  $-55$  mg/dL, respectively) before and after the basketball play and HDL-c ( $\Delta C = 1$  to  $-20$  mg/dL) after the basketball play. Conclusion: The FO supplementation associated to the training had a tendency to improve lipid profile in paraplegics and may minimize the risk to dyslipidemia.

13:45 - 14:45

## Poster presentations

## PP-PM19 Adapted Physical Activity 1

**THE TRAINING OF THE MONITORS THAT WORK IN ADAPTED PHYSICAL ACTIVITY PROGRAMS IN SPAIN**

González, M.D.1, Campos, A.2

*1: Alcalá University (Alcalá de Henares, Spain), 2: Polytechnic University of Madrid (Madrid, Spain)*

**Introduction** An essential factor that contribute to the appropriate development of adapted physical activity programs are the monitors, because if these professionals are not good trained, the effects in general health could have a boomerang effect (Campos, 2010). The objective of this study is to analyse the training of the physical activities professionals who work in adapted physical activity programs in Spain by age, gender and sport associations. **Methods** The quantitative methodology consisted of a cross-sectional survey. Cluster sampling was used. The final sample size was 241 monitors. Data were collected through structured questionnaires with face-to-face interview between January and November 2011. All the statistical analyses were done using the SPSS/Windows 19.0 statistical software. The inferential analysis with Cronbach's was .802. Signification levels were set at  $p < 0.05$ . **Results** 31,5% of the sports monitors that work in adapted physical activity programs are not qualified. 68,5% of monitors have a sports qualification. By gender, 69% of men have a sport qualification and 31% of them do not have any sport qualification. Regarding to women, 67,4% have a sports qualification and 32,6% of them do not have any sport qualification. By age, 30,1% of the physical activities monitors under 30 years are qualified and 69,9% are not; 27,6% between 30 and 45 years are qualified and 42,3% of the monitors older than 45 years are qualified. By organizations, 80,2% of the monitors who work in private organizations are not qualified and 19,8% of them have a sports qualification; in public organizations, 27,6% of the monitors do not have any sport qualification but 72,4% have sport qualification. **Discussion** One third of this monitors do not have any sport qualification and women show slightly higher values of non qualified staff than men. In private sport organizations, the number of non qualified sport monitors is higher than in public sport organizations. According to these results, it is necessary to improve the training of monitors (Le Roux & Frosberg, 2000; Campos, 2010) to ensure the proper development of adapted physical activity programs, especially in private organizations. **References** Campos, A. (2010). Dirección de recursos humanos en las organizaciones de la actividad física y del deporte. Síntesis, Madrid. Le Roux, N. & Frosberg, K. (2000). ENSSHE and the trends in sport and employment in Europe Bulletin - International Council of Sport Science & Physical Education, 30, 22-24. The research reported is a part of the Fundamental Research Project I+D+i DEP2009-12 828 which has been funded by the Ministry of Science and Innovation.

**OBJECTIVE PHYSICAL ACTIVITY IN CHILDREN WITH DOWN SYNDROME**

Matute-Llorente, A., González-Agüero, A., Gómez-Cabello, A., Gómez-Bruton, A., Morales, S., Vicente-Rodríguez, G., Casajús, J.A.

*GENUD Research Group, University of Zaragoza, Spain*

**Introduction** Children with Down Syndrome (DS) have been demonstrated as being less active<sup>1</sup> and have showed lower levels of physical fitness<sup>2</sup> than children without DS. To date, the information regarding physical activity (PA) and persons with DS is limited and inconclusive. Therefore, the aim of this study was to assess objectively the levels of PA in children with DS comparing with children without disabilities. **Methods** Forty two children (27 with DS) aged 12-18 years participated in this study. A uni-axial accelerometer (Actigraph GT1M) was used to register PA and steps of children during seven consecutive days. Accelerometer data to be valid had to present at least four days with eight hours of valid time. Minutes of valid time and minutes of sedentary, light, moderate, and vigorous physical activity were established by using the cut-offs proposed by Sirard<sup>3</sup>. Time of bouts (period of at least 5 min of consecutive moderate PA) and number of bouts were also measured. Differences between groups were established by 2-sided Student's t test. **Results** No significant differences between children with and without DS regarding sedentary, light, and vigorous times were observed neither in minutes (698.9 vs. 741.9; 49.7 vs. 49.4; 2.9 vs. 6.1 min/day) nor in the percentages of valid time (91.8 vs. 91.1; 6.5 vs. 6.1; 0.3 vs. 0.7 %) spent on those activities. However, children with DS engaged significantly less minutes in moderate (9.2 vs. 15.4 min/day) and moderate-vigorous physical activities (12.1 vs. 21.5 min/day) than their counterparts without DS. Similarly, the percentages of valid time (1.9 vs. 1.2 %) and (1.6 vs. 2.7 %) spent in those activities were lower. Moreover, lower time and number of bouts and steps were observed in the DS group compared with the control group (all  $p < 0.05$ ). **Discussion** Similar levels of sedentary and light PA were registered in children with and without DS; children with DS did not show a more sedentary behaviour than those without. Nevertheless, children with DS spent not only less total minutes of valid time participating in moderate and vigorous PA, but also lower percentage of their total valid time. Following ACSM guidelines children and adolescents should do at least 60 minutes of moderate PA 5 days a week; however, none of the two groups achieved these recommendations. Strategies aiming to increase moderate and vigorous activities in children with DS should be promoted as they may be at higher risk of developing diseases associated with physical inactivity such as osteoporosis or metabolic syndrome. **References** 1. Sharav, T. et al. Clin Pediatr (Phila). 1992. 2. Fernhall, B. et al. Clin Exer Physiol. 2001. 3. Sirard, J.R. et al. Med Sci Sports Exerc. 2009.

**PEAK POWER OUTPUT PREDICTS TT PERFORMANCE, IRRESPECTIVE OF TRAINING PHASE, IN NATIONAL CYCLISTS WITH PHYSICAL DISABILITIES.**

Boer, P., Terblanche, E.

*North West University, Stellenbosch University*

**Purpose** The purpose of this study was to ascertain which physiological or mechanical variable best predicts time trial (TT) performance (measured as TT time or TT average power) and whether the predictors of performance change according to training phases of the competition year amongst national cyclists with physical disabilities. **Methods** Seven male and two female cyclists ( $19 \pm 2$  yrs;  $169.6 \pm 10.1$  cm;  $64.7 \pm 10.8$  kg) were tested during the competition phase of their training year, as well as pre-season of the following training year (six months later). Methodological procedures were strictly adhered to and identical on both occasions. Participants performed a ramped (20W/min) exercise protocol to exhaustion and a self-paced, 20-km TT on two consecutive days on the Velotron cycle ergometer. Maximal, as well as sub-maximal responses ( $\dot{V}O_2$ , heart rate and power output) at the anaerobic threshold (AT) were determined for the

maximal exercise test. AT was defined as the point where the R-value was equal to 1.0. Relationships between 20-km TT performance (measured as TT time and TT average watts) and relative peak power output (PPO) (W), absolute PPO (W/kg), VO<sub>2</sub>max (ml/min/kg), power output (PO) at the AT, heart rate (HR) at the AT, and VO<sub>2</sub> at the AT were determined. Results Highly significant correlations ( $P < 0.05$ ) were found between absolute PPO of the maximal exercise test and average watts during the TT, in both in-season ( $r = 0.97$ ) and out-of-season ( $r = 0.94$ ). Slightly weaker, but still significant correlations were found between PPO and cycling performance measured as TT time (in season- 0.94 and out of season- 0.90;  $P < 0.05$ ). When accounting for body mass in PPO (W/kg), the relationships were also weaker in both training phases for both TT time and TT average watts. Likewise, correlations between VO<sub>2</sub> max-, PO at the AT-, HR at the AT-, VO<sub>2</sub> at the AT-, and TT time or TT average watts provided relationships much weaker than when absolute PPO was used. Conclusions This is the first study to show that there is a similar strong relationship between PPO and TT performance in cyclists with physical disabilities and able-bodied cyclists. This strong relationship held true even in the pre-season training phase. This study has also reiterated the fact that PPO is generally a better predictor of performance compared to VO<sub>2</sub> max and variables associated with the AT. It is concluded that absolute PPO, irrespective of training phase, is the best predictor of endurance cycling capacity in cyclists with physical disabilities.

## INFLUENCE OF PHYSICAL ACTIVITY ON CARDIOVASCULAR FITNESS IN CHILDREN AND ADOLESCENTS WITH DOWN SYNDROME

Matute-Llorente, A., González-Agüero, A., Gómez-Cabello, A., Gómez-Bruton, A., Morales, S., Vicente-Rodríguez, G., Casajús, J.A.

*University of Zaragoza*

**Introduction** Aerobic fitness during adolescence has a strong association with present and future health and cardiovascular diseases. Previous research has shown that persons with Down syndrome (DS) have impaired cardiovascular fitness, however; whether it depends on the levels of physical activity (PA) remains unknown in this population. Therefore, the aim of this study was to assess the relationship between the levels of PA and cardiovascular fitness in children with DS. **Methods** 27 children with DS aged 10-18 years participated in this study. A uni-axial accelerometer (Actigraph GT1M) was used to register PA during seven consecutive days. As recommended, accelerometer data to be valid had to present at least four days with eight hours of valid time. Percentage of valid time in sedentary, light, moderate, and vigorous physical activity were established by using the cut-offs proposed by Sirard<sup>1</sup>. Maximal oxygen uptake (VO<sub>2</sub>peak) and maximal heart rate (HRmax) were measured with a breath-by-breath gas analyzer in a treadmill. Pearson's bivariate correlations were applied to identify possible relationships between percentage of time spent in different levels of PA and the cardiovascular parameters (VO<sub>2</sub>peak and HRmax). Results VO<sub>2</sub>peak showed an inverse correlation with the percentage of time spent in sedentary activities ( $r = -0.39$ ,  $p < 0.05$ ). VO<sub>2</sub>peak and HRmax were correlated with the percentage of time spent in moderate intensity activities ( $r = 0.48$  and  $r = 0.39$  respectively, both  $p < 0.05$ ). **Discussion** As expected, spending more time in sedentary activities was associated with lower levels of VO<sub>2</sub>peak in children with DS. On the other hand, moderate correlations between VO<sub>2</sub>peak, HRmax and moderate activities have been observed. No correlation between VO<sub>2</sub>peak and percentage of time spent in vigorous intensity activities were observed. It could be due to the low time spent in vigorous intensity activities (with Sirard cut-offs) of children with DS. It might be also thought that this cut-offs are not suitable for children with DS, so it would be good to establish specific cut-offs for this type of population. Despite this, we could suggest that cardiovascular fitness could be improved in children with DS by enhancing time spent in moderate activities and decreasing sedentary time, this could be relevant to reduce the risk of cardiovascular diseases. **References** 1. Sirard, J.R. et al. *Med Sci Sports Exerc.* 2009.

## GIRL POWER IN HAND CYCLING: GENDER DIFFERENCES IN PHYSICAL EXERCISE CAPACITY

Kerkhof, F., Hettinga, F., van Ballegooijen, M., van der Woude, L.

*Centre for Human Movement Sciences, Groningen University*

Faes D. Kerkhof 1, Floor J. Hettinga 1, Marloes van Ballegooijen 1, Luc H.V. van der Woude 1. 1 Center for Human Movement Sciences, UMCG, Groningen **Introduction:** Wheelchair dependency is often accompanied by a low physiological exercise capacity which may lead to secondary health problems and a decreased participation in daily life. Pursuing an active and healthy lifestyle is often straining for wrist and shoulders. Hand cycling (HC) is a promising low impact training alternative. However, little is known about HC exercise, in particular for women. Therefore, the present study aims to gain insight into gender differences in exercise capacity during HC in order to customize exercise guidelines. **Method:** Ten male and 10 female able-bodied participants conducted an incremental exercise test (IET: 65 rpm, 5.0 km/h, resistance increased with 7 watt/min) on a hand cycle to determine peak exercise capacity. A bicycle incremental exercise test was used to determine maximal exercise capacity. VO<sub>2</sub>, HR, VE and power output (PO) were measured during all tests. **Results:** Peak female HC values were: VO<sub>2</sub> 2.03 L/min (SD 0.302), HR 169 (SD 15), VE 78.94 L/min (SD 18.91), PO 92.79 (SD 17.76). Peak male HC values were: VO<sub>2</sub> 2.69 L/min (SD 0.229), HR 160 (SD 37), VE 100.96 L/min (SD 19.73), PO 132.34 (SD 11.44). Bicycling maximum values for females: VO<sub>2</sub> 3.35 L/min (SD 0.489), HR 186 (SD 12), VE 92.74 L/min (SD 20.69), PO 254 (SD 26.75). Bicycling males scored: VO<sub>2</sub> 4.59 L/min (SD 0.693), HR 190 (SD 8), VE 156.62 L/min (SD 26.52), PO 368 (SD 13.98). Gender differences were found in HC for RPE, VO<sub>2</sub> and VE. No differences were found for HR. Peak HC capacity as a percentage of maximum cycling exercise capacity shows similar ratios in men and women for VO<sub>2</sub> (60% vs. 66%) and HR (90% vs. 84%) and PO (36% vs. 37%). However, VE<sub>peak</sub>/VE<sub>max</sub> ratio was much higher in females (85%) than in males (64%). **Conclusion:** Although peak/max ratios of Vo<sub>2</sub>, HR and PO were similar in men and women, absolute peak hand cycling values (VO<sub>2</sub>, HR, PO, VE) were 33%, 2%, 30% and 41% lower for females. This largely due to their smaller muscle mass. Besides a lower exercise capacity, the higher VE<sub>peak</sub>/VE<sub>max</sub> ratio in females indicates a relatively high respiratory strain at peak intensity. These findings suggest that females should exercise on a 33% lower absolute PO than males to achieve the same ventilatory load. However, considering the 2% difference in heart rate, training at lower PO level might not be high enough to achieve optimal cardiovascular load. Based on the results of the present study, there is a gender-related difference in hand cycling exercise capacity, that has to be kept in mind prescribing training intensities for females in a rehabilitation setting. In addition, different handicaps can affect exercise capacity differently. More research is needed for tailored exercise guidelines.

## IS IT POSSIBLE TO ADAPT ISOMETRIC LEG STRENGTH TEST TO MENTALLY RETARDED POPULATION?

Bofill-Ródenas, A.1, Corbi, F.2, Solana-Tramunt, M.3, Cartes, M.A.4, San, J.1

1:Universitat de Girona, 2:INEFC-Lleida, 3:University Ramon Llull, 4:ACELL-Special Olympics Catalunya

**Introduction** Isometric leg strength test (ILST) is the most common test used to evaluate leg strength and is commonly performed back leaning slightly forward and knees bend to about 120 degrees making it difficult to test execution in populations with disabilities as mental retardation (MR). We investigated if ILST performed at 120° and back leaning forward is superior to performance at 90° and keep back straight which is expected to reduce the compensatory muscle participation and increase the comfort to perform the test. **Methods** 45 adults, 15 with Down Syndrome (DS) (age=27+/-7.48yrs), 17 without DS (age=29+/-6.68yrs) and 15 general population (GP) (age=31+/-7.85yrs) acting as controls, participated in this study. We performed a familiarization process consisting of a session with all the individuals that comprised the study sample. After the familiarization they completed two ILST tests, on different days, for both at 120° and 90°. **Results** No significant differences were found between tests performed on different days. There was not a significant difference between ILST120° and ILST90° (85.34+/-45.60Kgw vs. 95.69+/-51.49Kgw), but by population the results obtained were 37.24Kgw vs. 30.67Kgw for DS, 44.86Kgw vs. 39.46Kgw for without DS and 87.45Kgw vs. 71.88Kgw for GP. The correlation obtained is 0.875 if considering all days test. **Discussion** These data show that ILST testing in this population is reliable from day to day. All populations got better results on the dynamometer at 120°, although this difference is not significant. In this position the results are better due the co-activation of the kinetic chain. It is possible to adapt ILST to mentally retarded population being the proposal testing at an angle of bending deeper than normally used in the administration of these tests and consider a wall support in guiding the movement to continue for traction without involving other muscle groups. **References** Fernhall, B., Tymeson, G. (1987). Graded exercise testing of mentally retarded adults: a study of feasibility. *Archives of Physical Medicine and Rehabilitation*, 68, 363-365. Legido, J.C., Segovia, J.C.; López-Silvarrey, F.J. (1996). *Manual de Valoración Funcional*. Madrid: Ediciones Eurobook, S.L. Thomas, J.R., Nelson, J.K. (1990). *Research Methods in Physical Activity* (pp.343-363). Champaign, IL: Human Kinetics Books.

## PASSIVE GLIDING OF SWIMMERS WITH DISABILITIES REGARDING IMPAIRMENT, FUNCTIONAL CLASSIFICATION AND PERFORMANCE

Karger, K.

*Chemnitz University of Technology*

**Introduction** In recent years swimming of people with disabilities became more importance in research. Competitions are organized by using the Functional Classification System (FCS). Both fairness and procedure are discussed controversially (Daly et al., 2003). Quantitative investigations improve information and can support further validation of FCS. Analysis of gliding phase, as an integral part of swimming efficiency, is accepted in competitive swimming (Lyttle et al., 1998). For swimmers with disabilities these studies are underrepresented (Chatard et al., 1992). **Methods** Swimmers with diverse locomotor disabilities (n = 98) took part in this study. Two passive towing trials in a standardized gliding position were performed, the first trial with a standard velocity (1.0 m/s) and the second with the individually best performance. To measure passive drag in water (FPD) we used a strain-gauge beam arrangement in a rope drum. The registration of frontal surface area (FSA) was carried out with a camera, placed under water. Additionally the coefficient of drag (CD) was evaluated. For impairment specific analysis the swimmers were separated in 5 disability groups. To investigate the relationship to FCS we used the functional class (FC) of the athletes. The division in 2 groups (participation in Paralympics or not) was accomplished to analyze performance specific differences. **Results** Regarding impairment specific the FPD of athletes with paralysis (FPD = 42,64 N; SD = 12,61 N) and with multiple dysmelia (FPD = 40,66 N; SD = 14,26 N) were higher than for swimmers with above-knee amputation on one side (FPD = 25,93 N; SD = 1,62 N). Concerning FCS the FPD decreased with increasing FC (r = -0.63). Nevertheless, there were no significant differences between adjacent classes and a wide range within classes was observed. Furthermore participants of Paralympics had a lower CD (CD = 0,68; SD = 0,19) than swimmers with nonattendance (CD = 0,86; SD = 0,27). **Discussion** Athletes with paralysis and multiple dysmelia had more inappropriate frontal resistance areas during gliding phase than swimmers with above-knee amputation on one side because of their streaming advantageous drop form (Bixler, 1999). These findings can contribute to enhancements regarding the FCS. The relation between CD and performance level leads to the assumption, that a specialized training program can optimize the impairment-specific hydrodynamic drag for swimmers with disabilities. **References** Bixler B. (1999). *American Swimm Mag*, 2, 8-11. Chatard JC, Lavoie JM, Othoz H, Randaxhe P, Cazorla G, Lacour JR (1992). *Med and Sci Sports Ex*, 1276-1282. Daly JD, Djobova SK, Malone LA, Vanlandewijck Y, Steadward RD. (2003). *APAQ*, 20, 260-278. Lyttle A., Blanksby B, Elliot B, Lloyd D. (1998). *J Swimm Res*, 13, 15-22.

## TITLE: EFFECTS OF COMBINED EXERCISES ON PHYSICAL PERFORMANCE, MOTION FUNCTION, AND EXPANDED DISABILITY STATUS SCALE IN MULTIPLE SCLEROSIS

Golzari, Z., Shabkhiz, F., Mojtahedi, S.

*university of tehran*

**Introduction** Several years ago, exercise was forbidden for MS patients due to the increase of the body temperature as a result of exercising but recently most of reports have noted that exercise therapy is safe and beneficial for patients with MS. The effect of exercise is particularly obvious regarding daily activities, and physical fitness. **Objective:** To determine the effectiveness of an eight-week combined exercise program on physical and motor function fitness indices, maximum oxygen consumption, Expanded Disability Status Scale (EDSS) in multiple sclerosis (MS) patients. **Methods and Materials:** In this randomized clinical trial, 24 female MS patients with EDSS ≤ 4 were divided into two groups: case (experimental) (13 patients) and control (11 patients). Patients in case group participated in 24 sessions (each session, 60-90 minutes) of combined exercise program (running, endurance training, resistance and stretching) for eight weeks. Patients of control group continued their normal activities. Following completion of eight-week program, both groups underwent post-tests and re-measurement of EDSS. **Statistics:** mean (±standard deviation) were used to express data. For comparison of continuous variables, the Mann-Whitney U test and the Wilcoxon test were used (P:0/05). **Results:** Significant statistical decreases were observed after combined exercises in case group in body fat mass [21.67 (±6.03) to 20.90 (±5.62); P = 0.01] and percent body fat [34.21 (±4.80) to 33.33 (±4.79); P = 0.006]. Except for motion function and endurance which showed significant decreases, there were statistically significant increases in flexibility [1.88 (±8.01) to 11.03 (±6.81); P = 0.002], strength [37.53 (±13.47) to 69.61 (±18.25); P = 0.002], and balance [37.69 (±36.98) to 117.87 (±121.6); P = 0.004]. There was a statistically significant decrease in EDSS in case group before [2.34 (±1.06)] and after study period [1.65 (±1.12)]; P = 0.04. None of changes in control group was significant. **Conclusion:** An eight-week combined exercise program was safe and improved flexibility, strength, and balance, EDSS, and maximum oxygen consumption in MS patients.

## 200-M BACKSTROKE RACE ANALYSIS AT THE 5TH DOWN SYNDROME SWIMMING WORLD CHAMPIONSHIPS

Junior, V.1, Querido, A.1, Araújo, D.1, Vilas-Boas, J.P.1,3, Corredeira, R.1, Daly, D.2, Fernandes, R.J.1

1: CIFI2D, Faculty of Sport, University of Porto (Portugal), 2: Faculty of Kinesiology and Rehabilitation Sciences (Leuven, Belgium), 3: Porto Biomechanics Laboratory, University of Porto (Portugal)

**Introduction** Down syndrome (DS), a genetic cause of intellectual disability, presents physical impairments that may affect their motor performance behavior. Race video recording is essential both to provide feedback of swimmers' performances and to analyze performance influencing factors. Since this has never been done for DS exclusively, the aim of this study is to analyze the 200-m backstroke event from the 5th DS World Championships. **Methods** The event was videotaped with two side view cameras, and 28 swimmers (15 men and 13 women) from the preliminary heats were analyzed for start, turn and swim times and stroke length (SL), rate (SR), and index (SI). Mean and SD were obtained, and Student t-tests were computed to compare gender groups. Pearson correlation analysis was performed between race components, stroking variables and end results ( $p < .05$ ). **Results** Differences were found between male and female swimmers on start ( $7.22 \pm .77$  &  $8.42 \pm 1.17$ s), swim ( $94.63 \pm 12.03$  &  $109.68 \pm 12.98$ s), turn ( $98.67 \pm 7.86$  &  $113.53 \pm 10.11$ s), finish ( $10.74 \pm 1.35$  &  $12.98 \pm 2.88$ ), and final times ( $211.25 \pm 18.94$  &  $244.53 \pm 24.91$ s), SL ( $1.59 \pm .18$  &  $1.33 \pm .17$ m), SI ( $1.34 \pm .25$  &  $.96 \pm .14$ ), and speed ( $.86 \pm .09$  &  $.74 \pm .07$ m/s). No differences between genders were observed for SR ( $32.85 \pm 4.86$  &  $34.51 \pm 6.01$ st/min). Higher significant ( $P < .05$ ) correlations with final time were found for swim (.93), finish (.81), turn (.78), and start times (.76), for men, and swim (.97), followed by turn (.92), start (.84), and finish times (.72), for woman. Inverse correlations were found between SR and SL (-.62 men & -.83 woman). **Discussion** As observed in previous studies with other populations (Arellano et al., 1994; Daly et al., 2003), male DS swimmers are significantly faster than their female counterparts in the 200-m backstroke event and demonstrated longer SL and higher SI, for a similar SR, implying that SL is more important for swimming speed than SR. For this event, swim and finish times are most determinant for final time in men, and swim and turn times in woman. In accordance with Chatard et al. (2003), starts were not of major importance for the final time. Since swimmers spend more time turning in a 25m pool than in free swimming, and considering that this race component is also related to final time, coaches should emphasize turning on the training process, so that swimmers will be able to improve their performance. **References** Arellano R, Brown P, Cappaert J, Nelson R. (1994). *J Appl Biom*, 10, 189-199. Chatard JC, Girold S, Caudal N, Cossor J, Mason B. (2003). *Biom and Med in Swimming IX*, 261-264. Daly D, Djjobova S, Malone L, Vanlandewijck Y, Steadward R. (2003). *Adapt Phys Activ Q*, 20, 260-278.

## PHYSICAL ACTIVITY AND AEROBIC FITNESS: DIFFERENCES BETWEEN CHILDREN AND YOUTH WITH AND WITHOUT CHRONIC ILLNESS?

Klasson-Heggebø, L.1, Kolle, E.2, Steene-Johannessen, J.3, Robsahm, T.E.4

1:Valnesfjord Rehab. Centre (Valnesfjord), 2:Norwegian School of Sport Science (Oslo), 3:Sogn og Fjordane University College (Sogndal), 4:The Cancer Registry of Norway (Oslo)

**Introduction:** Children with disabilities and/or chronic illnesses should be given the same opportunity as their able-bodied peers, for mastery and participation in school-, leisure- and sports activities (1). The present study aims to explore differences in physical activity and aerobic fitness between 9- and 15-year-olds reporting to be chronically ill and their healthy peers. **Methods:** In 2005-2006, a nationally representative sample of 2299 Norwegian 9- and 15-year-olds was randomly recruited to a cross-sectional study. Physical activity was assessed by accelerometers and aerobic fitness was directly measured, using a cycle ergometry test. In total, the participation rate was 82%, of whom 14.2% reported to be chronically ill. Independent T-tests assessed the equality of means between children and youth with and without a chronic illness. **Results:** The most commonly reported illnesses were asthma and allergy. Weight, height or body mass index did not differ between children with and without a chronic illness. In 15 year old boys/ girls and 9 year old boys, no variation in physical activity or aerobic fitness was observed between healthy and ill subjects. In chronically ill 9 year old girls the aerobic fitness level was significantly lower compared to their healthy peers,  $41.1$  ( $6.3$ )  $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  and  $43.3$  ( $6.7$ )  $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  respectively ( $p < 0.05$ ). Moreover, the physical activity level tend to be lower in chronically ill 9 year old girls ( $p = 0.07$ ). **Discussion:** Physical activity and fitness will, regardless of functionality level, influence children's health and the risk of secondary conditions (2, 3). Knowledge about objectively assessed physical activity and aerobic fitness in children with disabilities and/or chronic illnesses are scarce, and the level is suggested to be lower than in healthy peers (4). We only revealed differences among 9 year old girls. This can be due to: the inclusion in school setting of children with chronic illnesses, relatively small groups, or low levels of physical activity in 15 year olds which may weaken contrasts between subgroups. Further studies aiming to increase knowledge about children and youth with disabilities and/or chronic illnesses are important. **References:** 1. United Nations. (2006). Resolution 60/232. New York: United Nations. 2. Physical Activity Guidelines Advisory Committee (2008). Washington, DC: U.S: Department of Health and Human Services 3. van der Ploeg HP, van der Beek AJ, van der Woude LH, van Mechelen W (2004). *Sports Med*, 34(10), 639-49 4. Rimmer JA, Rowland JL (2008). *Developmental Neurorehabil*, 11(2), 141-148

## RELATIONSHIPS BETWEEN UPPER-BODY MAXIMAL STRENGTH, POWER AND SPRINT PERFORMANCE IN SLEDGE ICE-HOCKEY

Skovereng, K.1, Ettema, G.1, Welde, B.2, Sandbakk, Ø.1

1Norwegian University of Science and Technology, Trondheim, Norway; 2North-Troendelag University College, Levanger, Norway.

**Introduction** A high importance of upper body strength and power on double poling performance in cross-country skiing has been shown in several previous studies (1, 2). In order to examine the influence of strength and power on upper-body propulsion more isolated, sledge ice-hockey provides a good model as it is performed exclusively by upper body work. Furthermore, sledge ice-hockey requires high capability of acceleration and maximal speed which suggest that high maximal strength and power has an important impact on performance. Therefore, the purpose of the present study is to investigate the relationships between upper-body maximal strength and peak power on 30 meter sprint performance in sledge ice-hockey. **Methods** 13 male sledge ice-hockey players from the Norwegian national team performed three 30-m maximal sprint tests recorded by fixed light sensors. Acceleration was calculated during the first 10 m assuming constant acceleration and mean speed during the last 10 m was considered top speed. Cycle length and rate was measured by video analyses. In addition, 1 repetition maximal strength and peak power was assessed in the bench press (BPr), bench pull (BPu) and pull-down (PD) exercises using a barbell, and a linear encoder. **Results** Both maximal strength and peak power for all three strength exercises showed strong correlations with performance in the 30 meter sprint test ( $r = 0.748 - 0.861$ , all  $p < 0.005$ ). Total 30 meter sprint time correlated most strongly with maximal strength in PD ( $r = 0.861$ ,  $p < 0.001$ ) and with peak power in BPu ( $r = 0.812$ ,  $p = 0.001$ ). Also

acceleration and top speed correlated strongly with maximal strength and peak power in all tested exercises ( $r=0.597-0.834$ , all  $p<0.05$ ). Acceleration showed the strongest correlations with maximum strength ( $r=0.720$ ,  $p=0.005$ ) and peak power ( $r=0.672$ ,  $p=0.012$ ) in the PD and the BPr exercises respectively, whereas top speed showed the strongest correlations with maximum strength ( $r=0.824$ ,  $p=0.001$ ) and peak power ( $r=0.834$ ,  $p<0.001$ ) in PD and the BPr respectively. There were no significant relationships between kinematics in the sprint versus maximal strength and power. Discussion and conclusion The main findings of the present study are significant relationships between maximal strength and peak power upon sprint performance in sledge ice-hockey. Overall, these results indicate that all investigated exercises are relevant for performance in sledge ice-hockey, with maximal strength in the PD exercise as most influential. In order to further understand the specific requirements of strength and power in different exercises in sledge ice-hockey, and to determine the cause and effect relationship, future interventions studies are needed. References 1. Stöggl T, Lindiger S, Müller E (2007). *Med Sci Sports Exerc* 39:1160-1169 2. Lindinger S, Holmberg HC, Müller E, Rapp W (2009). *Eur J Appl Physiol* 106:353-363

**13:45 - 14:45**

## Poster presentations

### PP-PM20 Health & Fitness 1

#### PREVALENCE OF OVERWEIGHT AND OBESITY IN 9 AND 15 YEAR OLD CHILDREN FROM PRISHTINA

Gjaka, M.1, Tishukaj, F.1, Shalaj, I.1, Brestovci, B.1, Berisha, A.1, Selimi, M.1, Tschan, H.2, Froberg, K.3

1: University of Prishtina, 2: University of Vienna, 3: University of Southern Denmark

**Introduction** In last decades the prevalence of obesity and overweight has been increased substantially, and it is becoming one of the biggest health concerns for all age groups in developed and developing countries. High prevalence of obesity, overweight and the high body fat percentage have proven to have adverse effects on childhood and adolescent's health. **Objectives** The main objective of this study was to determine the prevalence of obesity, overweight as well as body fat percentage in Prishtina's schoolchildren. Another goal of this study was to see in which gender and age group, obesity, overweight, and body fat percentage was more prevalent. **Methods** 467 volunteer school children in Prishtina / Kosovo participated in the current cross sectional study. 250 of them have been 9 yrs old and 217 were 15 years of age. Following measurements were performed: height, weight, and BMI was calculated, waist circumference, skinfold measurements were performed at four sites of the upper region of the trunk (biceps brachii (BB), triceps brachii (TB), suprailiac (SI) and subscapular site (SS)). **Results** The overall prevalence of overweight among 9 and 15 year old children was 11.3%, whereas the prevalence of obesity was 3%. The prevalence of overweight in 9 year old children was 7.6% in girls and 16.6 % in boys, respectively and the prevalence of obesity was 5.7% in girls and 2.8% in boys, respectively. 8.7% of 15 year old girls and 10.5 % of boys were categorized as overweight, and 1% of 15 year old girls and 2.6% of 15 year old boys were classified as obese. Sum of measured skinfolds was higher among girls in both age groups. **Conclusion** In conclusion, the prevalence of overweight and obesity was found to be higher in 9 year old children compared with 15 years old is surprising and need further investigation. The prevalence of obesity was higher among 15 year old boys and girls from Prishtina compared to same age groups from Denmark, Portugal and Estonia. However, the prevalence of overweight 15 year old girls was reported to be higher than their age matched counterpart from Denmark, Portugal and Estonia, whereas the occurrence of overweight among 15 year old boys was lower than in Denmark and Portugal, but higher than they counterpart from Estonia.

#### CARDIO-RESPIRATORY FITNESS, FATNESS AND BLOOD PRESSURE AMONG 9 AND 15 YEAR OLD CHILDREN AND ADOLESCENTS IN PRISTINA, KOSOVO

Tishukaj, F.1, Gjaka, M.1, Brestovci, B.1, Shalaj, I.1, Berisha, A.1, Selimi, M.1, Tschan, H.2, Froberg, K.3

1: University of Prishtina, 2: University of Vienna, 3: University of Southern Denmark

**Introduction** Excess weight and body fat are currently recognized as the major determinants of high blood pressure in children and adolescents. Also, low cardio-respiratory fitness is a strong predictor for clustering of cardiovascular disease risk factors in children independent of age and sex. **Aim** This study aimed to assess whether overweight, obesity and resting blood pressure (RBP) are associated with the cardio-respiratory fitness level and to examine how does this association might appear. **Methods** 467 children volunteered in this cross-sectional study. The subjects were 250 (9 yrs) and 217 (15 yrs) school children, selected randomly within five different schools in Prishtina. A cross-sectional analysis of a school children urban sample was carried out with regard to; height, weight, waist circumference (WC), skin folds in four regions of the upper body; systolic and diastolic resting blood pressure; Andersen test was used as an indirect measurement for cardiorespiratory fitness (CRF). **Outcome measures** included BMI and waist to height ratio (WHR). **Results** Distance covered in the Andersen-Test was significant higher ( $p<0.001$ ) in 15 year-old ( $950\pm 138m$ ) compared to nine year old ( $846\pm 138m$ ). There was a significant gender difference ( $p<0.001$ ) in both age groups with higher values for boys compared to girls, respectively (9 yrs:  $877\pm 83$  boys;  $802\pm 71m$  girls; 15 yrs:  $1019\pm 136m$  boys;  $873\pm 93m$  girls). The correlation between CRF and fatness parameters was strongest among the 9 year old overweight/obese boys, and the sum of skinfolds provided the strongest correlation coefficient ( $Cc=.730^{**}$ ). Mean SBP was 95 mmHg for boys and 98 mmHg for girls, whereas, 119.2 mmHg for boys, and 119.8 for girls. Mean DBP was 59.3 mmHg for boys and 60 mmHg for girls. The strongest correlation between CRF and BP was noticed among 9 year old boys ( $Cc=.415^{**}$  for SBP, and  $Cc=.569^{**}$  for DBP). Significant gender differences were found only in SBP, between 9 year old groups. There was a low to moderate association between CRF and BP among all age and gender groups. **Conclusion** Cardiorespiratory fitness was inversely correlated with BMI and all other fatness parameters, Therefore it might be speculated that overweight/obesity is a predictor of CRF, among all age and gender groups included in the study.



### **BOTH RESISTANCE AND ENDURANCE EXERCISE TRAINING INCREASES CHANGES IN IL-10/TNF- $\alpha$ RATIO IN OVERWEIGHT SEDENTARY MALES**

Nikseresht, M., Taheri, A.

*Islamic Azad University, Ilam Branch*

Both Resistance and Endurance Exercise Training increases Changes in IL-10/TNF- $\alpha$  Ratio in Overweight Sedentary Males Mahmoud Nikseresht and Abdolhossein Taheri Islamic Azad University, Ilam Branch, Department of Exercise Physiology, Ilam, Iran Introduction Overweight and obesity are associated with increased plasma levels of pro-inflammatory cytokines such as TNF- $\alpha$  and decreased anti-inflammatory cytokines such as IL-10. The beneficial effects of physical activity-induced reduced cardiovascular risk are, in part, mediated by an exercise-induced amelioration of inflammation. Methods A sample of 31 sedentary subjects were assigned to a resistance group (n=10), an endurance group (n=11), or a control group (n=10). Before and after intervention, subjects were involved in muscular strength and aerobic fitness measurements and further provided a resting fasted venous blood sample for measure of IL-10 and TNF- $\alpha$ . The resistance and the endurance groups completed a respective 10-wk supervised and periodized training program, whereas the control group maintained sedentary lifestyle and dietary patterns. Results Both exercise training programs had no effect on baseline IL-10 and TNF- $\alpha$  concentrations, but did significantly increase IL-10/TNF- $\alpha$  ratio ( $p < 0.05$ ). Compared with the control group, the resistance and endurance groups exhibited significant ( $p < 0.05$ ) improvements in all aerobic fitness measures and significant reductions in body mass. Compared with the endurance and the control groups, the resistance group significantly ( $p < 0.05$ ) improved upper (46.3%) and lower (56.6%) body strength. Conclusion We demonstrate that IL-10/TNF- $\alpha$  ratio concentrations in plasma is affected by 10 wk of endurance and resistance training in overweight sedentary young male. There is no consensus in the literature about the effect of exercise training upon IL-10 and TNF- $\alpha$  production as some studies show increase in IL-10 and decrease in TNF- $\alpha$  (Jung et al, 2008), no change (Polak et al 2006) of this parameters. The anti-inflammatory effects of regular exercise may be mediated via both a reduction in visceral fat mass (with a subsequent decreased release of adipokines) and the induction of an anti-inflammatory environment with each bout of exercise (Gleeson et al, 2011). Taken together, our results suggest that increase in IL-10/TNF- $\alpha$  ratio by resistance and endurance training in sedentary male may lead to a shift towards decreased inflammation. References Gleeson M, Bishop NC, Stensel DJ, Lindley MR, Sarabjit S, Mastana SS, Nimmo MA. (2011). *Immunology*, SEP (11). Doi: 10.1038/nri3041. Jung Sh, Park HS, Kim KS, Choi WH, Ahn CW, Kim BT, Kim SM, Lee SY, Ahn SM, Kim YK, Kim HJ, Kim DJ, Lee KW. (2008). *J Nutr Biochem*, 19(6): 371-5. Polak J, Klimcakova E, Moro C, Viguerie N, Berlan M, Hejnova J, et al. (2006). *Metabolism* 55:1375-81.

### **SHORTENING AND MUSCULAR IMBALANCES IN MIDDLE AND HIGH SCHOOL STUDENTS IN A SPANISH POPULATION**

Pablos, A., Elvira, L., Esteve, H., Blasco, E., Gonzalez, M.D., Martin, M.

*Universidad Católica de Valencia*

Introduction Back pain in children and adolescents is a common cause of medical consultation. These problems are caused many times by muscle imbalances. The main reasons that lead to muscle imbalances are the poor and/or inadequate muscular work, the adoption of poor posture in performing everyday tasks and ongoing efforts to cause depletion of certain muscles. Therefore, the purpose of this study was to quantify muscle shortening and bilateral limb differences in Middle and High School students in a Spanish population. Methods It has applied a test of shortening and muscle imbalances to a population of 311 male subjects who were in middle and high school. The test has five measurements (Diagonal Posterior Chain (DPC), pectoral muscle stretch (PEC), Internal Hip Rotators (IHR), External Hip Rotators (EHR), Iliopsoas (IP) and Hamstrings (HAM)). Results The percentage of students with shortening and muscle imbalances was 46.9% for DPC, 24.1% for the PEC, 1.6% for the IHR, 0.3% for the EHR, 41.2% for HAM and 22.2% for IP. Discussion Bad postural habits and a sedentary lifestyle of the students can cause shortening and muscle imbalances. Staying seated for long hours and poor posture will involve the shortening of certain muscle groups and the relaxation of others. This we have been corroborated in our study. We found worrisome shortening of the muscles that moves the shoulder girdle, reaching percentages around 50% for the diagonal posterior chain and above 24.1% in pectoral stretch. These results are still lower than obtained in the study of Ramos et al. (2007), which include values of 85% for PEC. We also find percentages above 40% for knee flexor muscles (HAM), coinciding with Ramos et al. (2007). Their results show percentages of 55% for similar populations. Regarding the shortening and limb differences at the level of the hip flexor muscles (IP) values are reached 22.2%. These being lower than those found in the study of Ramos et al. (2007) exceeding 50% of the population in this age group. Showing the results we can see it is essential keep an active lifestyle, stretch the postural muscles and build the dynamic muscles. References González, J.L., López, M., Ramos, D., Mora, V., Mora, J., Rodríguez, H. (2009) Propuesta de tests de evaluación de la movilidad articular y estudio de los acortamientos musculares en una población universitaria. *Revista Española de Educación Física y Deportes*, 10, 63-77. Ramos, D., González, J.L. & Mora, V. (2007). Amplitudes articulares entre varones y mujeres en edad escolar. *Apunts. Medicina de l'Esport*, 42, 13-25. Ramos, D., González, J.L. y Mora, V. (2007) Propuesta de tests de evaluación de la movilidad articular y estudio de los acortamientos musculares en una población de educación secundaria obligatoria. *Revista Digital de Educación Física y Deportes*, 109. Revisado el 06 de Enero de 2012 desde Internet: <http://www.efdeportes.com/>

### **EFFECTS OF LISTENING MUSIC AND WATCHING IMAGES ON ENERGY EXPENDITURE, HR, PER, AND LACTATE IN ACCORDING TO EQUIPMENTS DURING EXERCISE**

LEE, H.K., KIM, M.J.

*SANGMYUNG UNIVERSITY*

EFFECTS OF LISTENING MUSIC AND WATCHING IMAGES ON ENERGY EXPENDITURE, HR, PER, AND LACTATE IN ACCORDING TO EQUIPMENTS DURING EXERCISE Hyung Kook Lee 1 Myung Ju Kim 2 1: Sangmyung University (Cheonan, Korea) 2: Seoul National University (Seoul, Korea) Introduction Listening music during exercise as a way of feeling or emotional techniques has been used to improve athletic performance (Simpson, et al, 2006). Also, during steady-state exercise, VO<sub>2</sub>, Q, SV, VE and Fb significantly increased while listening to fast music compared to the slow music and no music (Birnbbaum, et al, 2009). Recently, it has become a common practice to listen music and watch images while exercising in gym. We used to choose the favorite equipment for aerobic exercise. The aim of this study was to compare the effects of listening music and watching images on Calory, HR, PER, and Lactate during aerobic exercise. Methods 20 healthy university male students volunteered to participate in this research. They were divided into 3 groups at random. They have exercised with 3 equipment (treadmill, bicycle, arm) respectively and under 3 experimental conditions (no-music, music, images) repeatedly. Each exercise was performed during 25min with moderate intensity. It were measured energy expenditure (EE) and total heart rate (HR), total perceived exertion rate (PER) with Borg's Scales (6-20), and blood lactate concentration difference (DLA). Statistical analyses were completed

using repeated measures ANOVA. Results In case of treadmill, EE, tHR, tPER, and dLA were not significant difference between 3 conditions. But all of factors showed the highest in the case of no music condition. In case of bicycle ergometer, there were significant difference on EE( $p<.05$ ) and dLA ( $p<.05$ ) in the case of listen to music condition. Also, EE, tHR, and dLA at music listening condition and tPER at no music were the highest. In arm ergometer, also there were not significant difference, but EE, tHR at music listening condition and tPER, dLA at no music were showed the highest. Discussion In the case of treadmill, there were unlike the findings of previous studies (Hasan et al, 2008; Brownley, et al 1995; Birnbaum, et al, 2009). In this study, EE at no music listening condition was measured the highest. That is because audio or visual stimulator may interrupt to focus performance in treadmill. On the other hand, in exercising used bicycle ergometer, the results of this research have shown that it was increased on EE and dLA at music listening condition than others. In order to get the listen to music' positive effect, it is good to use the equipment as bicycle ergometer. References Birnbaum, L., Boone, T., & Huschle, B.(2009). Journal of Exercise hysiologyonline, 12(1), 50-57. Brownley K., McMurray, R., & Hackney, A. (1995). International Journal of Psychophysiology 19(3), 193-201. Hasan Mohammadzadeh, Bakhtiyar Tartibiyani, & Azhdar Ahmadi (2008). Physical Education and Sport, 6(1) 67-74. Simpson SD & Karageorghis CI, (2006). J Sports Sci, 24(10), 1095-1103.

### **THE JOURNEY TO MARS: VARIOUS KINDS OF EXERCISE LEAD TO DIFFERENT EFFECTS ON THE BRAIN CORTICAL ACTIVITY, MOOD AND COGNITIVE PERFORMANCE**

Jacobowski, A., Abeln, V., Schneider, S.

*German Sport University Cologne*

Introduction A general psychological model assumes that during long term spaceflights mood and cognitive functioning are impaired because of isolation. As physical activity has a strong influence on brain activity, mood and cognitive function it is hypothesized that exercise would be able to counteract mood and cognitive changes during isolation<sup>1,2</sup>. It is also known that the influence is stronger when people exercise at their chosen intensity and it is likely, that the effect also correlates with the performed kind of exercise. Therefore the aim of the study was to analyse in which way individuals react to sport concerning brain cortical activity, mood and cognitive performance and if these effects are based on the chosen exercise or depend on the individual itself. Methods The experiment took place during the MARS500 project initiated by the Institute of Biomedical Problems (IBMP) and the European Space Agency (ESA), where 6 male subjects (age 31,33±4,13) lived in confinement for 520 days, simulating a real mission to Mars. Every two weeks electrocortical activity (EEG), mood-parameters and cognitive performance parameters were recorded prior to and after one of six specified exercises (Active and Passive Running, Bicycle, Strength training, Expanders and Vibration). The measurement for mood parameters consisted of a self report on current psychological and physical state whereas cognitive performance was measured in form of commercially available brain games. Results A decrease of cortical brain activity in the prefrontal area was noticeable after all kinds of exercise; the effect was most pronounced after running and bicycling. The general cognitive performance was higher after sport for all kinds of exercise but also differed by a varying amount. The best results were reached after running and bicycling. Changes in mood regarding the exercises were more complex but always specific to sports. Discussion We could show that the effect on mood and cognitive performance depends on the performed exercise especially while comparing endurance training and strength training. Therefore it is proposed to regard personalised exercise during long term spaceflights as a possibility not only to counteract physiological but also neuro-psychological deconditioning in order to maintain and improve mission success and mission safety. References 1. Schneider S, Brümmer V, Abel T, Askew CD, Strüder HK. Changes in brain cortical activity measured by EEG are related to individual exercise preferences. *Physiol Behav* 2009;98(4):447-52 2. Schneider S, Brümmer V, Carnahan H, et al. Exercise as a countermeasure to psycho-physiological deconditioning during long-term confinement. *Behav Brain Res* 2010;211(2):208-14

### **EXPLORING MEDIATORS OF ACCELEROMETER ASSESSED PHYSICAL ACTIVITY IN YOUNG ADOLESCENTS IN THE HEIA STUDY – A RANDOMIZED CONTROLLED TRIAL**

Bergh, I.H.1, van Stralen, M.M.2, Grydeland, M.1, Bjelland, M.3, Lien, N.3, Andersen, L.F.3, Ommundsen, Y.1

*1: Norwegian School of Sport Sciences, Norway, 2: VU University Medical Center, the Netherlands, 3: Faculty of Medicine, University of Oslo, Norway*

Introduction School-based interventions which include efforts to increase physical activity (PA) may promote a healthy weigh development in adolescents, but results are inconsistent (Brown et al., 2009). One possible explanation for low efficacy or effectiveness is limited evidence as to how interventions induce behaviour change (Baranowski et al., 2005). The purpose of this study was to examine whether personal, social and physical-environmental factors mediated intervention effect on PA and whether gender and weight status moderated mediated effects in the HEIA study – a school-based, randomized controlled trial to promote healthy weight development among young adolescents. Methods Accelerometer assessed PA (mean count per minute) and six potential mediators based on the social-ecological framework were assessed at baseline and post-intervention after 20 months. The product-of coefficient test was used to assess mediating effects. Results No mediating effect of any of the hypothesized mediators was identified. Gender and weight status did not moderate any mediated effects with the exception of weight status that moderated the mediated effect of enjoyment. Few intervention effects were seen on the mediators, except for a positive change in social support from teachers among girls ( $p<.05$ ) and the normal weight ( $p<.05$ ), and a negative effect on enjoyment ( $p<.05$ ) and self-efficacy among the overweight ( $p<.001$ ). However, change in enjoyment, self-efficacy, perceived social support from friends and environmental opportunities were associated with change in mean count per minute, and thus show evidence of being potential mediators of physical activity in adolescents. Discussion Even though no mediating effect on PA change could be observed, personal, social and physical-environmental factors were identified as potential mediators. Future studies should continue to examine mediating and moderation mechanisms in PA change in adolescents using a broad set of mediators. References Baranowski T, Jago R. (2005). Understanding the mechanisms of change in children's physical activity program. *Exerc Sport Sci Rev*, 33,163-168. Brown T, Summerbell C. (2009). Systematic review of school-based interventions that focus on change in dietary intake and physical activity levels to prevent childhood obesity: and update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obesity reviews*, 10, 110-141.

## COMPETENCIES OF THE PHYSICAL EDUCATION PROFESSIONAL TO PERFORM IN PRIMARY HEALTH CARE: THE DIMENSION OF SKILLS

Coutinho, S.S.1, Queiroga, M.R.1, Ferreira, S.A.1, Mishima, S.M.2, Pereira, M.J.B.2

1: UNICENTRO (Guarapuava, Brasil), 2: USP (Ribeirão Preto, Brasil) Research Support: CNPq, Brasil.

**Introduction** The physical education professional working in the areas of Primary Health Care (PHC) is recent in Brazil. There is still a lack of empirical research demonstrating the skills that these professionals may have to act in this context. The professional skills are studied from a concept that comprehends three linked dimensions: knowledge, skills and attitudes (Durand, 2000). This study aims to develop and analyze the competencies of the dimensions of skills that are required for the physical education professionals in the context of PHC. **Methods** For data collection, the Delphi technique with the performance of three rounds was used. The sample consisted of 31 subjects: 4 general coordinators, 12 sectional coordinators and 9 professors of physical activity programs developed in the public health system in six different Brazilian cities and 6 researchers. Results 36 competencies of the dimensions of skills divided into five indicators were developed: planning (13 competencies), communication (6), evaluation (4), incentive (3) and management (10). **Discussion** The results indicate two aspects. 1) Narrow technical skills: direct and diversify bodily practices; assess and prescribe exercise; organize events; develop programs and projects; report on the physiological adaptations and benefits caused by physical activity and raise awareness about the importance of regular physical activity. 2) Skills that show a broader view: plan actions knowing the mission for public health; and develop strategies for transformation of health practices based on the principles of continuing education; act in an interdisciplinary and multi-professional team, with possibilities of matrix support; establish link by listening; evaluate people and communities based on social and cultural context; favor community participation and empowerment of the user; develop bodily practices that enable the participation of all, starting from the needs and desires expressed by individual and collective ideas; obtain intersectoral articulation, understanding that health is the result of multiple factors; deal with unexpected events, discuss possibilities of intervention and use high technology to solve population health problems. As in studies with other health professionals, the results of this research show the need for the physical education professionals conduct their actions in view of the health-disease process which should not be restricted only to the biological aspects (Carvalho, 2005). **References** Carvalho YM. (2005). *Motrivência*. 17(24), 97-105. Durand T. (2000). *Rev Fr Gest*, 127, 84-102. Simões EJ, Hallal P, Pratt M, Ramos L, Munk M, Damascena W. (2009). *Am J Public Health*, 99 (1), 68-75.

## ADHERENCE TO A PROGRAM OF EXERCISE PHYSICIST IN PATIENTS WITH RISK CARDIOVASCULAR

Meseguer Zafra, M., Manzanares Serrano, A., Soler Torroja, M., Pérez Valero, I., Sesma Arnaiz, R., Fernández Garrido, D.  
*universidad catolica san antonio, medical centers Jesus Marín*

**Introduction** The program "ACTIVA" is an initiative conducted by Ministry of Health from Region of Murcia (Spain), with the objective to initiate the practice of physical activity in sedentary subjects with cardiovascular risk factors (CVRF). This study investigated the adherence of patients to the program "ACTIVA" in the municipality of Molina de Segura. **Method** The subjects in this study were 540 (35-65 years), patients of two medical centers, municipality of Molina de Segura (Spain). The criteria for inclusion in the program were the presence of two or more CVRF (hypertension, lipid disorders, overweight and smoking) and sedentary lifestyle. The subjects were included on the program for their family doctor or nurse. The program "ACTIVA" consisted of 30 sessions of training on strength, flexibility and aerobic endurance on 10 weeks. Results The 61% Of the 540 subjects involved on this study were women. The average of age was 50.8±8.8 years (men 49.8±9.4; women 51.4±8.3; p=0.04). From all subjects participating in the study the 40.9% suffered hypertension, 60.8% obesity, the 53.4% had lipid disorders and the 35.9% were smokers. 77.9% were derived by doctors and nurses 22.1%. From the total of the subjects that initiated the program (at least one session) 80.9% (437 subjects) (men 79% women 82%). With respect to the initiation of the program, we found significant differences according to the age: attended the 69.2% of under 45 years, the 82.7% between 45 to 55 years and 91% of older 56 (p<0.001). Also there were significant differences between subjects derived by medical centers (85% and 77.7% each) (p = 0.03). The average of attendance was the 64.6% (68.2% men and women 63.3%), with small differences depending the health center of source (67.3% and 62.3%). We found very significant differences in adherence to the program by age: older than 50 years had an average of 69.2% attendance and under 50 years old had 50.6% (p = 0, 003) **Discussion** In contrast to what would be expected, the study shows that with an exercise program with participation and close coordination with health professionals and graduates in sports science, high adhesion may be obtained in older patients, sedentary subjects with CVRF (over 60% obese), being higher still in patients over 50 years. In fact, the current perspective focused on health promotion through the physical activity puts increasingly greater degree the phenomenon of adherence as one of the essential pillars of it, because only if you practice physical activity on a regular basis can be able to obtain certain safeguards about their potential benefits (Marquez, 2004). **References** Márquez, S. (2004). Adherence to physical exercise: determinants, models and strategies of maintenance. *Domus*, 11-12, 93-112

## THE EFFECTS OF THREE MONTHS EXERCISE TRAINING ON IN VIVO AND EX VIVO MUSCLE ENERGY METABOLISM IN OBESE INDIVIDUALS

Ukropcova, B.1, Kurdiová, T.1, Valkovic, L.6, Baláz, M.1, Zemková, E.2, Srbecký, I.3, Kyselovicová, O.2, Belan, V.3, Jelok, I.4, Vician, M.5, Krssak, M.6, Trattnig, S.6, Ukropec, J.1

1: Inst Exp Endocrinology SAS, 2: FSPE, 3: UHB Comenius University, 4: NICD & 5: SMU (Bratislava, Slovakia), 6: Vienna GH (Vienna, Austria).

**Introduction** Obesity significantly increases the risk of metabolic disease, associated with perturbation of muscle energy metabolism. An ample evidence documents the beneficial effects of regular exercise on the whole body and muscle metabolism. The aim of this study was to measure in vivo and ex vivo muscle energy metabolism in obese individuals before and after exercise training. **Methods** Obese sedentary individuals (M/F 11/8; age 36±6yrs., BMI 32.1±3.5kg/m<sup>2</sup>) completed 3 months endurance or strength (n=11/8) training program, with 1 hour exercise session three times per week. Phosphorus magnetic resonance spectroscopy (31P-MRS) was used to measure the energetic status of muscle in vivo by measuring the intracellular phosphorus metabolites; i.e. phosphocreatine (PCr), ATP, inorganic phosphate (Pi) and maximal oxidative flux after either chemical or magnetic equilibrium perturbation. The samples of skeletal muscle were taken by muscle biopsy (vastus lateralis) before and after training. Ex vivo respiration (cytochrome C oxidase [COX] activity) of permeabilized muscle fibers was measured by oxymetry. Maximal aerobic capacity (VO<sub>2</sub>max) was measured by bicycle ergometry. Results Three months of exercise training increased physical fitness (VO<sub>2</sub>max, p=0.01) and in vivo muscle energy metabolism as assessed by 31P-MRS (maximal oxidative flux, p=0.03; initial recovery rate p=0.07), without a significant effect on ex vivo muscle COX activity (n=0.1). In vivo depletion of muscle PCr was negatively associated with muscle COX activity (p=0.004) and PCr recovery rate was also associated with calf muscle volume, and with parameters of physical fitness such as maximal heart rate (p=0.004) and VO<sub>2</sub>max

( $p=0,046$ ). In addition, extramyocellular lipid content was associated with the ATPase reaction rate ( $p=0,045$ ). Discussion Low physical fitness is one of the major risk factors of obesity and metabolic disease. Exercise training increased physical fitness as documented by an increase in  $VO_2\max$ , as well as in vivo muscle energy metabolism, measured by  $^31P$ -MRS. It has been shown that mitochondrial respiration increases with training, the lack of the training effect on COX activity in our study might be attributed to the limited size of the study population. The association of in vivo energy metabolism with ex vivo muscle respiration, muscle mass and extramyocellular lipid content points at the complexity of regulatory processes associated with muscle training. In conclusion, 3 months training is sufficient to increase both cardiorespiratory and muscle fitness in obese individuals. Grant support: EFSD & Lilly Fellowship

### **ANNUAL MEDICATION COSTS NEGATIVELY CORRELATE WITH FUNCTIONAL FITNESS, MOOD STATES AND SF-36 SCORES IN ELDERLY WOMEN.**

Teixeira, A.M., Marques, J., Martins, R.

*University of Coimbra*

**Introduction** The importance of physical activity in the maintenance of the well-being and quality of life in the elderly is unquestionable. The aim of this cross-sectional study was to analyze the effects of a multicomponent exercise on functional fitness, mood states, mucosal immunity, quality of life and annual cost of medication in elderly women. **Methods** The sample study consisted of 41 women, 20 who had been engaged in a multicomponent exercise protocol in the last year (68,5+6,5 years old, 154,8+6,1m stature and 65,5+9,0 Kg body mass) and 21 that were sedentary (72,7+8,0 years old, 152,3+5,2m stature and 71,13+10,6Kg body mass). Written informed consent was obtained from all the participants. Functional fitness was assessed using the Senior Fitness Battery Tests. Mood states and quality of life were evaluated using the POMS-SF and the SF-36 questionnaires respectively. Anthropometric, hemodynamic and metabolic parameters, salivary IgA concentration and secretion rate were also analyzed. The annual cost of medication was calculated by recording for each participant the amount and commercial name of the medicines taken regularly on a daily basis. Statistical analysis was done using the independent samples T-test for differences between groups and the bivariate Pearson's correlation for the association between variables. The significance level was set at  $p<0.05$ . **Results** Anthropometric measures showed that the elderly women engaged in exercise had lower BMI, waist, hip and abdominal circumferences, waist-hip ratio and percentage of fat mass. Functional fitness components including lower and upper body strength, lower and upper body flexibility, speed, agility and balance and aerobic endurance were also better for the exercising group. More favourable values on the POMS and SF-36 questionnaires were also found for this group. Differences between the two groups were also found for the annual medication costs ( $p=0.003$ ). No differences between groups were found for systolic and diastolic blood pressure, resting heart rate, lipid profile, glucose, haemoglobin, HbA1c and salivary IgA levels or saliva flow rate. The annual cost of medicines negatively correlated with age, functional fitness, depression, anger, fatigue, tension, the different SF-36 components, total SF-36 scores ( $r=-0.575$ ,  $p=0.0001$ ) and log saliva flow rate. **Discussion** This study shows that elderly women that practice regular exercise have lower annual costs with medication than their sedentary counterparts. Financially exercise seems to be a good investment as it promotes quality of life in latter years and reduces the amount of medicines regularly taken cutting costs at the individual and public levels.

**13:45 - 14:45**

## **Poster presentations**

### **PP-PM21 Training & Testing 3**

#### **DYNAMIC AND MULTIDIMENSIONAL NATURE OF HANDBALL PLAYER**

Massuca, L.1,2,3, Fragoso, I.3

*1: UL-FEFD (Portugal); 2: ICPOL-ISCPSP (Portugal); 3: FMH-UTL (Portugal)*

**Introduction** Research on expertise or in talent identification has tended to be mono-disciplinary (Phillips et al., 2010) or focused in the inter relationships between morphologic and fitness profiles. In accordance, this study aims to identify the inter-relationships correlation between the morphologic, fitness, handball-specific skill (HBskill), psychological and biosocial profiles in handball players (HB). **Methods** A sample of male HB ( $n=225$ ) were evaluated in five dimensions: morphologic, fitness, handball-specific skill, psychological and biosocial. Predicted probabilities of each category were calculated using Massuca, Fragoso and Teles (in review) logistic regression models. Taking into account these scores, Pearson correlation analysis was performed to study the relation between profiles. **Results** Significant correlations were found between fitness profile and all the other dimensions considered in this study. Significant positive correlations were also found between the morphologic profile and: (1) "biosocial" ( $r=.450$ ,  $P<.001$ ); and (2) HBskill ( $r=.248$ ,  $P=.004$ ) profiles. The "biosocial" and HBskill profiles were significantly correlated with each other ( $r=.223$ ,  $P<.013$ ). **Discussion** The literature often focuses on the physical characteristics and/or physiological attributes to succeed in handball. However, this study showed that both dimensions were significantly correlated to each other ( $r=.669$ ,  $P<.001$ ). Moreover, they significantly correlate with HBskill (morphologic:  $r=.248$ ,  $P=.004$ ; fitness:  $r=.359$ ,  $P<.001$ ) and biosocial (morphologic:  $r=.450$ ; fitness:  $r=.550$ ; both  $P<.001$ ). According to literature, expert performers accumulate more minutes of sport-specific practice than non-expert performers (Baker et al., 2003; Helsen et al., 2000; Massuca & Fragoso, 2011). In fact, the amount of practice time seems to be associated with the time "needed" to learn and to improve technical and tactical skills. This may explain the positive correlation between the "biosocial" and handball-specific skills profiles ( $r=.223$ ,  $P<.05$ ). Nevertheless, all these findings underline the dynamic and multidimensional nature of HB. **References** Baker J, Côté J, Abernathy B (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of Applied Sport Psychology*, 15(1), 12-25. Helsen WF, Hodges NJ, Winckel JV, Starkes JL (2000). The roles of talent, physical precocity and practice in the development of soccer expertise. *J Sports Sci*, 18(9), 727-736. Massuca L, Fragoso I (2011). Study of Portuguese handball players of different playing status. A morphological and biosocial perspective. *Biology of Sport*, 28(1), 37-44. Phillips E, Davids K, Renshaw I, Portus M (2010). Expert Performance in Sport and the Dynamics of Talent Development. *Sports Medicine*, 40(4), 271-283.

## WORK IS A MORE RELIABLE ESTIMATOR THAN HEIGHT OF COUNTERMOVEMENT JUMP PERFORMANCE

Dias, P., Amaro, N., Matos, R., Morouco, P.

*Polytechnic Institute of Leiria*

**Introduction** Since the early 80s that 'Bosco Tests' are commonly used all over the world. Indeed, most coaches rely on the countermovement jump (CMJ) to evaluate muscular power of the lower limbs. This is acceptable because in short activity patterns muscular power plays a major role. In fact, it is assumed that there is a good correlation between lower limb maximum power and maximum jump height. Results of CMJ are usually expressed in height, i.e., the vertical displacement of the centre of mass. However, this parameter does not take into account the mass of the subject. Thus, the purpose of the present study was to analyze the possible relationships between height and work of the CMJ and power in Squat. **Methods** Forty-two national level swimmers (22 male and 20 female; age:  $15.6 \pm 1.8$  years; body mass:  $57.4 \pm 9.5$  kg; height:  $1.68 \pm 0.13$  m) volunteered as subjects. The height in the CMJ was obtained using the jump fly time (ErgojumpTM, Italy). Work was calculated according to  $W = m \cdot g \cdot \Delta h$ . Using a dynamic measurement system (T-Force System, Ergotech, Spain), each participant executed *n* incremental repetitions (5 min rest) in Squat to assess average propulsive power. After Shapiro-Wilk normality test, Pearson's correlation coefficient (*r*) was used to establish relationships between variables. The level of statistical significance was set at  $p < 0.05$ . **Results** The height assessed in the CMJ was  $0.34 \pm 0.09$  m, being calculated the correspondent work of  $209.5 \pm 36.6$  J. Maximum value of average propulsive power was  $355.33 \pm 56.4$  W. Significant correlations were observed between power in squat with CMJ height ( $r = 0.64$ ,  $p < 0.05$ ) and work ( $r = 0.92$ ,  $p < 0.001$ ). **Discussion** The high correlation between height and work ( $r = 0.88$ ,  $p < 0.001$ ) in CMJ can induce that both variables are good estimators for performance. Moreover, the generally used equipments to evaluate CMJ provide the height of jump immediately. However, not taking into account the mass of the subject does not seem the most accurate procedure. Indeed, power presented higher correlation with work than with height, inducing a more reliable estimator for performance in the gym exercise. These data corroborate the findings of Morouço et al. (2011), which reported higher correlations between work and swimming performance parameters, than with height. Coaches evaluating CMJ should take in account the mass that the subject must overcome, with the aim of having a more trustworthy estimator of muscular power. **References** Morouço P, Neiva H, González-Badillo J, Garrido N, Marinho D, Marques M. (2011). *J Hum Kinet*, SI, 105-112.

## EFFECTS OF SPECIFIC PREPARATION PHASE TRAINING TO THE PERFORMANCE CHARACTERISTICS IN FEMALE HANDBALL PLAYERS

Kale, M.

*Anadolu University*

**Introduction:** The aim of this study was to examine effects of specific preparation training to the performance in women handball players. **Methods:** Fourteen women handball players (age/year)= $20.2 \pm 1.9$ , height(cm)= $170.7 \pm 5.5$ , body weight(kg)= $65.8 \pm 8.3$ ) from Turkish Women Handball Super League were voluntarily participated. Body fat percent(BF%), somatotype, sprint variables (10m, 20m, 30m), anaerobic power(AP), anaerobic capacity(AC), squat jump(SJ), countermovement jump(CMJ), lactate threshold(LT), maximal oxygen consumption(VO2max), maximal heart rate (MHR) were tested at pre and post specific preparation phases. LT, VO2max, MHR were determined from Modified Shuttle-Run Test(MSRT) (Hazır, 2000). Subjects'FBLLs(fixed blood lactate levels) were determined from the MSRT. MSRT was started at velocity of 8km.h<sup>-1</sup> and in every 3min velocity was increased 1km.h<sup>-1</sup> until the exhaustion, with 1min rest intervals for blood sampling from earlobe. Third degree polynomial fit was used to estimate mean running velocities, heart rates, oxygen consumptions of FBLLs at 2mM.L-1, 3mM.L-1, 4mM.L-1, 5mM.L-1 respectively. The players were trained 2 mesocycles training (sprint, strength and power, endurance, and technical-tactical training) for the specific preparation. Each mesocycle included 5 day training period in a week for 3 weeks. The training period included endurance running at FBLLs, weight training, sport-specific strength, sprint running, training, and competition game. Wilcoxin test was used to determine the effects of specific preparation phase training to the performance characteristics. **Results:** The results show that there were no significant differences between pre and post specific preparation training for AP, AC, BF%, endomorphy, and mezomorphy but woman handball players increased their some performance characteristics. Ectomorphy, 10m-20m-30m sprint variables, SJ, CMJ, VO2max, running velocities, heart rate, and oxygen consumption at FBLLs were significant differences ( $p < 0.05$ ). **Discussion:** Specific preparation training resulted in significant increases in sprint variables, squat and countermovement jumps, VO2max, running velocities, heart rate, and oxygen consumption at FBLLs. Such performance characteristics as strength, speed, and endurance that increases have been found in woman handball players (Granados et al, 2007; Gorostiaga et al, 2006). It is concluded that such increases in specific preparation training are likely to be considered advantages to women handball players because these biomotor characteristics give the forceful muscle contractions and also endurance for required in some handball game actions, such as sprinting, throwing, blocking, jumping, pushing. **References:** Granados C, Izquierdo M, Ibanez J, Bonnabau H, Gorostiaga EM. (2007). *Int J Sports Med*. 28(10),860-7. Gorostiaga EM, Granados C, Ibanez J, Gonzalez-Badillo JJ, Izquierdo M. (2006). *Med Sci Sports Exerc*. 38(2),357-66. Hazır, T. (2000). Unpublished Thesis. Hacettepe Univ, Health Science Institute.

## THE SCORING SKILLS WHICH DISCRIMINATE RESULT , ACCORDING SET NUMBER IN WORLD CHAMPIONSHIP VOLLEYBALL 2010

Joao, P.V., Silva, M., Lacerda, D., Vaz, L.

*IResearch Center for Sports Sciences, Health and Human Development (CIDESD) UTAD - Vila Real, Portugal.*

**Introduction** The study of the knowledge of the match isn't a recent concern, since one of the biggest challenges of the investigation has been, for a long time, the concern for the interpretation and understanding of the development of the specific knowledge in team sports. The aim of the present study intends to identify the actions of the game which discriminate the result (win/lose), according set number. **Methods** The sample of this study has been taken from the World Championship of Volleyball Male Seniors – Italy 2010. Were analyzed *n*=24 games, 3 were played in 5 sets, 12 in 4 sets and 9 in 3 sets which outcomes the result of 90 sets played throughout the 3rd round, which are the elite matches until the present study. These correspond to 24670 actions, in which 4083 services, 3434 receptions, 4906 attacks (3030 attacks after reception, 1876 attacks in transition), 2109 blocks, 1933 digs and 3299 sets. The Data Volley software was used in this research. To the data analysis was used the discriminating function (AD) in order to identify, throughout canonical structuring coefficient (CCE), the indicators which contribute the most to establish the maximum difference between the victories and defeats. We consider as relevant to the interpretation of the linear composite the  $|CCE| \geq 0,30$  (Tabachnick & Fidell, 1996). The level of significance was established in 5%. The calculation of the results was made by the software SPSS version 17.0. **Results** Regarding the total amount of the sample, the results suggest that the service point, the reception error and the block error were discriminating variables to the final out-

come of the match. Only in the matches of 4 sets occurred significant differences in the actions of serve point, side out error, service error and attack error, contributing to the result of the match. Discussion Regarding the results obtained throughout the positioning of the setter (defense zone and attack zone), the discriminating variables were service point, service error, excellent pass, pass error, excellent defense, side out error, counter attack point, attack point, excellent reception, side out point and reception error. We can say the action service point, it's possible associate to the success (win). It's very important training the efficacy of this action according the final outcome.

### **SPRINT VS INTERMITTENT TRAINING IN YOUNG BASKETBALL PLAYERS**

Padulo, J.1, Attene, G.2, Bramani, S.3, Pizzolato, F.4

1: University of "Tor Vergata" (Rome ITALY), 2: University (Cagliari ITALY), 3: Rehab. Institute (Como ITALY), 4: University (Verona ITALY).

Introduction In young basketball players, it is not known whether sprint or intermittent training fulfils the criterion of effective training to improve sprint vs endurance. The aim of this study was to compare the effects of intermittent training and repeated sprint ability training (Ferrari Bravo et al.; 2008) on physiological variables in female basketball players. Methods Sixteen participants were randomly assigned to either the intermittent training group (YYIRG, n= 8) or repeated-sprint training group (RSAG, n= 8). The following outcomes were measured at baseline and after 6 weeks of training: Yo-Yo IRT (YYRT) and RSA tests (Castagna et al.; A-B 2008). The YYIRG performed at the 80% of the maximal speed (YYIRT) 3 sets of 5' of shuttle running (16.47±0.61m - total time 20"), with 20" of recovery and 3' between sets. The RSAG performed (15+15m) with repeated sprint training: 3 sets of six maximal sprint with 20" of recovery and 4' between sets. Result The main effect of training type for all the variables investigated was never significant. In the RSA, best time (BT) was found a significant main effect of time (pre vs post) ( $p < 0.0001$ ), and the interaction training type x time ( $p < 0.03$ ). The RSAG showed a decrease in the BT by 3.1% ( $p < 0.005$ ) and the YYIRG showed a decrease by 6.2% ( $p < 0.0001$ ). Significant main effect of time in the worst time, with a decrement of 5.36%; in the total time, with a decrement of 5.08%; in blood lactate with a decrement of 24.02%. In the YYIRT significant main effect of time in the distance with an increment of 26.9%. Significant main effect of time in the final speed with an increment of 1.23%. Discussion These findings suggest that the two training protocols used in this study can be an effective training strategy for inducing anaerobic and basket-specific training adaptations. Therefore, even weather the YYIRG training is not done at very high speed, it can more increase the maximum speed of the RSAG. Moreover, given that the two trainings are different in terms of volume of work, we can suggest choosing the RSA training in team sports when we want to reduce the volume of work without compromising the anaerobic fitness. References Ferrari Bravo, D., Impellizzeri, F. M., Rampinini, E., Castagna, C., Bishop, D., & Wisloff, U. Sprint vs. interval training in football. (2008). *Int J Sports Med*, 29(8), 668-674. Castagna, C. A, Impellizzeri, F. M., Rampinini, E., D'Ottavio, S., & Manzi, V. The Yo-Yo intermittent recovery test in basketball players. (2008). *J Sc Med Sport*, 11(2), 202-208 Castagna, C. B, Abt, G., Manzi, V., Annino, G., Padua, E., & D'Ottavio, S. Effect of recovery mode on repeated sprint ability in young basketball players. (2008). *J Str Cond Res*. 22(3), 923-929

### **PHYSIOLOGICAL PERFORMANCE IN MALE HANDBALL PLAYERS ACCORDING TO AGE AND PLAYING POSITION.**

Torres-Ronda, L., Gerona, T., González-Badillo, J.J.

*Fútbol Club Barcelona*

Torres-Ronda, L.1, Gerona, T.1, González-Badillo, J.J.2 1: F.C. Barcelona (Spain), 2:UPO (Seville, Spain) Introduction Few studies have evaluated specific physiological performance measures in male handball players (Ziv & Lidor, 2009). The aim of the present study was to analyze physiological characteristics of men's handball players according to age group and specific positional roles. Methods Eighty players from F.C. Barcelona handball teams volunteered to take part in this study (Senior-b:n=15;Under-18:n=16;Under-16a:n=17;Under-16b:n=16;Under-14:n=16). Players were measured for anthropometry, horizontal explosive power (5J), agility (T-test), throw speed and repeated sprint (6 x 12.5 m) and CMJ sequences. Results Results showed the experience of age in fitness performance in handball players. Differences were evident in mean and best result of 5JT, jumping, standing and sitting throw and T-test ( $P < 0.001$ ). For the repeated sprint and jump sequences mean, best and % decrease in CMJ was significantly different between age groups ( $P < 0.05$ ), but not for sprint sequences. No differences between play positions (goalkeepers, playmarkers, backs, pivots and wings) were found. Finally, weight and height showed significant correlation between all performance measures ( $P < 0.05$ ) irrespective of age group. Discussion The results indicate that age and years of training handball players aged 14 and over 20 years is an important determinant of performance in specific actions in the game, but not the relative endurance and the degree of fatigue reached when performing repeated sprints of the same distance. The fact that a significant correlation remains between weight and height and performance variables analyzed, independently of age, indicates that the weight and height are key variables in handball performance, which means that these variables are determinants of performance even when players have completed their biological and technical development (Mohamed, et al., 2009). These results suggest that there should be some difference in the testing analyzed between the different play positions, given the characteristics of height and weight between players. The lack of differences between play positions within each age could be explained by the small number of players within each team in various positions (Chaouachi, et al., 2009). References Chaouachi, A., Brughelli, M., Levin, G., Boudhina, N. B. B., Cronin, J. & Chamari, K. (2009). Anthropometric, physiological and performance characteristics of elite team-handball players. *J Sport Sci*, 27(2), 151-157. Mohamed, H., Vaeyens, R., Matthis, S., Multael, M., Lefevre, J., Lenoir, M., et al. (2009). Anthropometric and performance measures for the development of a talent detection and identification model in youth handball. *J Sports Sci* 27(3), 257-266. Ziv, G. & Lidor, L. (2009). Physical characteristics, physiological attributes, and on-court performances of handball players: A review. *Eur J Sport Sci* 9(6), 37-386

### **THE COMPARISON OF THE VISUAL REACTION TIME AND SPRINT TIME PARAMETERS OF MALE SOCCER AND BASKETBALL REFEREES**

Gurol, B.1, Okcu, M.1, Kale, M.1

*anadolu university health sciences institution*

THE COMPARISON OF THE VISUAL REACTION TIME AND SPRINT TIME PARAMETERS OF MALE SOCCER AND BASKETBALL REFEREES Gurol, B.1, Okcu, M.1, Kale, M.1 1: School of Physical Education and Sports, Anadolu University, Turkey Introduction The purpose of the study was to evaluate visaul reaction time and sprint time parameters of amateur leauge soccer and basketball referees. Methods In this study, 11 male soccer referees (age: 26,00±3,03 year), and 7 male basketball referees (age: 24,86±3,67 year) volunteered to the study. Visual reaction time (5s, 10s, 15s), and sprint time (5m, 10m, 15m, 20m) were tested. Subjects performed 1 attempt, and 2 visual reaction time test at each duration. Each referee performed 2 sprint conditions for each distance. Visual reaction time test, and sprint time test performed via Sport Expert MPS 501 (Turner Electronic, Ankara, Turkey) system. Results Average, minimum and maximum visual reaction time (5 sec)

of the soccer referees was  $0.512 \pm 0.064$  sec.,  $0.457 \pm 0.058$  sec., and  $0.561 \pm 0.084$  sec. respectively. Average, minimum and maximum visual reaction time (5 sec) of the basketball referees was  $0.519 \pm 0.054$  sec.,  $0.490 \pm 0.055$  sec., and  $0.599 \pm 0.031$  sec. respectively. 5m, 10m, 15m, and 20m sprint time of the soccer referees was  $1.061 \pm 0.063$  sec,  $1.852 \pm 0.082$  sec,  $2.557 \pm 0.107$  sec,  $3.267 \pm 0.119$  sec respectively. 5m, 10m, 15m, and 20m sprint time of the basketball referees was  $1.060 \pm 0.106$  sec,  $1.846 \pm 0.182$  sec,  $2.550 \pm 0.226$  sec,  $3.199 \pm 0.300$  sec respectively. Discussion It is concluded that visual reaction time and sprint time parameters can be analyzed in male soccer and basketball referees. In this way, the speciality of different branches' refereeing can be identified. Because of doing the similar training and sprint distances of soccer and basketball referees, results are close to each other. In conclusion, there was no statistical differences for visual reaction time and sprint time parameters between soccer and basketball referees ( $p > 0.05$ ). References Spierer, D, K; Petersen, R, A; Duffy, K, J Strength Con Res (2010), Ardigo, Luca P, J Strength Con Res, (2010), v.24, n.9, 2532-2538.

### DOES PLAYING VENUE AFFECT FREE TESTOSTERONE CONCENTRATIONS IN ELITE BASKETBALL PLAYERS?

Moreira, A., Arruda, A.F.S., Aoki, M.S., Freitas, C.G., Drago, G., Oliveira, R., Crewther, B.T.

*University of São Paulo, Swansea University, EC. Pinheiros*

DOES PLAYING VENUE AFFECT FREE TESTOSTERONE CONCENTRATIONS IN ELITE BASKETBALL PLAYERS? Moreira, A.1, Arruda, A.F.S.1, Aoki, M.S.2, Freitas, C.G.1, Drago, G.5, Oliveira, R.1, Crewther, B.T. 3,4 1: School of Physical Education and Sport, USP (São Paulo, Brazil), 2: School of Arts, Sciences and Humanities, USP (São Paulo, Brazil), 3: Hamlyn Centre, Imperial College (London, UK), 4: Health and Sport Portfolio, College of Engineering, Swansea University (Swansea, UK), 5: CIIA- EC. Pinheiros (São Paulo, Brazil), Introduction The home advantage has been documented in some team sport competitions (Nevill and Holder, 1999). Pre-game increases in testosterone (T) levels have been reported with sports teams playing in their own home stadium, versus an opponent's venue (Carré, 2009) which could be related to the concept of territoriality. However, we are unaware of any studies taking a dyadic approach to the assessment of playing venue and using basketball teams of similar rankings. Thus, this study examined the influence of playing venue on free T concentrations in elite basketball players of similar abilities. Method 18 male athletes from 2 basketball teams were monitored during 2 competitive matches that were played against each other on a home and away basis. The teams were ranked first and second in the State championship during the monitoring period. Salivary free T was measured before and after each match and a session ratings of perceived exertion (RPE) was taken post-game. Results Playing at home was accompanied by elevated pre-game free T concentrations compared to playing away ( $p < 0.05$ ). The home teams also won their games. The T responses to competition were similarly elevated (% change from pre to post) when playing at home and away. No differences in session-RPE were noted across the playing venues. Discussion Playing at one's home venue resulted in elevated pre-match free T concentrations during competitive basketball games and these games were also won. The higher T concentrations at home might be related to the concept of territoriality and could be applicable to other team sports. Moreover, the territoriality and its association with dominance, aggressiveness and status emerges as a possible candidate to explain the perceived advantages of a sports team playing at their home venue, relative to playing at another venue (Archer, 2006). Interestingly, playing venue did not affect the free hormonal responses to competition, nor the perceived effort of athletes during these matches suggesting that perceived effort is independent of the playing venue and the corresponding outcomes of wins and losses. References Archer, J. (2006). *Neurosci Biobehav Rev*, (30), 319-345. Carré, J. (2009). *Am J Hum Biol*, (21), 392-394. Nevill, A. and Holder, R.L. (1999). *Sports Med*, (28), 221-236.

## 14:45 - 15:45

### Poster presentations

#### PP-BN03 Sport Biomechanics 2

##### NEURAL CONTROL OF BOUNCING GAITS ON DIFFERENT STIFFNESS SURFACES

Marquez, G., Morenilla, L., Fernandez-del-Olmo, M.

*Catholic University San Antonio*

Neural Control of Bouncing Gaits on Different Stiffness Surfaces. Gonzalo Márquez 1, 2, Luis Morenilla 2, Miguel Fernandez-del-Olmo 2. 1. Biomechanics Laboratory of Catholic University San Antonio (Murcia) Spain. 2. Motor Control and Learning Group of the University of A Coruña. Spain. Introduction. When we walk, run or jump, our musculoskeletal system needs to adapt its stiffness according to the physical features of the surfaces. Although, it has been suggested that the stretch reflex could play a role in adjusting joint stiffness during running on different surfaces stiffness (1), more studies are required in order to address this hypothesis. The aim of the present study was to explore the contribution of different neural pathways during repetitive vertical jumps (hopping) in different stiffness surfaces. Methods. Ten healthy subjects (173cm, 72.3Kg, 25.3yr) participated in this study. Subjects were instructed to hopping at 2.2 Hz on a stiff and elastic surfaces. Stiff surface consist on a force plate (~35.000 kN/m) and elastic surface was a sprung surface mounted over the force plate (60 kN/m). These two different experimental conditions were carried on a counterbalanced order at the same session. Transcranial Magnetic Stimulation (TMS) was applied in the contralateral primary motor cortex (M1) of the leg area using a double cone coil secured to the head through a custom made helmet (90% RMT intensity). H-Wave of the soleus was obtained by electrical stimulation (intensity of 20% and 50% of the Mmax) on the posterior tibial nerve. Motor evoked potentials (MEP) by TMS, H-wave and background EMG (EMG) of the soleus of the right leg was recorded during hopping at distinct intervals after ground contact: SLR (45ms), MLR (70ms) and LLR2 (120ms). In addition, leg stiffness (Kleg), contact and flight times during the jumps were calculated. Two way ANOVA was performed for the mentioned parameters. Results. Kleg was statistically higher during hopping on the elastic than on the stiff surface without differences in contact and flight times. Cortical excitability during jumps on the elastic surface was statistically higher than on the stiff surface, in all stimulation intervals. H-waves were significant higher during hopping on the stiff surface than on the elastic surface at SLR, and lower at LLR2, without differences at MLR. No differences were found on EMG nor M-waves. Discussion. The higher cortical excitability during jumps on the elastic surface suggests an increased supraspinal control of leg mechanics during the stance phase, since subjects need to couple with the displacement of the surface. In addition, the change in the pattern of discharge of Ia afferents across surfaces highlights the importance of this pathway in the accommodation of leg stiffness to the new surface. References: 1. Ferris et al. (1999) *J Biomech*. 32: 787-794.

## ELECTRICALLY ASSISTED BICYCLE ALTERS MUSCLE ACTIVATION PATTERNS

Morio, C., Louis, J., Androuet, P., Temprado, J.J., Barla, C.

*Oxylane Research*

**ELECTRICALLY ASSISTED BICYCLE ALTERS MUSCLE ACTIVATION PATTERNS** Morio, C.1, Louis, J.2, Androuet, P.1, Temprado, J.J.2, Barla, C.1 1: Oxylane Research (Lille, France), 2: CNRS6233 (Marseille, France) Introduction Commuter cycling is a growing activity in modern cities and it is a good means to do sport and improve health (Oja et al., 2011). But exercise intensity of commuter cycling can lead to dropout for less fit and motivated people (Engbers et al., 2010). Thus, electrically assisted bicycle (EAB) represents an alternative means for such people. The EAB has been recently found to be a sufficient activity to meet the physical activity guidelines for untrained people (Simons et al., 2009). A recent study made by our group (Louis et al.) shows a reduction in gross efficiency while pedalling on EAB. The aim of the present study is to highlight changes in muscle activation in order to explain the impaired gross efficiency previously observed. Methods 19 subjects participated in this study. A single session of exercise on EAB on a home-trainer consisted in pedalling at 3 different speeds (16km/h, 21km/h, freely chosen) with 3 different electrical support modes (NO: without, S1: light and S4: high support). Surface EMG of 6 of the main lower limb muscles (VL, RF, BF, TA, GAL, SOL) were recorded. Average activity of each muscle was calculated for both pushing and pulling phase. Onset and offset of the main EMG burst were calculated in degrees referred to the crank angle. Metabolic and mechanical parameters were also recorded during the pedalling on EAB. ANOVA with repeated measures (3 speeds x 3 supports) were performed on every parameter. Results ANOVA analyses show speed and support effects on power output, energy expenditure (EE), gross efficiency and EMG parameters. The electrical support induces 20% and 60% power output reduction and 12% and 35% EE reduction for the light and high support, respectively. The EMG analysis do not corroborate this reduction with reduced EMG activity of the VL, RF, BF and SOL muscles while the TA and GAL muscle activation increased. Changes in the timing of muscle activation have been found for the RF and BF muscles. Discussion The higher reduction in power output compared to EE is confirmed by the impaired gross efficiency with electrical support during cycling (Louis et al., submitted). The changes observed in EMG activities and the muscle timing activations supposed that pedalling skills is alter while electrical support is provided to the cyclist. This modified pedalling technique might explain the impaired gross efficiency. This should be further confirmed by a reduction in pedalling efficacy index. References Engbers LH, Hendriksen IJ (2010) *Int J Behav Nutr Phys Act* 7: 89. Louis J, Brisswalter J, Morio C, Barla C, Temprado JJ (submitted) *Int J Sport Med*. Oja P, Titze S, Bauman A, de Geus B, Krenn P, et al. (2011) *Scand J Med Sci Sports* 21: 496-509. Simons M, Van Es E, Hendriksen I (2009) *Med Sci Sports Exerc* 41: 2097-2102.

## GROWTH-INDUCED INCREASE IN THE ACHILLES TENDON MOMENT ARM DOES NOT COINCIDE WITH THOSE IN THE SELECTED BODY DIMENSIONS : A CROSS-SECTIONAL STUDY

Hashizume, S.1, Iwanuma, S.1, Kanehisa, H.2, Kawakami, Y.1, Yanai, T.1

1: *Waseda University*, 2: *National Institute of Fitness and Sports in KANOYA*

**Introduction** It is well established that, as body height and mass increase with growth, his or her capacity for muscle performances increases. Muscular strength, measured often as a muscle torque, is determined by the muscle force and the moment arm. Age-related increase in the moment of a tendon force, therefore, may be affected by an increase in muscle force and/or moment arm. Whereas growth-related difference in muscle strength has been studied extensively, growth trend of moment arm over the rapid growing phase have not been studied. The purpose of this study, therefore, was to examine the age-related difference in the Achilles tendon moment arm during growth stage, in relation with the changes selected body dimensions. **Methods** Five students in lower grades (LE, age:  $8.2 \pm 0.8$  years) and six students in upper grades (UE, age:  $11.3 \pm 0.6$  years) of elementary school, 10 junior high school students (JH, age:  $13.0 \pm 0.8$  years) and 12 adults (AD, age:  $25.4 \pm 1.8$  years) participated in this study. A magnetic resonance imaging system was used to record a series of coronal images of the right ankle at  $10^\circ$  dorsiflexion, anatomical position and  $10^\circ$  plantarflexion. The line of action of the Achilles tendon force was projected to the orthogonal plane of the talocrural joint axis, and the shortest distance between the projected line and the talocrural joint axis was determined as the Achilles tendon moment arm at anatomical position (Hashizume et al., 2012). Body height, body mass, lower limb length and foot length were measured for each subject. A one-way analysis of variance with Bonferroni's post hoc test was conducted to test the differences in the measured variables among the four age groups ( $p < 0.05$ ). **Results** The AD group had significantly greater Achilles tendon moment arm (40 mm) than the other groups (25 - 31 mm). However, there are no significant age-related differences in the Achilles tendon moment arm between LE (25 mm) and UE groups (29 mm) and between UE and JH groups (31 mm). In all pairs of age groups, significant differences were found in body height and mass. On the other hand, the lower limb length did not show significant effect of age between UE (351 mm) and JH (368 mm) and between JH and AD groups (383 mm). The foot length significantly differed among the four groups except for UE (239 mm) and JH groups (240 mm). **Discussion** The present results suggested that the Achilles tendon moment arm rapidly increase between AD and JH groups, whereas body dimensions increase between each groups. The results found in the present study indicate that the growth trend in the Achilles tendon moment arm is different from those in whole body and limb length. It was concluded that the age-related difference in the Achilles tendon moment arm differ from that in the selected body dimensions. **References** Hashizume S, Iwanuma S, Akagi R, Kanehisa H, Kawakami Y, Yanai T. (2012). *J Biomech*, 45, 409-413

## THE EFFECT OF KNEE ANGLE DURING ISOMETRIC TRAINING ON MAXIMAL FORCE AND MUSCLE SIZE

Noorkoiv, M., Nosaka, K., Blazevich, A.J.

*Edith Cowan University*

**Introduction** It is known that increases in force production in response to exercise training typically occur at or around the training angle. However, the mechanisms underpinning this angle specificity are not known. The purpose of this study was to investigate the mechanisms underlying the angle-specific strength change after isometric training at short and long muscle lengths. **Methods** One group ( $n=8$ ) of young healthy men performed 6 weeks of isometric knee extension training in a flexed position (kneeFlex) corresponding to 80% of their maximal force-angle relationship value ( $38 \pm 4^\circ$ ,  $0^\circ$ =full knee extension). Force was calculated as torque per moment arm (measured using x-ray imaging). Another group ( $n=8$ ) trained at the corresponding force level in an extended knee position (kneeExt;  $88 \pm 6^\circ$ ). Subjects trained 3 times a week, 5 sets of 5 repetitions (5 contractions, 5 s rest, 1 min inter-set rest). Maximum torque and the EMG:M-wave ratio were measured at 8 knee angles ( $30$ - $100^\circ$ ) at 0, 3 and 6 weeks of training. Vastus lateralis (VL) fascicle length was measured with ultrasound and muscle cross-sectional area (CSA) was assessed with MRI at 0 and 6 weeks. **Results** In kneeExt force increased after 3 wk at  $40$  and  $50^\circ$  (7.6-6.2%), and after 6 weeks at  $30$ ,  $40$  and  $50$  deg (9.0-12.2%). In kneeFlex, force increased only from 0 to 6 wk at  $30$ ,  $40$



and 50° (5.7-11.5%). The changes in EMG:M-wave ratio were minimal in both groups, and these changes were not clearly correlated with changes in angle-specific force. Rectus femoris (RF), VL and vastus medialis (VM) CSA increased in a kneeFlex only. Correlation analysis revealed that subjects whose VM and RF CSA increased in distal regions tended to increase force production at short muscle lengths, whereas those who increased in middle and proximal regions of VL tended to increase force at long muscle lengths. Fascicle length increase was variable in both groups and, unexpectedly, only increased significantly in kneeExt (P=0.01). Interestingly, there was a negative correlation between the fascicle length at 0 wk and the change in fascicle length with training (P=0.02). Discussion The results that there is a clear specificity when isometric training has been performed at kneeExt and it is more variable with kneeFlex, are in agreement with the findings from others (Thepaut-Mathieu et al. 1988; Kubo et al., 2005). The mechanisms of angle specificity seem to be a complex interaction amongst many factors, however, variability in kneeFlex appears to be related to region of selective hypertrophy. Further analysis of fascicle length and other factors is needed. References Thepaut-Mathieu C, Van Hoecke J, Maton B (1988). *J Appl Physiol*, 64(4), 1500-1505. Kubo K, Ohgo K, Takeishi R, Yoshinaga K, Tsunoda N, Kanehisa H, Fukunaga T (2006). *Scand J Med Sci Sports*, 16, 159-167.

### **DETERMINING THE LOAD FOR RESISTED SPRINT TRAINING WITH SLED TOWING IN SOCCER PLAYERS. A PILOT STUDY**

Cánovas, J.F.1, Martínez-Valencia, M.A.2, Marín-Pagán, C.1, González-Zaragoza, M.1, Alcaraz, P.E.1

1: UCAM (Murcia, Spain), 2: UCLM (Toledo, Spain)

**INTRODUCTION** Sled towing is one of most used training methods to improve specific strength and power during sprinting. Unfortunately, there are no studies about this type of training on soccer players specifically. Two studies (Alcaraz et al., 2009; Lockie et al., 2003), with sprinters and field-sport athletes proposed a regression equation to determine the load for sprint training with sled towing. These equations were based on percentage of athlete's body mass (Bm). The purpose of this study was to develop an equation that accurately describes the relationship between towing loads and speed in the acceleration phase of sprinting in soccer players. **METHODS** Fourteen male semi-professional soccer players (23.07 ± 3.29 years; height 1.77 ± 0.07 m; weight 75.43 ± 6.38 kg) were recruited for the study. The tests were performed on a natural grass surface. After a specific warm-up, subjects completed 10 × 20-m sprints, an unloaded sprint and nine ones with different loads according to Bm. Maximum velocity (Vmax) of each sprint was measured with a radar gun with a record data frequency of 33 Hz. The order for the trials was randomized and a five-minute rest period was allocated to remove the effects of fatigue. A regression analysis was used to determine the relationships between load (as a percentage of Bm) and velocity (as a percentage of Vmax over 20-m, established in the unloaded sprint). **RESULTS** The regression analysis showed the following regression equation:  $y = -0.995x + 101.67$ , with a value of  $R^2 = 0.8299$ . In this equation, "y" represents the percentage of load, and "x" is the required training velocity, as a percentage of Vmax. The  $R^2$  value reflects a highly significant lineal relationship among these variables ( $p < 0.001$ ). **DISCUSSION** As expected, an increase in time and a reduction of speed was observed when the load raised. However, the regression equation, behaves differently when compare with other equations published (Alcaraz et al., 2009; Lockie et al., 2003). It seems that a higher slope (m) may reflect a higher level of maximum strength, and therefore, a better performance with high loads. In this study, "m" had a value of -0.995, greater than slope calculated with athletes  $m = -0.867$  (Alcaraz et al., 2009) but less than sport-field athlete's slope, where  $m = -1.96$  (Lockie et al., 2003). These data may indicate that depending on different variables such as sport modality, strength characteristics, etc. athletes should use a different equation. This study aims to provide a new tool that allows coaches to determine the optimal load for training with soccer players. **REFERENCES** Alcaraz PE, Palao JM, Elvira JLL (2009). *J Strength Cond Res*, 23(2), 480-485. Lockie RG, Murphy AJ, Spinks CD. (2003). *J Strength Cond Res*, 17(4), 760-767.

### **TENDON STIFFNESS FOLLOWING YEARS OF SYSTEMATIC STRETCHING**

Moltubakk, M., Eriksrud, O., Paulsen, G., Seynnes, O., Bojsen-Møller, J.

*Norwegian school of sport sciences*

**Introduction** Stretching is commonly used as a means of improving sports performance, reducing injury risk, and in rehabilitation (Doucette and Goble, 1992, Wilson et al., 1992, Woods et al., 2007), while evidence of such effects at best is limited. Habitual stretching is assumed to reduce the stiffness of force transmitting tissues (Taylor et al., 1990), but stretching intervention studies of up to 8 wks have failed to provide a clear understanding of musculotendinous adaptations to this type of training (Weppler and Magnusson, 2010). We had the opportunity to examine a unique group of elite gymnasts; thus the purpose of the present study was to examine whether the large stretching component of these athletes' training routine would affect patellar tendon mechanical properties. **Methods** Twenty two national team rhythmic gymnasts (GYM) were compared to 16 control subjects (CON). This abstract includes preliminary data from 6 GYM and 5 CON. GYM (17±2 yrs) had performed systematic stretching of their quadriceps for 9±2 years, while CON (20±3 yrs) had been active in sports for 13±2 years, without systematic stretching. Patellar tendon force was determined during voluntary isometric knee extension ramp contraction at a knee joint angle of 90°. Corresponding tendon elongation was obtained by ultrasonography. Tendon stiffness was determined between 2250 and 2500 N, reflecting the lowest common force interval between subjects. Results Maximal tendon force and stiffness did not differ significantly between groups (GYM 3591±533 N; CON 3717±615 N;  $p=0.75$ , and GYM 1640±222 N/mm; CON 1991±791 N/mm;  $p=0.16$ , respectively). **Discussion** The present results suggest that years of systematic stretching, as performed during the training routine of female elite gymnasts, do not reduce tendon stiffness. These findings are in agreement with previous studies (Kubo et al., 2002 and Mahieu et al., 2007) reporting unaltered Achilles tendon stiffness after 3 to 6 wks of static stretching. It is possible that rigorous stretching imposes mechanical loads similar to those of strength training, with corresponding tendinous adaptations (Seynnes et al., 2009), or that an eventual reduction in tendon stiffness due to stretching is counteracted by the other components of the athletes' training routine. **References** Doucette SA, Goble E (1992). *Am J Sports Med*, 20 Kubo K, Kanehisa H, Fukunaga T (2002). *J.Appl.Physiol*, 92 Mahieu NN et al. (2007). *Med Sci Sports Exerc*, 39 Seynnes et al. (2009). *J Appl Physiol*, 107(2) Taylor et al. (1990). *Am J Sports Med*, 18 Weppler CH, Magnusson SP (2010). *Phys Ther*, 90 Wilson GJ, Elliott BC, Wood GA (1992). *Med Sci Sports Exerc*, 24 Woods K, Bishop P, Jones E (2007). *Sports Med*, 37

### **MECHANICAL PROPERTIES OF THE PATELLAR TENDON IN ELITE VOLLEYBALL PLAYERS WITH AND WITHOUT PATELLAR TENDINOPATHY**

Helland, C., Bojsen-Møller, J., Raastad, T., Seynnes, O.R., Moltubakk, M.M.H., Jakobsen, V., Visnes, H., Bahr, R.

*Norwegian School of Sport Sciences*

**Introduction** Patellar tendinopathy (PT) has an estimated prevalence of 40-50 % among elite volleyball players (Lian, Engebretsen & Bahr, 2005). The risk factors and functional consequences of this overuse injury are not fully understood. The aims of the present study were to

determine whether PT affects tendon mechanical properties in elite volleyball players, and whether potential changes in these properties impair jumping performance. Methods 20 healthy and 20 male volleyball players with PT were identified from a 5-year prospective cohort study on junior elite volleyball players. Subjects were evaluated with respect to maximal vertical jump performance and patellar tendon mechanical properties were examined using Ultrasonography (US) and Magnetic Resonance Imaging (MRI). An unpaired t-test was applied to evaluate group differences with an alpha level of 0.05. Results Preliminary results indicate that the PT group jumped significantly higher than controls in counter movement jumps (CMJ) and spike jump (SPJ) compared to the control group, PT:  $44.0 \pm 4.6$  cm and  $81.5 \pm 6.1$  cm vs. control:  $39.1 \pm 4.3$  cm and  $75.2 \pm 7.1$  cm, respectively ( $p < 0.05$ ,  $n = 24$ ). CMJ-SJ ratio was greater in PT compared to the control group;  $4.0 \pm 2.1$  vs.  $1.6 \pm 1.9$  ( $p < 0.05$ ). No differences were found in patellar tendon stiffness between the two groups ( $n = 14$ ). No differences were found in patellar tendon length between the two groups. Discussion Although mechanical properties were similar between groups, it may be speculated that differences exist in material properties (decreased Young's modulus in PT) as a result of the increased cross-sectional area (CSA) of the injured tendon. The differences in jump performance between the groups seem to correspond to earlier findings linking PT prevalence to higher jumping performance and therefore greater loading and/or more intense jump training (Lian, Refsnæs, Engebretsen, & Bahr, 2003; Visnes & Bahr, 2012). Importantly, these results indicate that jumping performance in elite volleyball players with PT is not impaired beyond the level of a matched control group. References Lian, O., Refsnæs, P. E., Engebretsen, L., & Bahr, R. (2003). *Am J Sports Med*, 31(3), 408-413. Lian, O. B., Engebretsen, L., & Bahr, R. (2005). *Am J Sports Med*, 33(4), 561-567. Visnes, H., & Bahr, R. (2012). *Scand J Med Sci Sports*.

### INTRAMUSCULAR DIFFERENCES IN FASCICLE LENGTH, FIBER LENGTH AND SERIES SARCOMERE NUMBER OF THE HUMAN TRICEPS SURAE: A CADAVER STUDY

Hirata, K.1, Komatsu, T.2, Ema, R.1, Fukutani, A.1, Hashizume, S.1, Iwanuma, S.1, Miyamoto, N.1, Wakahara, T.1, Kanehisa, H.3, Kawakami, Y.1

1: Waseda University (Tokorozawa, Japan), 2: Osaka University (Toyonaka, Japan), 3: National Institute of Fitness and Sports in Kanoya (Kanoya, Japan)

Introduction Skeletal muscle architecture has considerable effects on muscle force and power generation. Especially, muscle fiber length (LFiber) and series sarcomere number (SN) are important parameters that influence the length-force-velocity relationships of a muscle. Available data on the muscle- architectural parameters suggest existence of regional differences within a muscle, but few studies have clarified this over the whole muscle. Therefore, we aimed to examine in a cadaver study intramuscular differences in fascicle length (LFascicle), LFiber, and SN of the three muscles of the human triceps surae (medial gastrocnemius: MG, lateral gastrocnemius: LG, soleus: SOL). Methods The triceps surae was dissected from both legs of a cadaver (sex: male, body height: 153 cm, body mass: 59.6 kg). The lengths of fascicles removed from nine sites of MG and LG (proximal, central, and distal positions of medial, midsagittal, and lateral regions, respectively), 16 sites of SOL (3 sites [proximal, central and distal positions] of the anterior compartment and 13 sites [proximal and central positions of medial and lateral regions and in between, and distal positions of medial, midsagittal, and lateral regions] of the posterior compartment) were determined by a caliper. The lengths of fibers isolated from fascicles under a microscope were measured. For each fiber, sarcomere lengths were calculated at five positions (0%, 25%, 50%, 75% and 100% LFiber) by taking the inverse of the centroid frequency of the first-order peak obtained from microscopic image of the fiber by using the fast Fourier transformation. The SN was calculated from the LFiber divided by the average of five sarcomere lengths. Results & Discussion LFascicle, LFiber, and SN of each muscle ranged from 37.4 - 51.3 mm, 35.1 - 48.2 mm and 16160 - 22434 in MG, 31.0 - 53.9 mm, 33.0 - 47.1 mm and 16328 - 21001 in LG, and 20.7 - 37.3 mm, 20.4 - 32.4 mm and 11896 - 17374 in SOL, respectively. The LFascicle showed tendencies to increase from proximal to distal, and medial to lateral directions in MG, from distal to proximal, and lateral to medial directions in LG and from distal to proximal direction in SOL. Similar tendencies were observed also for LFiber and SN showing intramuscular differences. There was no substantial variation in the SN per LFiber among the sites of each muscle. These results indicate that there are intramuscular differences in length-related parameters of each muscle of the human triceps surae. These regional differences are attributable to those of SNs within fibers.

### CHANGES IN MUSCLE ARCHITECTURE AND TENDON COMPLIANCE AFTER A BOUT OF ECCENTRIC CONTRACTIONS

Vieillevoye, S., Boucher, C., Duchateau, J., Carpentier, A.

Université Libre de Bruxelles

Introduction Unaccustomed eccentric exercise induces muscle soreness and alterations in muscle cellular structure (Ishikawa et al., 2006). The aim of the present study was to investigate the changes in muscle architecture and tendon compliance during muscle contraction and passive stretching after eccentric contractions. Methods Ten male subjects performed a training session with the right calf muscles, consisting in 10 sets of 10 eccentric contractions at 120% of 1RM. Subjects were tested at baseline and immediately, 2 hours (H+2), 2 days (D+2), 4 days (D+4) and 7 days after the session. Muscle architecture and tendon compliance were investigated using ultrasonography (Abellaneda et al., 2009; Chen et al., 2006). Fascicle length (FL) and pennation angle (PA) of the Gastrocnemius Medialis muscle and Achilles tendon elongation (TE) were recorded, respectively, during passive stretching and muscle contraction at different torque levels. During passive stretching, the ankle joint was moved from  $-10^\circ$  to  $+30^\circ$  of dorsiflexion. Isometric contractions of the plantarflexor muscles were performed with the ankle joint in neutral position ( $90^\circ$ ). Results Isometric torque during MVC was reduced ( $22 \pm 9\%$ ;  $P < 0.001$ ) immediately after the eccentric contractions. Maximal torque was still significantly ( $P < 0.001$ ) depressed at H+2 ( $18 \pm 10\%$ ) and D+2 ( $13 \pm 10\%$ ). During contraction, FL shortened and PA increased progressively with the increase in target torque and reached, respectively,  $-51.8 \pm 3.8\%$  and  $+82.7 \pm 14.0\%$  of initial values at MVC. FL increased and PA decreased significantly during MVC after the session and remained enhanced until D+4. Distal TE during MVC decreased immediately after the session ( $-20.6 \pm 23.1\%$ ;  $P < 0.01$ ) and recovered its initial value at H+2. After the training session, passive torque recorded during stretching increased for ankle angle of  $25^\circ$  ( $+35.3 \pm 38.7\%$ ;  $P < 0.01$ ) and  $30^\circ$  ( $+27.2 \pm 34.9\%$ ;  $P < 0.01$ ). Passive torque values returned to baseline at H+2, but re-increased at D+4. No significant changes were recorded after the session for FL, PA and TE. Discussion The new finding is that the drop in MVC torque after eccentric contractions is associated with an increase in FL and a decrease in PA and TE, whereas the enhancement in passive torque during stretching is not associated with changes in muscle architecture and tendon elongation. In conclusion, a session of eccentric contractions did influence the components associated with muscle contraction but did not affect the passive components of the muscle-tendon unit. References Ishikawa M, Dousset E, Avela J, Kyröläinen H, Kallio J, Linnamo V, Kuitunen S, Nicol C, Komi PV. (2006). *Eur J Appl Physiol*; 97: 298-306 Chen TC, Nosaka K. (2006). *J Strength Cond Res*; 20: 108-116, Abellaneda S, Guissard N, Duchateau J. (2009). *J Appl Physiol*; 106: 169-177

### LONG-RANGE CORRELATIONS IN STRIDE INTERVAL OF THREE SIDEWARD GAIT PATTERNS

Yamashita, D.1,2, Yoshii, H.1, Fujii, K.1,2, Kouzaki, M.1

1: *Kyoto University (Kyoto, Japan)*, 2: *Japan Society for the Promotion of Science (Japan)*

**Introduction** Side stepping is often performed in daily life and various sports. Our preliminary study showed that there are three different gait patterns in side stepping; walk-like, run-like, and gallop-like gait patterns. Kinematic analyses revealed that gait patterns are dependent on side stepping speed. However, decision factor for these sideward gait patterns is still unknown. It is well known that, in case of forward walking and running, gait patterns are generated by neural networks referred to as central pattern generators (CPGs). CPGs produce not white-noise like (i.e., random) but pink-noise like fluctuations in their gait cycles (Hausdorff et al., 1995). If sideward gait patterns are also governed by CPGs, long-range correlations should be found in the sideward gait. Thus, we aimed to investigate the strength of long-range correlations for sideward gait patterns using detrended fluctuation analysis (DFA). **Methods** Six healthy male participants were required to step sideward on a treadmill. Participants sufficiently practiced in advance three gait patterns and each preferred speed was determined based on each subject's report. They performed each gait pattern for 8-10 minutes at each preferred speed. The data of 512 stride intervals were extracted. The strength of long-range correlations of stride intervals was assessed by "α" values in DFA (Hausdorff et al., 1995): white noise corresponds to an α of 0.5 whereas pink noise corresponds to an α of 1. An α value between 0.5 and 1 indicates long-range correlations such that any given stride interval is dependent on a stride interval at remote previous times. **Results** The preferred speed in walk ( $2.00 \pm 0.15$  km/h) was significantly slower than in gallop ( $3.95 \pm 0.14$  km/h) and run ( $4.01 \pm 0.20$  km/h), but not different between in gallop and in run. The exponent scale α was  $0.77 \pm 0.08$  in walk,  $0.88 \pm 0.10$  in gallop, and  $0.98 \pm 0.09$  in run. The exponent α in run was significantly higher than in walk ( $p = 0.008$ ) and tended to be higher than in gallop ( $p = 0.077$ ). **Discussion** We found the presence of long-range correlations in the stride interval during all the three sideward gait patterns in similar to the forward gait patterns, would be suggesting that these patterns are controlled by CPGs activities. It is also noteworthy that the high exponent scale α in run was close to 1. Our results suggest that the gallop mode is more well-coordinated gait pattern compared to the run mode in case of human sideward locomotion because the α value that is close to 1 reflects immature gait dynamics (Ashkenazy et al., 2002). **Reference** Hausdorff et al. (1995). *J Appl Physiol*, 80, 349-358 Ashkenazy et al. (2002). *Physica A*, 316, 662-670

### THE NET ACTION DIRECTION OF MUSCLES SPANNING KNEE AND HIP JOINTS IN COMPLICATED ACTIVITIES WITH VARIOUS DIRECTIONS

Hagio, S., Kouzaki, M.

*Kyoto University*

**Introduction** Appropriate electromyogram (EMG) processing makes it possible to estimate muscle activities producing the joint torques. To assess the movements more particularly, however, it is significant to estimate a net action direction of muscles: the force traces produced in the direction are actually correlated to EMG traces of a muscle. The purpose of the present study was to examine the net action direction of muscles spanning knee and hip joints in complicated activities with multi-directions. **Methods** Six subjects were seated comfortably in a chair with the hip and knee flexed at 90° from full extension. Then, the tri-axial force transducer was attached to the right ankle, and two force vectors in the medial-lateral, and anterior-posterior directions on the horizontal plane around the ankle joint were measured. Isometric endpoint forces for 20-s were produced in 12 different directions on the horizontal plane and at two different magnitudes (10 N and 20 N). For each trial, the subjects viewed the desired force as a target on the visual display. Surface EMGs were recorded from the twelve muscles around the knee and hip joints. Raw EMG traces were first rectified and averaged across the steady period. Then, the EMG activity was represented by polar plots as a function of task direction. Cross-correlation was calculated between surface EMG and the simultaneously recorded two force components. Then, EWA (EMG weighted averaging) direction was determined from peak correlation coefficient (Kutch et al., 2010), which indicates the net action direction of the muscle. The EWA directions for all tasks were represented by polar histograms. **Results** All muscles had wide active ranges, while the EWA directions of almost all the muscles denoted the roughly specific net action directions. For example, semitendinosus muscle was active mainly in the lower quarter plane of horizontal plane, while its EWA direction was approximately 255°. **Discussion** Present results demonstrated that some muscles (e.g. semitendinosus muscle) had roughly specific action directions. In others (e.g. sartorius muscle), however, the EWA directions were variable: no specific action directions. It was considered that the formers mainly produced the desired forces, and the latters were also involved in position stabilization. Additionally, the variability of the EWA directions gave suggestions that the action directions were dependent on the direction of muscular fascicle (Vieira et al., 2011). **References** Kutch JJ, Kuo AD, and Rymer WZ (2010). *J Neurophysiol*, 103, 3535-3546. Vieira TMM, Loram ID, Muceli S, Merletti R and Farina D (2011). *J Physiol* 589 (2), 431-443

### MOTOR LEARNING BY OBSERVING BIOLOGICAL AND NON-BIOLOGICAL MOTION: CONTRIBUTING SENSORIMOTOR AND HIGHER-LEVEL PROCESSES

Roberts, J.W.1, Bennett, S.J.1, Elliott, D.1,2, Hayes, S.J.1

1: *Liverpool John Moores University*; 2: *McMaster University*

**Motor learning by observing biological and non-biological motion: Contributing Sensorimotor and Higher-level Processes** Roberts, J. W.1, Bennett, S. J.1, Elliott, D.1, 2, & Hayes, S. J.1 1: *Liverpool John Moores University*; 2: *McMaster University* **Introduction** Motor learning via observation is the result of the action-observation network coding biological motion. The following study aimed to examine the preferential motion information coded during action-observation for motor learning and thereby the processes involved. **Method** EXP1 tested the biological specificity of action-observation. Participants were randomly assigned to one of four groups: biological motion (BM), non-biological motion (NBM), end-state (END) and control. Attempts were made to perform a novel manual timing sequence in a pre- and post-test design. Prior to post-test the experimental groups observed a model featuring specialised trajectory information: expert performance (BM), computer-generated constant velocity (NBM), end-state information with no trajectory (END). EXP2 and EXP3 tested the processes involved during action-observation. The pre-test phase was withdrawn to withhold task objectives. We incorporated a recognition test after motor performance. Participants viewed a previously observed model and novel models followed by rating the certainty of recognition. In addition, EXP2 featured two sets of instructions designed to bias beliefs surrounding the origins of the model: human-generated cue, computer-generated cue. EXP3 featured an additional cognitive task (tone counting), which was treated as the primary task objective. **Results** The relative timing error revealed both BM and NBM groups learned ( $p < 0.05$ ) (EXP1). Incorporating a human- and computer-generated cue had no significant effect on timing performance, although the human cue combined with BM resulted in a greater rating of uncertainty than its computer counter-part ( $p < 0.05$ ) (EXP2). Furthermore, there was a significant negative correlation

between relative timing error and rating of certainty for the same group ( $r = -.61$   $p < 0.05$ ). The addition of a cognitively demanding task significantly attenuated learning ( $p > 0.05$ ). Discussion The similar learning effects of BM and NBM groups contrast suggestions that the learning system is biologically specific. Moreover, the learning advantage of these groups compared to controls indicates that trajectory information is essential during action-observation. Instructional cues influenced how participants processed the trajectory models. This is consistent with observation of biological motion combined with a human belief leading to an implicit representation associated with sensorimotor processes. The detrimental effect of the cognitively demanding task shows implicit motor learning through observation is not independent of cognitive processes. These findings support the view of a combined sensorimotor and higher-level system contributing to motor learning through observation.

**14:45 - 15:45**

## Poster presentations

### PP-BN04 Sport Biomechanics 3

#### MOMENTUM AND KINETIC ENERGY DURING THE TACKLE IN RUGBY UNION

Hendricks, S., Karpul, D., Lambert, M.I.

*University of Cape Town*

**Introduction** The tackle in rugby union is a dynamic and high impact contact situation that occurs frequently during matches and exposes players to a high risk of injury and muscle damage. Large differences in momentum and kinetic energy between the ball-carrier (BC) and tackler (T) have been identified as risk factors for injury and may contribute to the outcome of the tackle. Given the importance of the tackle in rugby union, little is known about the physical components of the tackle in real match situations. **Aim** The purpose of this study was to firstly quantify momentum and kinetic energy before contact in the tackle during real match situations in 3 competitions (Super 14, Varsity Cup and Under 19 Currie Cup) for the ball-carrier and tackler. Next, the study explored the relationship between these physical components and the outcome of the tackle. **Methods** Using a two-dimensional scaled version of the field, the velocity of the ball-carrier and tackler were measured 0.5s before contact. Players' weights were obtained from player profiles either from their National Union, Super 14 franchise or Provincial Union. Accordingly, momentum and kinetic was determined. Thereafter, the outcome of the tackle, and tackle location was identified. **Results** BC momentum in both types of tackles (front-on  $505 \pm 209$  kg.m/s; side-on  $500 \pm 186$  kg.m/s) was not significantly different to T momentum (front-on  $536 \pm 217$  kg.m/s; side-on  $458 \pm 183$  kg.m/s). Similarly, BC kinetic energy in both types of tackles (front-on  $1443 \pm 1407$  Joules (J); side-on  $1741 \pm 1262$  J) was not significantly different to T momentum (front-on  $1422 \pm 1009$  J; side-on  $1294 \pm 1043$  J). In isolation, the odds of a player succeeding in the tackle is increased by 50% (Odds Ratio (OR) 1.49, 95%CI 0.51-4.39) when the player enters the contact at a higher P or KE than the opponent. However, considering level of play, type of tackle, player position and distance from set piece, this odds ratio decreased to OR 0.92, 95CI% 0.25-3.38. **Discussion** This is the first study to quantify momentum and kinetic energy before contact in the tackle during real match situations for the ball-carrier and tackler. The lack of differences between level of competition and tackle types may indicate the dynamic nature of the tackle. As expected, the player with the higher momentum or kinetic energy was more likely to succeed in contact. However, when level of competition, type of tackle, player position and distance from set piece were considered, this odds ratio decreased. Using this study as a basis, it is recommended that future studies focus on the relationship between these physical components and the technical characteristics of the ball-carrier and tackler. Also, studying the impact dynamics of the tackle situation and its association with injury is proposed.

#### THE EFFECTS OF VARIOUS ANGLES IN SCULLING ON HUMAN BODY LIFT AND DRAG

LEE, H.T., KIM, Y.J.

*Department of Physical Education, Graduate School of Pukyong National University, Busan, Korea.*

**INTRODUCTION** This study analyses the effects of various angles in sculling on human body lift and drag by means of computational fluid dynamics, discusses the importance of sculling and provides a basis for the development of future water safety education programmes. **METHODS** Study subjects were based on the mean data collected from males in the age of 20s from a survey on the anthropometric dimensions of the Koreans. Moreover, lift, drag as well as coefficient values, all of which were governed by the angle of the palm, were calculated using 3-dimensional modelling produced by computational fluid dynamics programmes i.e. CFD. Interpretations were performed via general k- $\epsilon$  turbulence modelling in order to determine lift, drag and coefficient values. Turbulence intensity was set to one per cent as per the figures from preceding research papers and 3-dimensional simulations were performed for a total of five different angles 0°, 15°, 30°, 45° and 60°. **RESULTS** The drag and lift values for the differing angles of the hands during sculling movement are as follows. The lift and drag values gradually increased with the increasing angle of the palm, however, the magnitude of increase for drag started to predominate lift from 45° and lift gradually decreased from 60°. **DISCUSSION** Overall, it is concluded that the optimal efficiency of sculling can be achieved at the angles 15° and 30°, and it is anticipated that greater safety and informative education can be ensured for Life saving trainees if the results were to be applied to practical settings. However, as the study was conducted using simulation programmes which performed analyses on the collected anthropometric dimension, the obtained results cannot be made universal, which warrants further studies involving varied study subjects with actual measurements taken in water. **REFERENCES** Barry Bixler, Scott Riewald.(2002). Analysis of a swimmer's hand and arm in steady flow conditions using computational fluid dynamics. *Journal of Biomechanics* 35, 713-717. Berger, M.A.M., G. de Groot, and A.P. Hollander.(1995). Hydrodynamic drag and lift forces on human hand/ arm models. *Journal of Biomechanics* 28(2), 125-33. *Biomechanics and Medicine in Swimming* X(2006). Proceedings of the Xth International Symposium for Biomechanics and Medicine in Swimming, Portuguese Journal of Sport Sciences, 6(2).

## LARGE POSTURAL FLUCTUATION BUT UNCHANGED POSTURAL SWAY DYNAMICS DURING TIPTOE STANDING IN COMPARISON WITH QUIET STANDING

Tanabe, H.1, Fujii, K.1, Kouzaki, M.1

*1:Kyoto University*

LARGE POSTURAL FLUCTUATION BUT UNCHANGED POSTURAL SWAY DYNAMICS DURING TIPTOE STANDING IN COMPARISON WITH QUIET STANDING Tanabe, H.1, Fujii, K.1, Kouzaki, M.1 1: Kyoto University (Kyoto, Japan) Introduction Tiptoe standing (TS) is used frequently by humans. Maintaining TS seems to require more complex control dynamics than quiet standing (QS). Although postural maintenance during TS represents a significant component of human movement, surprisingly few studies have revealed postural control dynamics during TS. Therefore, the purpose of this study was to examine the postural control dynamics during TS in comparison with QS. Methods Eight healthy male subjects were asked to perform two QS or TS on a force platform for approximately 40 s. During QS and TS, the orientation of the center of pressure (COP) was measured, and a surface electromyogram (EMG) was recorded from the soleus (SOL) and flexor hallucis brevis (FHB) muscles. To assess the postural sway amplitude, the path length and rectangular area of COP trajectory were calculated. In addition, to examine the dynamics of the neuromuscular mechanisms underlying balance control, we computed COP stabilogram-diffusion (SD) plots (Collins and De Luca, 1993). Moreover, we analyzed the power spectral density of the COP sway to examine the frequency domain characteristics of postural sway under different standing conditions. Finally, to investigate the relationship between COP and the activity of each muscle in the frequency domain, we adopted the squared coherence spectrum. Results and Discussion The path length and rectangular area were significantly larger during TS than during QS. In addition, the power spectral density (PSD) of the COP sway up to 6-7 Hz was significantly larger during TS than during QS. This might happen because (1) the feedback of somatosensory information from sole of the foot decreased (Diener, 1982); (2) relatively small muscle which contributes to TS requires muscle activity in higher frequency compared with QS (Kouzaki, 2012). On the other hand, there was no difference in the scaling coefficients from SD analysis between QS and TS. The scaling coefficient represents the probability that the COP will move efferently or afferently and reflects the control by central nervous system. In fact, the coherence spectrum between the COP and EMG from the SOL and FHB muscles showed statistically significant levels during TS at frequencies up to 17 Hz, while that of QS only showed significant level below 1 Hz. Therefore, our results suggested that large fluctuations during TS was compensated by the activities of the SOL and FHB muscles to enhance the postural control and the postural control dynamics during TS was consistent with that during QS.

## JUMPING PERFORMANCE DIFFERENCES AMONG COMPETING ELITE FEMALE HANDBALL PLAYERS WITH OR WITHOUT PREVIOUS ACL RECONSTRUCTION

Setuain, I., Millor, N., Alfaro, J., Gorostiaga, E., Izquierdo, M.

*1Research, Studies and Sport Medicine Center, Government of Navarre, Spain*

JUMPING PERFORMANCE DIFFERENCES AMONG COMPETING ELITE FEMALE HANDBALL PLAYERS WITH OR WITHOUT PREVIOUS ACL RECONSTRUCTION Igor Setuain<sup>1</sup>, Nora Millor<sup>1</sup>, Jesús Alfaro<sup>2</sup>, Esteban Gorostiaga<sup>1</sup>, Mikel Izquierdo<sup>3</sup>. <sup>1</sup>Research, Studies and Sport Medicine Center, Government of Navarre, Spain <sup>2</sup> San Miguel Clinic, Traumatology service, Pamplona, Spain <sup>3</sup>Public University of Navarre, Department of Health Sciences, Spain Female handball players are one of the most exposed athletes to the ACL injury. Persisting strength and neuromuscular control deficits may be observed among the athletes who had suffered this injury, despite having complete the rehabilitation process due to inadequate or incomplete rehabilitation. This factor could be one of the explaining reasons for the ACL reinjury rates among this population. Measuring jumping performance such as stance phase contact times or jump height during the rehabilitation process would help to minimize high-cost reinjury rate among female handball elite athletes. PURPOSE: To describe jumping performance among a group of 20 female handball elite athletes using a previously validated jump test battery. Secondly, to identify possible differences between injured and uninjured extremities, in jump height, stance phase contact time, and reached distance obtained. We hypothesized that previously injured extremities would show deficits in jumping performance despite the injured athletes have completed their rehabilitation process and being competing at the maximum level. METHODS: 20 female elite athletes (6 previously injured and reconstructed and 14 uninjured subjects) were evaluated performing a previously validated jump test battery that includes bilateral drop jump, unilateral drop jump, unilateral countermovement jump, unilateral triple jump for distance and the cross over hop for distance. Height (m), flight time (s), stance phase contact time (s) and distance (m) were obtained in each jump test performed. For the unilateral jump tests, comparison was made between reconstructed legs and the dominant ones of the uninjured subjects. For the bilateral drop jump test, comparison was made between reconstructed and uninjured subjects. RESULTS: Previously ACL reconstructed athletes demonstrated significantly lower bilateral drop jump flight time (0,393 vs 0,541 s;  $P < 0.001$ ) and less distance reached in triple leg hop for distance (0,382 vs 0,435 m;  $P < 0.05$ ) on their reconstructed leg compared with the healthy legs of the uninjured subjects. No significant differences were observed in the other variables recorded CONCLUSION: Previously ACL reconstructed athletes may cope with some functional deficits once returning to competition, potentially increasing their reinjury risk. Restoration of these deficits would help to decrease the reinjury rates among this population. REFERENCE: 1. Hewett TE, Myer GD, Ford KR. Anterior cruciate ligament injuries in female athletes: Part 1, mechanisms and risk factors. Am J Sports Med 2006; 34(2):299-311.

## INFLUENCE OF FATIGUE ON THE STRIDE CHARACTERISTICS DURING AN INTENSE ENDURANCE RUNTEST.

Jidovtseff, B., Rodriguez de la Cruz, C., Croisier, J.L., Maquet, D., Bury, T., Deflandre, D.

*University of Liege*

INFLUENCE OF FATIGUE ON THE STRIDE CHARACTERISTICS DURING AN INTENSE ENDURANCE RUNTEST. Jidovtseff, B, Rodriguez de la Cruz, C, Croisier, JL, Maquet, D, Bury T, Deflandre, D ULG (Liège, Belgium) Introduction The analysis of the stride and its variation during endurance running has been investigated in different studies (Slawinski et al, 2008). Most of them were achieved in laboratory and/or with heavy and complex equipment. Very recently, a small and practical device, adapted to field testing has been developed to analyze stride characteristics: the Myotest Run. This accelerometer allows the measurement of thirteen biomechanical parameters of the running stride. Therefore, the aim of the study was to investigate the influence of fatigue on stride mechanics during an exhaustive endurance test with Myotest Run. Methods Twenty male subjects (16-36 yrs) were involved in the study divided into two sessions: 1) a treadmill progressive VO<sub>2</sub>max test; 2) a field test at 90% of the VvO<sub>2</sub>max until exhaustion. Mechanical parameters (e.g. step frequency, step distance, contact time, distance on the contact time, stiffness) were recorded with the Myotest Run at each velocity during the treadmill test and at each lap in the 90% exhaustive test. Based on these two tests, three investigations have been conducted: 1) the influence of velocity on stride characteristics; 2) treadmill vs. field running characteristics 3) influence of fatigue on stride mechanics. A reproducibility analysis was also

performed with standardized running recordings achieved before the field test. Results The results show an excellent reproducibility of the Myotest Run values, except for the asymmetry of the race ( $CV > 5\%$ ). The stride on treadmill was not significantly different in comparison with the one on track, except for the hip angle at touchdown ( $p < 0,05$ ). Myotest analysis at different speed during the treadmill test showed that all biomechanical parameters changed with running speed ( $p < 0,05$ ). Surprisingly, classical statistics revealed only few significant changes in the stride with fatigue (decrease in CM vertical movement and in reactivity;  $p < 0,05$ ). However, an individual analysis allowed us to put forward four different changes of the stride with fatigue: 1) increase in stride length; 2) decrease in stride length and in CM vertical movement 3) decrease in stride length contact time; 4) no change in stride characteristics. These observations were partly observed by different authors (Avogadro et al, 2003). Conclusion This study confirmed that Myotest Run is a useful device in the stride analysis. The impact of fatigue on running pattern could be different according to subject characteristics. More researches are needed to elucidate how programs should be individualized. References Avogadro P, Dolenc A, Belli A. (2003). Eur J Appl Physiol, 90, 165-170. Slawinski J, Billat V. (2008). Effets de la fatigue sur la depense energetique et sur l'energie mecanique en course de demi-fond. AEIFA

## KINEMATIC ANALYSIS OF TREADMILL WALKING IN HEALTHY ADULTS ACCORDING TO PHYSICAL PERFORMANCE

Annoni, I.1,2, Cirasella, M.3, Mapelli, A.1, Sidequersky, F.V.1, Sforza, C.1, Galvani, C.2

1Università degli Studi di Milano; 2,3Università Cattolica del Sacro Cuore di Milano

Introduction Modified joint range of motion (ROM) and spatio-temporal gait parameters in elderly or obese healthy subjects have been found. Authors have hypothesized that these alterations may be due to a reduction in physical performance, especially for strength and flexibility (Daley, 2000; Wearing, 2006; Wert, 2010), but quantitative studies measuring the influence of physical performance on gait pattern are scanty. The aim of this study was to analyse the kinematics of treadmill walking of healthy adults to understand if strength and flexibility could affect gait parameters. Methods 20 healthy adults (age,  $26.9 \pm 4.7$  yr; BMI,  $22 \pm 1.9$  kg/m<sup>2</sup>; iMVC,  $1458 \pm 458$  N; Flexibility,  $34.8 \pm 13.6$  cm; PWS,  $5.5 \pm 0.5$  km/h) were recruited in the study. Isometric maximal voluntary contraction (iMVC) was measured by two force plates (Twin Plates, Globus, Italy) which were fixed onto the foot platform of a horizontal leg press (Technogym SpA, Gambettola, Italy). Flexibility was assessed by the V-sit and reach test. The preferred walking speed (PWS) was determined on a 50-m section of athletics track. A kinematic analysis was performed with an optoelectronic system (SMART-E, BTS, Italy) during a 10-min bout of treadmill walking at 5.5 km/h. The following parameters were computed: step length and width (m), step frequency (step/min), stance and swing phase durations (% cycle), double support time (% cycle), hip and knee extension (°) and hip and knee ROM (°). Results Significant associations, adjusted for age, height and weight, were identified between iMVC and step width ( $r = 0.501$ ,  $F = 6.04$ ,  $p = 0.024$ ), stance ( $r = 0.537$ ) and swing ( $r = -0.537$ ) phase durations ( $F = 7.28$ ,  $p = 0.015$ ), double support time ( $r = 0.639$ ,  $F = 12.43$ ,  $p = 0.002$ ), and between Flexibility and step length ( $r = -0.547$ ,  $F = 7.68$ ,  $p = 0.013$ ). Discussion Our data indicate that lower limb maximal strength and hamstring flexibility influence step length and width, stance and swing phase durations and double support time of treadmill walking, suggesting the necessity to attain and maintain adequate levels of both strength and flexibility even in a healthy adult population. References Daley MJ and Spinks WL. Sports Med. 2000;29:1-12. Wearing SC et al. Obes Rev. 2006;7:13-24. Wert DM et al. Phys Ther. 2010;90:977-85.

## BOOT FORCE AND ACCELERATIONS ARE SIMILAR FOR SLALOM AND GIANT SLALOM ALPINE SKI RACING

Kipp, R.W.1, Scheiber, P.2, Müller, E.2, Seifert, J.G.3

1: USA (Park City, USA) 2: CDL – Biomechanics in Skiing (Salzburg, AUT) 3: MSU (Bozeman, USA)

Introduction Slalom (SL) and giant slalom (GS) are very different skiing disciplines. This can be exemplified by the fact that on the men's World Cup there are only six ski racers that are found in both SL and GS top 30 World Cup point lists (FIS, 2012). This would lead one to believe that the two events are more different than alike. Determining differences in SL and GS kinetics would be valuable information for the preparation of competitive athletes. The purpose of this study was to determine if force and acceleration could be used to differentiate between SL and GS. Methods After IRB was accepted and consents forms signed, 3 male and 5 female collegiate ski racers [FIS SL pts. =  $75.53$  (29.11), GS pts. =  $71.02$  (28.95)] skied a warm up run, then completed 1 run of SL set at 10.2 m vertical distance and 4 m horizontal offset, and 1 run of GS set at 20.4 m vertical distance and 6 m offset on SL and GS skis (2010/11 FIS ski specifications), respectively. The 94m vertical run was groomed prior to data collection. Data from each of the 6 middle turns were averaged and used. Unidirectional force was measured with force insoles (Pedar, Novel Electronics) (100 Hz sampling frequency) and with triaxial accelerometry (Pendant G Data Logger) (50 Hz sampling frequency) attached to the lower ski boot. Sagittal (x), frontal (y) and vertical (z) were recorded. The inner and outer ski relationship during the turn was used to determine percent contribution for force between the SL and GS skis and for acceleration comparison. Data are listed as mean (+/-SD). Alpha level of significance was  $p < 0.05$ . Results Mean total force per turn in SL was  $943.71$  (291.24) and GS  $937.03$  (225.03) N,  $p = .45$ ,  $r = .87$ . When adjusted for body weight SL was  $1.323$  (.26) and GS  $1.324$  (.24) N/kg,  $p = .44$ ,  $r = .73$ . The inner SL ski accounted for  $33.51$  (6.84) and the inner GS ski  $31.16$  (7.84) %,  $p = .12$ ,  $r = .75$ . Mean acceleration (m/s<sup>2</sup>) for the outer ski: SLx  $-6.37$  (2.53), GSx  $5.46$  (3.84)  $p = .20$ ; Sly  $-0.67$  (2.17), GSy  $0.24$  (3.51)  $p = .24$ ; SLz  $11.96$  (1.55), GSz  $10.85$  (2.87)  $p = .06$ . For the inner ski: SLx  $-6.64$  (3.51), GSx  $-5.94$  (4.22)  $p = .20$ ; Sly  $-0.25$  (2.58), GSy  $-0.68$  (3.06)  $p = .35$ ; SLz  $12.64$  (2.02), GSz  $10.17$  (4.50)  $p = .07$ . Discussion There were no significant difference in absolute and relative mean forces between SL and GS. The inside ski accounted for about 1/3 of the total force in both SL and GS for a none significant difference. Accelerations were also non significant for both the inner and outer ski for SL and GS for all measurements. This would lead one to conclude that SL and GS with respect to mean force and acceleration measured at the boot, under these test parameters, are similar, and the differences found in race results must lie elsewhere.

## COMPARISON OF THE KNEE ANGULAR VELOCITY DURING SINGLE-LEG LANDING BETWEEN BASKETBALL AND VOLLEYBALL COLLEGE PLAYERS: DESCRIPTION BY QUATERNIONS REPRESENTATION

Domingos, M.B.1, Cunha, S.A.1, Spanó, N.V.1, Santiago, P.R.P.1

1: USP-EFERP (Ribeirão Preto, Brazil), 2: UNICAMP-LIB (Campinas, Brazil)

Introduction Knee joint movement analysis during the single-leg drop landing task has been used in studies of sports-related anterior cruciate ligament injury mechanism. Quaternions have a mathematical advantage, compared to Euler angles, since gimbal lock does not happen. However, this technique defines only one axis of rotation and, for that reason, there is no correspondence to the anatomical axes. On the other hand, Euler angles are dependent on the sequence of rotation chosen by the researcher, different from quaternions. Even with the possibility of standardizing the sequence of rotation as proposed by International Society of Biomechanics, differences will be found when angular velocities are calculated. Therefore, in situations of applied biomechanics, angular velocity is calculated in only one way when using quaternions. Objective The aim of the present study was to use the quaternions rotational representation to com-

pare the knee angular velocity during the single-leg drop landing task between basketball and volleyball college players. Methods Ten male college players (five basketball and five volleyball) without prior lower limb injuries and pain participated in this study. They performed ten single-leg drop landings from a platform with a height of 0.5 m. Six passive markers (three on the thigh and three on the shank) were used to obtain the 3D kinematics. Routines written in the Matlab software were used to smooth the raw data with the cubic splines function, and to create coordinate systems of the thigh and shank to extract the unit quaternions from the knee joint observed in the task. Then the scalar portion of the unit quaternion was used to calculate the angular velocity in degrees per second (°/s). Comparisons between groups were done using the boxplots (median and the confidence interval  $p < 0.05$ ) of the maximum angular velocity. Results The results indicate significant differences between the two groups (volleyball = 385.5 °/s [362.8 - 408.2] and basketball = 313.0 °/s [272.5 - 353.5]). Discussion The results of the current study showed that the maximum angular velocity of the volleyball players was higher than that of the basketball players. In general, it was observed that the volleyball players performed higher amplitudes of movements of the knee in the single-leg landing task compared to basketball players. This may occur due to the specificity of this movement in each sport. Acknowledgments: This work received financial support by the Research Foundation of the State of Sao Paulo (FAPESP - process number: 2010/20538-7), and (PIC/USP/CNPq - process number: 124719/2010-4).

### MOVEMENTS NECESSARY FOR INCREASING SPEED IN ROLLER SKIING WITH A DIAGONAL STRIDE

Nakai, A., Ito, A.

*Kinki Welfare University*

Movements necessary for increasing speed in roller skiing with a diagonal stride Nakai, A.1, Ito, A.2 1: Kinki Welfare University (Hyogo, Japan), 2: Osaka University of Health and Sport Sciences (Osaka, Japan) Introduction In roller skiing, the centre of mass of the total body of the athlete is positioned on the roller ski in contact with the ground and moves forward all the time. Roller skiing speed (RS), which was calculated from mean horizontal velocity of the total-body centre of mass, was expected to depend on horizontal velocity of roller skis. Thus, the purpose of this study was to examine the relationship between RS and movements of roller skis during diagonal roller skiing to understand the movements necessary for an increase in RS. Methods Two-dimensional kinematics were recorded using a digital video camera in seven male collegiate cross-country ski athletes who roller skied with a diagonal stride at the paced speeds of 1.67, 2.50, 3.33, 4.16 and 5.00 m/s on a level track. The duration of the single-support phase (SS), the double-support phase (DS) and the transition phase (TR) and cycle time (CT) were computed from the video images over one cycle. Additionally, horizontal velocity of the total-body centre of mass, maximal horizontal velocity of the roller ski (Vmax) and mean acceleration of the roller ski during DS were calculated. Results RS had negative correlations with the duration of SS, DS and TR ( $r = -0.465$ ,  $p < 0.01$ ;  $r = -0.396$ ,  $p < 0.05$ ;  $r = -0.920$ ,  $p < 0.001$ , respectively) and also CT ( $r = -0.900$ ,  $p < 0.001$ ). A highly positive correlation was found between RS and Vmax ( $r = 0.988$ ,  $p < 0.001$ ). Vmax negatively correlated with the duration of DS and TR and the mean acceleration of the roller ski during DS ( $r = -0.407$ ,  $p < 0.05$ ;  $r = -0.915$ ,  $p < 0.001$ ;  $r = -0.908$ ,  $p < 0.001$ , respectively). Discussion Vmax, which occurs at the beginning of the ground contact of the roller ski, was significantly associated with RS. The duration of DS and TR and the mean acceleration of the roller ski during DS decreased with an increase in RS. Therefore, reducing the duration of DS and TR and the mean acceleration of the roller ski during DS would result in higher Vmax, hence increasing RS more. CT and the duration of each phase decreased with increasing RS. The duration of TR showed a remarkably strong correlation with RS compared to that of the other phases. These facts indicate that shorter duration of the individual phases, particularly that of TR, would lead to increasing RS. Consequently, greater deceleration of the roller ski before kicking and more rapid movements of kicking and transition to the opposite roller ski would cause effective acceleration of RS. Moreover, it is suggested that the above movements for shorter duration are required to increase RS.

### ACUTE AND DELAYED SSC FATIGUE EFFECTS ON TREADMILL RUNNING: INFLUENCE OF FOOTWEAR VISCOELASTICITY

MORIO, C., BARLA, C., BERTON, E., NICOL, C.

*Oxylane Research*

ACUTE AND DELAYED SSC FATIGUE EFFECTS ON TREADMILL RUNNING: INFLUENCE OF FOOTWEAR VISCOELASTICITY Morio, C.1, Barla, C.1, Berton, E.2, Nicol, C.2 1: Oxylane Research (Lille, France), 2: UMR6233 (Marseille, France) Introduction Endurance running is a typical stretch-shortening cycle type exercise (SSC), which is well known for inducing acute (<2 hours post-exercise) and delayed (up to 8 days) functional defects (Nicol & Komi, 2011). Although various studies investigated the potential footwear capacity to reduce suspected risk factors (Jenkins & Cauthon, 2011), influence of footwear characteristics on the locomotor adjustments to fatigue remain unexplored. This study examined in both acute and delayed SSC recovery phases the influence of footwear visco-elasticity on neuro-mechanical changes of the running pattern. Methods An exhaustive SSC exercise was performed on a sledge apparatus by 8 healthy male subjects who repeated series of 25 bilateral jumps, with inter-series rests of 3 min. Rebound height was set at 80% of maximal performance. Functional fatigue effects were quantified before (PRE), after (POST) and two days (D2) later in a maximal drop jump test. Each testing session included also two submaximal treadmill runs of 3 min duration performed randomly with viscous (V) and elastic (E) type shoes. Footwear influence on the neuro-mechanical adjustments to fatigue were examined for the last 15 seconds of each run using 3D kinematics and electromyography of 8 major muscles of the right lower limb. Appropriate two-way ANOVA analyses (V-E vs. PRE-POST-D2) were performed with a significance level set at 0.05. Correlation coefficients were used to compare the V vs. E shoe influence. Results Delayed onset muscle soreness (DOMS) was reported in all lower limb extensors at D2. Drop jump performance decreased at both POST (-7±4%) and D2 (-8±8%). Treadmill run was mostly affected at D2, showing 8±9% increased lower limb stiffness, 7±13% reduced knee flexion and 32±38% increased ankle eversion ( $p < 0.05$ ). Emphasizing the similarity of the changes observed with both shoes, significant correlations were found for most neuromechanical parameters ( $0.51 < r <= "" p="" > </r$

### TALENT TRANSFER IN SPORT: EXPERT COACHES' INSIGHTS

Dickinson, R.K.1, Mallett, C.J.1,2, Gulbin, J.2, Weissensteiner, J.2

1: *University of Queensland, Australia*, 2: *Australian Institute of Sport, Australia*

Introduction Talent transfer (TT) is a relatively newly discussed term appearing in academic literature (e.g., Vaeyens et al., 2009), referring to the idea of athletes "swapping" sports, or being "recycled" within a sport system. As such, TT as a distinct phenomenon is relatively under-researched in either theoretical or empirical published literature compared to many other approaches to sport talent identification and development (TID&D). Despite little research, the strategy has been used on a systematic level by a number of countries. The current study aimed to understand TT in more depth through rigorously gathering the expert knowledge of coaches who have undertaken the

"transferring" of athletes within the Australian sport system. Method 13 expert coaches (10 male) experienced in attempting to "transfer" athletes participated in semi-structured interviews regarding their background, involvement, processes, and experiences in TT. Interviews were conducted face-to-face (11), and by telephone (2), averaging 92 mins. Interviews were audio recorded and transcribed, member-checked, and coded using Nvivo9 software, checking for inter-coder agreement amongst researchers. Data were organised into meaning units, higher and lower order themes, as per qualitative research methodology published by Côté et al (e.g., 1993), and also represented in the form of a model. Results There were conceptually varied definitions of TT within the sample. Coaches gave insights from their experiences into broad themes such as: transferable and non-transferable elements between sports, barriers and facilitators, coach skills and qualities, athlete qualities, possibilities and limits of TT, necessary support, and important considerations for TT. Considerations such as: the differences between sport cultures and environments, athletes' personal characteristics, squad dynamics, the importance of a clear and well structured program of training with realistic goals and expectations, respect for athletes' backgrounds, and adequate access to resources were key factors suggested for successful TT. Discussion A multi-dimensional model of successful TT, including physical, mental, environmental, interpersonal, and structural considerations is proposed. Results are discussed in relation to conceptions of TT, implications for coaching practice and talent management by individual coaches and national sport systems, and the wider context of TID&D research. Limitations of the current study and future research areas are also discussed. References Côté, J., et al. (1993). Organizing and interpreting unstructured qualitative data. *The Sport Psychologist*, 7(2), 127-137. Vaeyens, R., et al. (2009). Talent identification and promotion programmes of Olympic athletes. *J of Sports Sciences*, 27, 1367-1380.

## THE EFFECT OF STRENGTH VS. POWER TRAINING ON THROWING PERFORMANCE

Zaras, N., Spengos, K., Methenitis, S., Papadopoulos, C., Karampatsos, G., Georgiadis, G., Stasinaki, A., Manta, P., Terzis, G.

*University of Athens*

Introduction Shot put is a power demanding activity (Zatsiorsky et al., 1981). Recently it was shown that strength training enhances muscle mass and shot put performance, in novice throwers (Terzis et al., 2008) but the effect of power training on shot put performance remains unexplored. Aim of this study was to investigate the effects of 6 weeks strength vs. power training on shot put performance. Methods Seventeen participants were divided into Strength (N = 9) or Power (N = 8) groups. Training was performed 3/week for 6 weeks with 3 resistance exercises: leg press, bench press and semi-squat. For the Strength group, the load was set at 6RM while the Power group trained with ballistic exercises with 30% of 1RM (Kyröläinen et al., 2005). The following tests were performed before and after the training period: shot put throws, counter movement jumps (CMJ), Wingate, 1RM strength and ballistic throws tests. Vastus lateralis thickness, pennation angles and fascicle lengths were examined with ultrasonography, while fiber type composition and cross sectional area (fCSA) measured on histochemically stained muscle samples. Results Shot put performance increased significantly but similarly after strength and power training (7-13.5% vs. 6-11.5%, respectively). Leg press 1RM increased more after strength than after power training. Power training induced an increase in CMJ by 8.5% (p=0.006), and in ballistic throws by 9-26% (p<0.05), while strength training did not alter performance in these tests. Peak power during the Wingate test increased similarly in both groups. Muscle thickness increased only after strength training (10%, p=0.004). Muscle fCSA increased in all fiber types after strength training by 17-25% (p<0.05), while only type IIx fibers hypertrophied significantly after power training. Type IIx fibers (%) decreased after strength but not after power training. Discussion The results of the present study suggest that shot put throwing performance can be increased similarly after 6 weeks of strength or power training, in novice throwers. Improvements in shot put performance after strength training could be attributed mainly to muscle hypertrophy while improvements after power training might be attributed to adaptations in type IIx muscle fibers, although neural adaptations might have contributed also. It appears that ballistic power training might be used effectively during the last weeks before competition, when the strength training load is usually reduced, in order to increase muscle power and shot put performance in novice throwers. References Zatsiorsky V, Lanka G, et al. (1981). *ESSR* 1981;9:353-389. Terzis G, Stratakos G, et al. (2008). *JSCR* 22(4):1-7. Kyröläinen H, Avela J, et al. (2005). *SJMSS* 15:58-64.

14:45 - 15:45

## Poster presentations

### PP-PM09 Physiology 1

#### BIKING 2770 KM IN 14 DAYS: EFFECT ON MAXIMAL FAT OXIDATION

Morville, T., Rosenkilde, M., Munch-Andersen, T., Andersen, P.R., Kjær, K., Rasmussen, H.K., Mattsson, N., Grau, A.G., Dela, F., Helge, J.W.

*Xlab, Center for Healthy Aging*

Introduction Endurance training increases maximal fat oxidation and very prolonged exercise has been shown to markedly increase fat utilization during exercise. However, the limiting steps of fat oxidation are still subject to some discussion. This study examined the effects of 13 days repeated prolonged exercise on maximal fat oxidation and substrate stores as well as the primary steps regulating transport and oxidation of fat in skeletal muscle. Methods Data were obtained from 6 males completing a 13-day bike ride, covering 2770 km (age: 61 ± 4 yrs; cycling VO<sub>2</sub>-max: 48 ± 2 mL kg<sup>-1</sup> min<sup>-1</sup>). Before and 2 days after the bike ride a blood sample and a muscle biopsy (m. vastus lateralis) was obtained at rest overnight fasted. Body composition was determined using skinfold and bioimpedance techniques and respiratory gasses were sampled during a fat-max test and a VO<sub>2</sub>max test. Continuous heart rate sampling was performed throughout the 13 days in order to estimate the intensity and duration of exercise. The intensity was estimated as the average of 10 minutes intervals of heart rate recording from which the percentage of VO<sub>2</sub> max was then calculated. Results Maximal fat oxidation decreased from 0.63 ± 0.05 to 0.43 ± 0.07 g/min (P < 0.01). Plasma FFA concentration decreased from 500 ± 77 to 160 ± 38 μmol/L (P < 0.002). VO<sub>2</sub>max decreased from 48 ± 2 to 45 ± 2 mL/(kg min) (P < 0.04). The exercise intensity that elicits maximal fat oxidation was not significantly changed (59 ± 2 to 54 ± 5 % of VO<sub>2</sub>-max). Plasma glucose (5.9 ± 0.2 to 6.0 ± 0.3 mmol/L) and plasma triacylglycerol (0.9 ± 0.1 to 1.0 ± 0.2 mmol/L) as well as muscle glycogen (602±78 to 639±59 mmol/kg d.w.) and triacylglycerol (71±15 to 66±5 mmol/kg d.w.) all remained unchanged, pre and post, respectively. There were no changes in muscle CS- or HAD-activity. Average daily duration of exercise



was  $580 \pm 30$  min and the mean intensity was  $53 \pm 1$  % of  $VO_{2max}$ . Body weight and composition remained unchanged ( $77.4 \pm 4.6$  to  $77.7 \pm 4.8$  kg and  $21 \pm 1$  to  $20 \pm 3$  %, pre and post respectively). Discussion Maximal fat oxidation as well as aerobic fitness decreased. Very low plasma FFA at rest suggests low exogenous FFA delivery during exercise and along with the decreased aerobic fitness this could account for the decrease in maximal fat oxidation. Thus, in this study, the probable attenuation of exogenous FFA availability during exercise induced by the repeated prolonged exercise is likely to be the limiting factor for maximal fat oxidation.

### **SPRINT EXERCISE-INDUCED PDH ACTIVATION: ROLE OF FIO<sub>2</sub> AND FREE RADICALS.**

Morales-Álamo, D.1, Guerra, B.1, Guerrero, M.2, Cadefau, J.A.2, Cussó, R.2, Ponce-González, J.G.1, Guadalupe Grau, A.1, Rodríguez-García, L.1, Dorado, C.1, Calbet, J.A.1

1. 1. Dep. Educación Física, Universidad de Las Palmas de Gran Canaria, Spain. 2. 2. Unitat de Bioquímica, Facultat de Medicina, Universitat de Barcelona, Spain

Anaerobic glycolysis is strongly activated by sprint exercise and hypoxia ( $FIO_2=0.10$ ). It has been reported that free radicals (FR) may slow the kinetics of the oxidative metabolism in a pyruvate dehydrogenase (PDH) dependent manner. Since hypoxia increases free radicals levels, sprint exercise in hypoxia may result in greater dephosphorylation (activation) of PDH. Purpose. To determine if FR are implicated in the sprint exercise-induced PDH de-phosphorylation. To this purpose we determined PDH phosphorylation levels in response to a sprint exercise in normoxia (N,  $FIO_2=0.21$ ) and hypoxia (H,  $FIO_2=0.10$ ) in two conditions placebo (P) after the ingestion of antioxidants (A. The antioxidant cocktail was compound by 300 mg of alpha-lipoic acid, 500 mg vitamin C, and 200 IU vitamin E, and was administered to 2 h and 1.5 h before the sprints). Methods: Nine males (age:  $25 \pm 5$  yrs;  $VO_{2max}$ :  $51 \pm 6$  ml.kg<sup>-1</sup>.min<sup>-1</sup>; means  $\pm$  SD) performed on separate days in random order four 30s-isokinetic Wingate tests at 100 rpm in NP, HP, NA, and HA. Immediately before the start, at the end, and at 30 and 120 min into the recovery period, muscles biopsies were taken and PDH phosphorylations determined by Western blot and pyruvate concentration by spectrofluorometry. Results: Mean power output (MPO) and mean  $VO_2$  were, respectively, 6% and 37% lower in HP than in NP ( $P < 0.05$ ). Compared to NA, mean  $VO_2$  was decreased by 31% in HA, respectively ( $P < 0.05$ ). Peak blood lactate was similarly increased after the sprints. Muscle pyruvate concentration was increased by 104% immediately after the sprints, without significant differences between conditions. Ser293-PDH-1Ealpha and Ser300-PDH-1Ealpha phosphorylation were decreased by 65% and 88%, respectively, returning to near baseline values within 30 minutes of recovery ( $P < 0.05$ ). Conclusion: PDH dephosphorylation (activation) in response to sprint exercise is not influenced by the  $FIO_2$  or the ingestion of antioxidants. These findings indicate that free radical production during sprint exercise do not appear to play a major role in inducing PDH dephosphorylation. Supported by Ministerio de Educación y Ciencia, (DEP2009-11638) and (DEP2010-21866).

### **SOFTWARE FOR THE RAPID AND AUTOMATIC CALCULATION OF PHYSIOLOGICAL PARAMETERS CORRESPONDING TO THE MAXIMUM CONSUMPTION OF LIPIDS DURING EXERCISE**

Vittori, L.N., Manners, D.N., Maietta, P., Tentoni, C.

University of Bologna

Introduction Numerous studies have described the relationship between exercise intensity and fat oxidation, but few have assessed this relation at different exercise intensities. Most exercise programs for obese patients and resistance training for athletes, have been evaluated for their respiratory and cardiovascular benefits and increased oxidative capacity in skeletal muscle. The study of fat metabolism, induced by training during exercise, has received less attention, although its importance has been recognized both in performance sports and for its impact on health [1-4]. It is therefore imperative to precisely define rigorous standardization procedures (feeding, pre-test activities, test protocol, etc.) that allow a reliable determination of the maximum consumption of lipids (FatMax). In addition, for routine use such procedures should be integrated with an appropriate software to automatically determine parameters of physiological interest, related to the FatMax, in a robust and operator-independent manner. Methods Our group has developed an automatic procedure for determining FatMax, both in terms of load applied and in terms of parameters such as heart rate and RER. The program uses a robust curve fitting procedure for reliable results. The initial application for this procedure is the determination of exercise prescription for overweight subjects, with the aim of maximizing fat loss for a given exercise duration. In the study currently underway, we have recruited 16 subjects (14 female, age 40-54 years, BMI 23-34), who have undergone an initial incremental test to determine their individual FatMax, followed by twice weekly sessions lasting 1 hour, during which the subjects exercise on bike, steps and treadmill for 20 minutes each. During the session a heart rate monitor is used to hit the target heart rate prescribed, and a respirometer to check that the target RER is achieved. At the end of the study period a final incremental test will be performed to ascertain whether relevant physiological parameters have been altered by the training. Results The study is currently underway. The latest results will be presented, emphasizing the design and use of the software that we have developed, and aim to make freely available. References 1. Van Aggel-Leijessen DP, et al. *Metabolism* 2002; 51:1003-10 2. Turcotte LP, et al. *Am J Physiol* 1992; 262:E791-E799 3. Romijn JA, et al. *Am J Physiol* 1993;265:E380-91 4. Jeukendrup AE. *Curr Opin Clin Nutr* 1999; 62:999-1005

### **COMPARATIVE STUDY OF TRADITIONAL AEROBIC EXERCISE V/S SPRINT INTERVAL TRAINING WITH RESPECT TO PULMONARY FUNCTION TESTS & PHYSICAL FITNESS INDEX IN YOUNG SEDENTARY MALES: A RANDOMIZED CONTROLLED TRIAL**

Badaam, K.M., Khan, S.T., Munibuddin, A., Chaudhari, S.P., Doiphode, R.S.

Government Medical College, Aurangabad

Introduction: Physical inactivity and sedentary living are now a global 'non-communicable' disease. [1] Exercise is known to prevent various diseases and promote health. [2] However, for exercise guidelines to yield a health benefit for the individual, not only should the regime reliably modify key disease risk factors, it must also be plausible to implement. SIT is an exercise strategy that is intended to improve performance and health with short training sessions. [2] Methods: The trial registered with W.H.O: UIN: U1111-1126-7019 and in CTRI as CTRI/2011/12/002312. 14 Young sedentary healthy males age 18-25 years with normal baseline ECG, were enrolled & randomly allocated to either group to undergo an intervention for 3 weeks. Group I: AE: Subjects ran at low intensity like jogging for 30 minutes a day for 5 days a week. Group II: SIT: 60 seconds intense exercise followed by 90 seconds rest, repeated for 4 cycles, making a total of 10 minutes thrice per week. Pulmonary function test parameters (FVC, MVV) and Physical Fitness Index were measured at beginning and 2 days after 3 weeks intervention. Results: The improvement in FVC in litres in Group I was  $0.31 \pm 0.11$  and in Group II was  $0.48 \pm 0.17$ . The improvement in MVV in litres in Group I was  $21.5 \pm 11.6$  and in Group II was  $27.77 \pm 7.03$ . Thus, SIT showed better improvement in FVC &

MVV although difference in improvement was statistically not significant with p value of 0.09 & 0.29. Also, the improvement in Physical Fitness Index was more in Sprint interval training group and the difference was statistically significant. Discussion: Survival in asymptomatic adults without chronic respiratory diagnoses or persistent respiratory symptoms is associated with Forced Vital Capacity and not with airway obstruction as measured by the FEV1/FVC ratio. [3] Maintaining or improving fitness is associated with a lower risk of all-cause and Cardiovascular Disease mortality in men. Preventing age-associated fitness loss is important for longevity regardless of Body Mass Index change. [4] SIT showed better improvement in FVC, MVV and Physical Fitness Index compared to traditional aerobic exercise. References: 1. Gordon O M, et al. Responsibility of sport and exercise medicine in preventing and managing chronic disease: applying our knowledge and skill is overdue. *Br J Sports Med* 2011;45:1272-1282 doi:10.1136/bjsports-2011-090328. 2. Peter K, Jonathan M. Exercise in Cardiovascular Disease, Exercise and Physical Activity Clinical Outcomes and Applications. *Circulation*.2010; 122: 1637-1648doi:10.1161/CIRCULATIONAHA.110.948349. 3. Burney PG, Hooper R. Forced vital capacity, airway obstruction and survival in a general population sample from the USA. *Thorax* 2011;66:49-54 doi:10.1136/thx.2010.147041. 4. Duck-chul L, et al. Long-Term Effects of Changes in Cardiorespiratory Fitness and Body Mass Index on All-Cause and Cardiovascular Disease Mortality in Men. *Circulation*. 2011; 124: 2483-2490 doi: 10.1161/CIRCULATIONAHA.111.038422

### COMPARISON BETWEEN SUPINATED AND NEUTRAL WRIST POSITIONS ON ECCENTRIC CONTRACTION-INDUCED MUSCLE DAMAGE OF THE ELBOW FLEXORS

Lau, W.Y., Blazeovich, A., Newton, M., Nosaka, K.

*Edith Cowan University (Australia)*

COMPARISON BETWEEN SUPINATED AND NEUTRAL WRIST POSITIONS ON ECCENTRIC CONTRACTION-INDUCED MUSCLE DAMAGE OF THE ELBOW FLEXORS Lau, W.Y., Blazeovich, A., Newton, M., Nosaka, K. ECU (Australia) Introduction Eccentric contraction-induced muscle damage (EIMD) is characterised by delayed onset of muscle soreness, loss of muscle strength and increases in muscle proteins such as creatine kinase (CK) in the blood (1). Previous studies (e.g. 2) investigated EIMD of the elbow flexors in a supinated position; however, it seems likely that the wrist position would affect the magnitude of EIMD. No previous studies have systematically compared between supinated and neutral wrist positions on EIMD. The present study tested the hypothesis that eccentric contractions of the elbow flexors in a neutral position would induce less EIMD than those in a supinated position. Methods Ten non-resistance trained men (21-39 y) performed two exercise bouts consisting of 10 sets of 6 maximal isokinetic (60°s<sup>-1</sup>) eccentric contractions of the elbow flexors in a different wrist position (supinated vs neutral) for each arm separated by 4 weeks in a randomised, counterbalanced order. During the eccentric contractions, the elbow joint was forcibly extended from a flexed (60°) to a fully extended position (0°). The movements of the biceps brachii aponeurosis were recorded by B-mode ultrasonography (Aloka SSD-α10, Japan), and the movement distance of the aponeurosis origin from the beginning to the end of each contraction was calculated, and the average change in a set was obtained. Maximal voluntary isometric contraction strength (MVC), range of motion (ROM), muscle soreness and serum CK activity were assessed before, immediately after and 1-7 days following each exercise bout. Changes in these variables over time and changes in aponeurosis elongation over sets were compared between supinated and neutral wrist conditions by a two-way repeated measure ANOVA. Results Peak torque produced during eccentric contractions was similar between conditions. The aponeurosis origin was extended during eccentric contractions, and the average aponeurosis elongation increased ( $P < 0.05$ ) from the 1st set ( $8.0 \pm 2.0$  mm) to the 10th set ( $15.8 \pm 1.9$  mm) for the supinated condition; however, no significant increases were found in the neutral condition (1st set:  $5.1 \pm 1.0$  mm, 10th set:  $5.0 \pm 0.8$  mm). Compared with the supinated condition, changes in MVC, ROM, muscle soreness and serum CK activity following exercise were smaller ( $P < 0.05$ ) for the neutral condition. Discussion These results suggest that EIMD is less for the neutral than the supinated position, and this is likely associated with the smaller strain to muscle fibres and surrounding connective tissue in the neutral than the supinated condition. It is concluded that the wrist position affects the magnitude of elbow flexor muscle damage. References 1.Nosaka et al. *Eur J Appl Physiol*. 111:2427-37, 2011 2.Lau, Nosaka. *Am J Phys Med Rehab*. 90:648-57, 2011

### REMOVAL OF STRATUM CORNEUM ENHANCES LOCAL SWEATING RATE

Ler, H.Y., Thompson, M.W., Ruell, P.

*University of Malaya*

REMOVAL OF STRATUM CORNEUM ENHANCES LOCAL SWEATING RATE Ler, H.Y. 1, 2, 3 Thompson, M.W.1 Ruell, P.1 1: University of Sydney (Australia); 2: University of Malaya (Malaysia); 3: Tunku Abdul Rahman College (Malaysia) The vapour pressure at the skin surface and the surrounding ambient vapour pressure determine the extent of skin wettedness and ultimately the effect on sweating efficiency (Candas, 1983). It has been suggested that prolonged skin wettedness might cause the stratum corneum to swell, thus causing a mechanical obstruction of the sweat duct (Randall, 1957). The present study investigated the effect of skin wettedness on local sweating rate with the removal of the stratum corneum. 8 healthy males (age:  $34.0 \pm 7.7$  yr; height:  $175.0 \pm 5.8$  cm; weight:  $68.3 \pm 7.2$  kg; body fat:  $9.7 \pm 3.9\%$ ) completed 2 sessions of a walking protocol ( $5.5 \text{ km} \cdot \text{hr}^{-1}$ , 4% inclination) for 90 min in hot, humid conditions ( $37^\circ\text{C}$ , 60% rh) on two separate days. A marked area at ventral upper-arm was stripped sequentially 5 times and stratum corneum was removed using an acrylic adhesive film (OPSITE™ Flexigrid). Colorimetric method was used to determine the amount of stratum corneum removed. Local sweating rate (SR), skin blood flow (SkBF), local skin temperature (Tsk) were measured continuously at both stripped and unstripped sites. Sweat samples were collected every 30 min and electrolyte concentrations of Na, K, Cl and Ca were analysed. The removal of stratum corneum layers on the stripped site was similar between trials ( $18.27 \pm 6.97$  vs.  $17.18 \pm 5.36 \mu\text{g}$ ;  $p = 0.79$ ). Local SR increased progressively but at the stripped site was significantly higher than at the unstripped site from 6-min ( $0.22 \pm 0.18$  vs.  $0.18 \pm 0.14$ ;  $p = 0.03$ ) to the subsequent measures:  $0.78 \pm 0.20$  vs.  $0.66 \pm 0.18$  at 25-min,  $p = 0.006$ ;  $0.86 \pm 0.13$  vs.  $0.71 \pm 0.12$  at 55-min,  $p = 0.013$ ;  $0.91 \pm 0.14$  vs.  $0.77 \pm 0.17$  mg.min<sup>-1</sup>.cm<sup>2</sup> at 85-min,  $p = 0.022$ . SkBF and local Tsk at both sites remained stable over time after the initial 10 min of walking. Local SR was significantly correlated with SkBF ( $r = 0.741$  vs.  $r = 0.734$ ;  $p < 0.01$ ) and local Tsk ( $r = 0.609$  vs.  $r = 0.374$ ;  $p < 0.01$ ) at stripped and unstripped sites respectively. Similar results were observed for sweat [Na], [K], [Ca] and [Cl] between sites. To our knowledge this is the first investigation to report a relationship between the removal of stratum corneum and local SR. Local SR was ~14.3% higher at the stripped site compared with the unstripped site. This implies that the removal of stratum corneum has a significant effect in lowering the skin wettedness level with a reduction of water reabsorption into the skin. However, the removal of stratum corneum did not affect Tsk, SkBF measures and mineral concentrations. In conclusion, the removal of stratum corneum using a stripping method enhances local SR during exercise in hot and humid conditions. Candas, V. et al (1983). *Eur J Appl Physiol*. 50, 223-234. Randall W.C. & Peiss, C.N. (1957). *J. Invest Dermat*. 28, 435-441.

### PSEUDOEPHEDRINE AND ENDURANCE PERFORMANCE: A DOSE RESPONSE?

Pritchard-Peschek, K.1, Jenkins, D.1, Osborne, M.2, Slater, G.3, Taaffe, D.4

1: UQ (Brisbane, Australia), 2: QAS (Brisbane, Australia), 3: USC (Maroochydore, Australia), 4: UN (Ourimbah, Australia)

**Introduction** Previous research examining the influence of pseudoephedrine on exercise performance has found that ingesting doses  $\geq 180$  mg of pseudoephedrine elicits performance improvements of 5.1% in  $\sim 30$  min cycling time trials,<sup>1</sup> power output in a 30 s Wingate test by 2.8%,<sup>2</sup> and 1500 m run time by 5.8 s.<sup>3</sup> These findings collectively support the contention that only pseudoephedrine taken in doses of  $\geq 180$  mg is likely to improve exercise performance. The purpose of the present study was to examine a possible dose-response between pre-exercise pseudoephedrine intake and cycling time trial performance. **Methods** Ten trained male endurance cyclists ( $26.5 \pm 6.2$  years,  $75.1 \pm 5.9$  kg,  $70.6 \pm 6.8$  ml/kg/min) undertook three cycling time trials in which a fixed amount of work (7 kJ/kg body mass) was completed in the shortest possible time. Sixty minutes before the start of exercise, subjects orally ingested either 2.3 mg/kg or 2.8 mg/kg body mass of pseudoephedrine or a placebo in a randomized, double-blind manner. Following ingestion, subjects then consumed a standardized pre-exercise meal providing 2 g/kg body mass of carbohydrate. Venous blood was sampled at baseline, pre- and post-warm up and post-exercise for the analysis of pH and lactate, glucose, plasma catecholamine and plasma pseudoephedrine concentrations. **Results** Neither dose of 2.3 mg/kg nor 2.8 mg/kg body mass of pseudoephedrine significantly improved cycling time trial performance of  $\sim 30$  min duration. Plasma pseudoephedrine concentration increased from pre-warm up to post-exercise in both treatment conditions, with the 2.8 mg/kg body mass dose eliciting the highest concentration at both time points ( $p < 0.001$ ). There was large individual variation in plasma pseudoephedrine concentration both pre- and post-exercise between subjects following supplementation. **Discussion** The considerable variation in plasma pseudoephedrine was unexpected, and clearly indicates that a number of factors influence pseudoephedrine's uptake and appearance in the blood which are not yet fully understood. Peak plasma pseudoephedrine concentrations following pseudoephedrine supplementation also did not appear to coincide with the start of the performance trials. Combined with the differences in plasma pseudoephedrine between individuals, this may partially explain the lack of a performance benefit in the present study, and also the inconsistencies in performance following pseudoephedrine supplementation in previous investigations. **References** 1. Pritchard-Peschek K, Jenkins D, Osborne M, Slater G, Taaffe D. (2010). *Int J Sports Nutr Exerc Metab*, 20, 132-138. 2. Gill N, Shield A, Blazevich A, Zhou S, Weatherby R. (2000). *Br J Clin Pharma*, 50, 205-213. 3. Hodges K, Hancock S, Currell K, Hamilton B, Jeukendrup A. (2006). *Med Sci Sports Exerc*, 38, 329-333.

### THE EFFECT OF PHYSICAL INACTIVITY ON EXERCISE-INDUCED IL-6 RELEASE FROM THE LEG

Reihmane, D., Hansen, A.V., Gram, M., Olsen, A.B., Helge, J.W., Dela, F.

*University of Copenhagen*

**Introduction** Data on interleukin-6 (IL-6) release during acute exercise from working legs are not conclusive and lack information about the impact of training status. Some studies have shown an increase (Febbraio et al., 2003) whereas others report no changes (Steensberg et al., 2002) in IL-6 release during the first hour of exercise. In this study our aim was to investigate leg IL-6 release during moderate intensity exercise, and to test if there were differences in IL-6 release between an immobilized (IM) and a control (C) leg. **Methods** To examine our hypothesis, eleven healthy male subjects (age  $23 \pm 1$  (mean  $\pm$  SEM) yrs; BMI  $23.6 \pm 0.8$  kg m<sup>-2</sup>; VO<sub>2</sub>max  $43.2 \pm 1.2$  ml kg<sup>-1</sup> min<sup>-1</sup>) performed 45 min of two leg dynamic knee-extensor exercise (absolute leg workload  $18.1 \pm 0.6$  watts; relative workload for C  $52 \pm 3\%$ , for IM  $62 \pm 5\%$  of the leg maximal workload) after wearing a donjoy cast for 14 days. Arterial (A) and femoral venous blood samples from C and IM legs were collected every 15 minutes during exercise. Femoral blood flow was measured by ultrasound Doppler. **Results** There was an increase in average arterial plasma IL-6 concentrations during exercise comparing pre- and post-exercise levels (A:  $1.1 \pm 0.1$  vs.  $3.0 \pm 0.3$  pg ml<sup>-1</sup>, respectively,  $P < 0.05$ ). The IL-6 release was increased from rest to after 15 min of the exercise in both legs (C:  $0.35 \pm 0.10$  vs.  $0.73 \pm 0.03$  ng min<sup>-1</sup>; IM:  $0.38 \pm 0.07$  vs.  $0.79 \pm 0.17$  ng min<sup>-1</sup>; rest and exercise, respectively,  $P < 0.05$ ) where after it remained constant until the end of exercise. The IL-6 release did not differ between C and IM leg during rest or exercise. **Discussion** The present study for the first time shows that the immobilization for 14 days had no effect on leg IL-6 release during submaximal exercise. The immobilization resulted in a higher relative workload for IM leg, but this did not lead to an intensity induced increase in leg IL-6 release (Helge et al., 2003). In agreement with a prior study (Febbraio et al., 2003) leg IL-6 release was increased already 15 min after onset of exercise with this experimental model. **Reference List** Febbraio MA, Steensberg A, Starkie RL, McConnell GK & Kingwell BA (2003). *Metabolism* 52, 939-944. Helge JW, Stallknecht B, Pedersen BK, Galbo H, Kiens B & Richter EA (2003). *J Physiol* 546, 299-305. Steensberg A, Keller C, Starkie RL, Osada T, Febbraio MA & Pedersen BK (2002). *Am J Physiol Endocrinol Metab* 283, E1272-E1278.

### THERMAL AND PERCEPTUAL RESPONSES INDUCED BY ROWING IN COLD AND MODERATELY WARM CONDITIONS

Fournet, D.1,2, Williams, M.1, Redortier, B.2, Havenith, G.1

1. *Environmental Ergonomics Research Centre (Loughborough University, UK)* 2. *Oxylane Research (Villeneuve d'Ascq, France)*

**Introduction** The range of environmental conditions in which athletes are expected to perform may vary greatly between seasons. Though a multitude of studies have looked at cycling and running in this context, no investigations have focused on the influence of low temperatures on perceived exertion and thermal responses during rowing, an exercise type using different muscle groups. The aim of this study was therefore to evaluate the thermal strain associated with a fixed rowing exercise at two ambient conditions (10 and 20°C). **Methods** Eight active males exercised minimally clothed on a rowing ergometer at 55%VO<sub>2</sub>max in a cold (C) and moderately warm (W) environment. Rectal temperature and heart rate were monitored throughout the protocol. Skin temperature (T<sub>sk</sub>) was recorded by whole-body infrared thermography before and after 40 minutes of rowing (T40). A bodymapping technique was used to obtain population-averaged T<sub>sk</sub> maps (Fournet et al. 2011). Thermal sensation was assessed at each stage as well as rating of perceived exertion (RPE) using the 6-20 Borg scale. Sweat loss was calculated from body mass loss and water intake. Body fat percentage was deduced from skinfold thickness (7 sites). **Results** Rectal temperature and heart rate were similar in the C and W conditions. Sweat loss was significantly higher in W compared to C ( $225 \pm 88$  vs  $126 \pm 29$  g/m<sup>2</sup>/h,  $p < 0.01$ ). Mean T<sub>sk</sub> and local T<sub>sk</sub> were consistently higher in W (4°C on average) while the range of T<sub>sk</sub> over the body was larger in C. Interestingly, T<sub>sk</sub> body maps revealed similar patterns of T<sub>sk</sub> distribution in C and W with warmer upper back and arms than other segments. Only in C, significant correlations were found between mean T<sub>sk</sub> and BF% ( $r = -0.86$ ), local T<sub>sk</sub> and local skinfold thickness. Thermal sensation was warmer in W and RPE-T40 reached a higher value in W ( $12.0 \pm 1.2$  vs  $11.0 \pm 1.1$ ,  $p < 0.05$ ). **Discussion** At the same workload, the effort perception was less intense in C than W. This was associated with the same core temperature dynamics but a 4°C colder mean T<sub>sk</sub> in C, inducing a "slightly cool" sensation. This contribution of peripheral (vs central) inputs to RPE has also been shown elsewhere (Maw et al. 1993). Evaporative sweat loss contributed more to temperature

regulation in W compared to a larger dry heat loss (skin-air temperature gradient) in C. Larger local insulation provided by body fat directly influenced Tsk only in C where vasoconstriction was more pronounced. Rowing-specific patterns of whole-body Tsk distribution were produced for the first time which highlighted warmer Tsk over the rowing-specific active muscles. References Fournet D et al. (2011) ECSS Proceedings: 132 Maw JG et al. (1993) Eur J Appl Physiol 67:174-179

### EFFECT OF TRAINING SURFACE ON ACUTE PHYSIOLOGICAL RESPONSES FOLLOWING INTERVAL TRAINING

Binnie, M., Peeling, P., Pinnington, H., Landers, G., Dawson, B.

*University of Western Australia*

This study compared the effect of sand and grass training surfaces during a common pre-season interval training session in well-trained team sport athletes (n=10). Participants initially completed a preliminary testing session to gather baseline (BASE) performance data for vertical jump (VJ), repeated sprint ability (RSA) and a 3 km running time trial (RTT). Three days subsequent to BASE, all athletes completed the first interval training session, which was followed by a repeat of the BASE performance tests the following day (24 h post-exercise). Seven days later, the same interval training session was completed on the opposing surface, and was again followed 24 h later by the BASE performance tests. During each session, blood lactate (BLa), ratings of perceived exertion (RPE) and heart rate (HR) were recorded. Additionally, venous blood was collected pre-, post-, and 24 h post-exercise, and analysed for serum concentrations of Myoglobin (Mb), Creatine Kinase (CK), Haptoglobin (HP) and C-Reactive Protein (CRP). Results showed significantly higher BLa and HR responses experienced during the SAND session ( $p < 0.05$ ), with no differences observed between surfaces for the blood markers of muscle damage, inflammation and hemolysis ( $p > 0.05$ ). Twenty-four hours later, the RTT was performed significantly faster following the SAND session compared to GRASS ( $p = 0.001$ ). These results suggest that performing interval training on a sand (versus grass) surface can result in a greater physiological response, and less decrement in next day endurance performance.

### WEARING AN ICE VEST IMPROVES CYCLING CAPACITY IN THE HEAT

Cuttell, S., Victor, K., Tyler, C.

*Moulton College, Roehampton University.*

Institutions: 1 Moulton College, Moulton, NN3 7RR, UK. 2 Roehampton University, Whitelands College, Holybourne Avenue, London, SW15 4JD, UK. Introduction: Increased core body temperatures are widely accepted as a limitation of exercising in the heat (Armstrong et al., 1995). Interventions such as acclimation and cooling have been shown to attenuate the reduction in exercise performance and capacity observed. Most of the literature has focused on pre-cooling; however, such approaches are often impractical. Practical cooling of the neck during exercise has been shown to enhance running capacity in the heat (Tyler and Sunderland, 2011) but the torso covers a much larger area of the body's surface and so theoretically may be a more effective site to cool than the neck. The aim of study was to investigate the effects of ice vest cooling on cycling capacity in the heat. Methods: Twelve untrained, healthy, unacclimatised males ( $24 \pm 3.7$  years,  $83.1 \pm 12.1$  kg mass,  $1.82 \pm 0.08$  cm stature) completed an incremental cycle test to determine maximum power output ( $W_{max}$ :  $240 \pm 25$  W). Following this test and a full familiarisation participants completed two experimental cycle capacity tests; one with (VC) and one without (CG) an ice vest. During the familiarisation and main trials the participants cycled in a hot environment ( $35.0 \pm 0.1^\circ\text{C}$ ;  $50 \pm 1\%$  rh) to volitional exhaustion at 60%  $W_{max}$ . Physiological (HR, body mass, rectal and skin temp) and perceptual (RPE, feeling scale, thermal sensation of torso and skin) variables were measured at 5 minute intervals. Significance was set at the  $P < 0.05$  level. Results: Mean cycling capacity was longer in VC ( $28.91 \pm 10.48$  min) compared to CG ( $23.54 \pm 8.86$  min) ( $P = .024$ ;  $d = 0.46$ ). There was a significant difference between trials and temperature at the torso (CG:  $36.26 \pm .80$   $^\circ\text{C}$ ; VC:  $31.15 \pm 1.50$   $^\circ\text{C}$ ;  $P = .001$   $d = 3.63$ ). There was no effect between any other physiological variables ( $p = 0.05$ ). There was a significant difference between CG and IV for skin temperature at the torso (CG:  $36.26 \pm .80$   $^\circ\text{C}$ ; IV:  $31.15 \pm 1.50$   $^\circ\text{C}$ ;  $P = 0.01$ ) and thermal sensation of the torso (CG:  $6.74 \pm .992$ ; IV:  $4.62 \pm .881$ ;  $P = 0.001$ ). Other perceptual variables reported no significant differences between conditions CG and IV ( $p = 0.05$ ). Discussion: The present study indicates that the use of an ice vest can have a beneficial effect while exercising in the heat. Cardiovascular measures appear not to be effected, thus the study points towards thermal sensation of the torso having sufficient effect to enhance performance in the heat. Reference Armstrong, L, Maresh, C, Riebe, D, Kenefick, R, Castellani, J, Senk, J, Echegaray, M and Foley, M (1995) Med Sci Sports Exercise, 27 (2), 211 – 216. Tyler CJ, Sunderland C (2011). Journal of Athletic Training, 46(1):61-68.

### REDUCTION IN THERMAL SENSITIVITY TO COLD DURING EXERCISE AND POST-EXERCISE RECOVERY

Ouzzahra, Y.1, Havenith, G.1, Redortier, B.2, Voelcker, T.2

*(1) Loughborough University; (2) Oxylane Research (FRANCE)*

Introduction A low skin temperature (Tsk) at the onset of exercise has been shown to improve performance (Schlader et al., 2011). Pre-exercise skin cooling is however limited by cold and uncomfortable perceptions resulting from a reduced Tsk. According to the concept of thermal alliesthesia (Cabanac, 1972), light exercise during skin cooling may improve thermal comfort associated with a low Tsk. Therefore, the aim of the present study was to compare thermal sensation and thermal comfort before, during, and after exercise, while cooling the skin in one body segment. Methods Using a customised liquid cooling garment, the whole chest of eight male participants ( $22.0 \pm 3.6$  y;  $181.8 \pm 2.3$  cm;  $78.3 \pm 5.7$  kg) was continuously cooled during three consecutive conditions: 30 min rest, 15 min exercise (cycling at 30%  $\text{VO}_2\text{max}$ ) and 15 min post-exercise recovery. Thermal sensation from 0 ("neutral") to -10 ("extremely cold") and thermal comfort from +5 (very comfortable) to -5 (very uncomfortable) were scored at 5 min intervals. Core temperature ( $T_c$ ) and chest Tsk (4 sites) were recorded throughout the experiment. Results Cooling caused a chest mean Tsk decrease from  $33.0 \pm 0.6^\circ\text{C}$  to  $28.1 \pm 0.9^\circ\text{C}$  in the resting period, resulting in a local thermal sensation of  $-6.9 \pm 1.6$  and a local thermal comfort of  $-3.4 \pm 1.1$ . Despite a further decrease in Tsk to  $27.8 \pm 0.9^\circ\text{C}$  during the exercise period, thermal sensation and thermal comfort both increased, respectively to  $-1.8 \pm 1.8$  ( $p < 0.05$ ) and  $1.0 \pm 2.1$  ( $p < 0.05$ ). This was accompanied by a minimal increase in  $T_c$  ( $0.1 \pm 0.1^\circ\text{C}$ ). During the recovery period, Tsk further decreased to  $26.6 \pm 1.0^\circ\text{C}$ , while thermal sensation and thermal comfort decreased to  $-4.9 \pm 1.1$  ( $p < 0.05$ ) and  $-2.0 \pm 0.9$  ( $p < 0.05$ ), respectively. Discussion The improvement in thermal comfort is in line with the concept of thermal alliesthesia. However, the mechanisms behind the decrease in thermal cold sensation despite a lower Tsk remain unclear, but may be related to the activation of stress-induced analgesia during exercise (Koltyn, 2000). The present results suggest the possibility of reducing discomfort and cold sensation by the incorporation of light exercise in pre-performance cooling strategies. References Cabanac, M., Massonnet, B., Belaiche, R. (1972) Preferred skin temperature as a function of internal and mean skin temperature. J Appl Physiol, 33:699-703. Koltyn, K.F. (2000) Analgesia following exercise, a review.

Sports Med, 29(2):85-98. Schlader, Z.J., So, pms, S.E., Stannard, S.R., Mundel, T. (2011) Skin temperature as a thermal controller of exercise intensity. Eur J Appl Physiol, 111:1631-1639.

## 14:45 - 15:45

### Poster presentations

#### PP-PM10 Physiology 2

##### **THE EFFECT OF TWO WEEKS OF IMMOBILIZATION AND 6 WEEKS OF SUBSEQUENT AEROBIC TRAINING ON MITOCHONDRIAL RESPIRATION IN YOUNG HEALTHY MEN**

Gram, M., Hansen, A.V., Olsen, A.B., Reihmane, D., Helge, J.W., Dela, F., Hey-Mogensen, M.

*Faculty of Health Sciences*

**Introduction** Mitochondrial dysfunction has been related to lifestyle conditions such as obesity and type-2 diabetes. It is well known that these conditions are strongly affected by physical inactivity. Even so there is limited information on the effect of physical inactivity on mitochondrial function in human subjects. Thus, the aim of the present study is to investigate whether 2 weeks of unilateral immobilization and 6 weeks of aerobic retraining affect mitochondrial respiration in young healthy men. Also, we wanted to investigate if the inactive or trained state affects the mitochondrial ability to respond to acute exercise. **Methods** We recruited 12 young healthy recreationally active males. Subjects had one leg randomly immobilized with a DonJoy knee brace for 2 weeks. After the immobilization period subjects performed 6 weeks of supervised cycle ergometer training (20 sessions of 55 min). After immobilization and after the retraining period, subjects performed acute exercise for 45 min on a kicking ergometer. Muscle biopsies were taken before and after immobilization and after the retraining period, and before and after acute exercise in the immobilized and retrained state. Mitochondrial function was determined as respiration in saponin-permeabilized muscle fibers. Furthermore maximal voluntary contraction; VO<sub>2</sub>max and leg lean mass were measured. **Results** Maximal voluntary contraction and leg lean mass decreased from baseline to immobilization and increased to baseline again after retraining in the immobilized leg with no change in the control leg. VO<sub>2</sub>max was reduced after immobilization and was significantly higher than basal level after retraining. Immobilization resulted in a significant decrease in the ratio between succinate and glutamate supported respiration. This ratio returned to basal values after retraining. Furthermore, retraining caused an increase in succinate supported respiration and State 4<sub>o</sub>. Acute exercise resulted in a decreased state 2 and antimycin A inhibited respiration in the non-immobilized leg with no change in the immobilized leg. **Discussion** The major finding of the present study was that immobilization caused intrinsic changes in mitochondrial function, shown as a significant decrease in the substrate control ratio (succinate vs. glutamate supported respiration). Acute exercise altered the mitochondrial function in the control leg but this was not present in the immobilized leg. Based on these results we hypothesize that the acute exercise induced increase in oxidative stress, caused a mitochondrial adaptation resulting in a lower mitochondrial free radical production in the control leg; an adaptation which was blunted in the immobilized leg.

##### **INFLUENCE OF LOCALISED COOLING ON MUSCLE OXYGENATION AND BLOOD VOLUME CHANGES FOLLOWING INTENSE EXERCISE**

Ihsan, M., Abbiss, C.R., Lipski, M., Watson, G.

*Edith Cowan University*

**INFLUENCE OF LOCALISED COOLING ON MUSCLE OXYGENATION AND BLOOD VOLUME CHANGES FOLLOWING INTENSE EXERCISE** Ihsan, M.1, Abbiss, C.R.1, Lipski, M.2, Watson, G.1,3. 1: ECU (Joondalup, Australia), 2: GSU (Cologne, Germany), 3: UTAS (Tasmania, Australia) **Introduction** Post exercise cold water immersion (CWI) may enhance the rate of recovery following endurance exercise (Vaile et al., 2008). However, vasoconstriction induced by cooling is likely to suppress local blood flow and oxygen (O<sub>2</sub>) supply. We are currently unaware of any study that has examined changes in tissue oxygenation and blood volume during post-exercise CWI. Therefore, the purpose of this study was to investigate the effect of post exercise CWI on tissue oxygenation and blood volume changes. **Methods** Nine physically active males performed 30 min of continuous running (CR) at 70% of their maximal aerobic running speed (MAS), followed by 10 bouts of intermittent running (INT) at 100% of MAS. Following exercise, one of the participants' limbs was immersed in a cold water bath (10°C; COOL) to the level of their gluteal fold for 15 min. The contra-lateral remained outside the water bath and served as a control (CON). Vastus lateralis (VL) skin temperature (T<sub>sk-VL</sub>), VL tissue oxygenation (tissue oxygenation index, TOI) and blood volume changes (total haemoglobin volume, tHb = oxygenated Hb (O<sub>2</sub>Hb) + de-oxygenated Hb (HHb)) were monitored continuously throughout exercise and CWI using near infrared spectroscopy (NIRS). **Results** T<sub>sk-VL</sub>, TOI and tHb parameters were not significantly different between CON and COOL during CR and INT respectively. In contrast, T<sub>sk-VL</sub> was significantly lower in COOL compared to CON throughout CWI with peak differences occurring at the end of CWI (CON: 35.1 ± 0.6 vs COOL: 16.9 ± 1.7°C). Beyond 3 minutes of cooling, tHb was significantly lower during COOL compared with CON, with peak differences of ~ 20% evident at the end of the 15 min CWI. TOI was significantly higher in COOL, compared with CON, with peak differences of ~ 21% evident at the 12th min of CWI. Compared with pre-immersion values, TOI was higher throughout the CWI in the COOL condition however, at the end of CWI, TOI in CON was not significantly different from pre-immersion values. **Discussion** Post exercise elevations in muscle blood flow and O<sub>2</sub> consumption facilitates recovery by replenishing muscle O<sub>2</sub> stores and facilitating glycogen resynthesis (Tuominen et al., 1997). The present data indicates that blood supply (tHb) and muscle O<sub>2</sub> demand are lower following CWI and as such may be detrimental to the initial recovery process. **References** Vaile J, Halson S, Gill N, Dawson B. (2008). Int J Sports Med, 29(7), 539-544. Tuominen J A, Peltonen J E, Koivisto V A. (1997). Med Sci Sports Exerc, 29(7), 874-881.

##### **EFFECT OF PRECOOLING AND ACCLIMATION ON REPEAT SPRINT PERFORMANCE IN HEAT**

Brade, C., Dawson, B., Wallman, K.

*University of Western Australia*

**Introduction** To reduce the potential negative effects of heat on exercise performance, practises such as acclimation and the more acute method of precooling have both been used and reported to enhance performance. Acclimation is likely the more powerful of the two

methods, but it has yet to be established whether an acclimated individual would perform better if precooling was also done. Therefore, the aim of this study was to determine if precooling would have an additive effect on performance of an acclimated individual during repeat sprint exercise in the heat. Methods Ten physically active males completed three experimental trials; a Pre Acclimation (Pre Acc) trial and two post acclimation trials, one with precooling (Post Acc + PC) and another without (Post Acc). These trials consisted of a 30 min baseline period followed by a 70 min repeat sprint cycling protocol performed in the heat (~35.0°C and 60% RH) comprising 2 x 30 min periods of exercise and a 10 min half time period. Each half comprised 30 x 4 s maximal sprints interspersed with exercise at varying intensities. Precooling (ice slushy and cooling jacket) was administered during the baseline and half time periods. Separating the pre and post trials were five acclimation sessions (spread over 10 days) involving repeated (increasing from 8 to 12 by the last session) 3 min cycling efforts performed at 80% maximum power output with 1 min of passive rest between. Physiological measures included core (TC) and mean skin temperature (TSk), heart rate (HR), sweat loss, rating of perceived (RPE) exertion and thermal sensation (TS). Performance measures obtained were peak and mean power and work done. Results Moderate effect sizes suggested a greater amount of work per kg BM ( $J \cdot kg^{-1}$ ) was done in Post Acc (1st Half,  $1606 \pm 102$ ; 2nd Half,  $1605 \pm 71$ ) compared to Pre Acc (1st Half,  $1533 \pm 153$ ; 2nd Half,  $1538 \pm 109$ ). Furthermore, several (possible, likely and very likely) smallest worthwhile effects were found between these conditions, suggesting benefits in Post Acc. Post Acc + PC performance was not different to either Pre Acc or Post Acc. Moderate to strong effect sizes also suggested lower TC (0.2-0.3°C) in the Post Acc + PC and Post Acc compared to the Pre Acc, particularly over the second half of exercise. Sweat Loss was significantly higher ( $p < 0.05$ : 23.1%) in Post Acc + PC compared to the other two conditions. No significant differences were observed for TSk, HR, RPE or TS. Discussion Here, a short term (partial) heat acclimation protocol was beneficial for repeat sprint performance in the heat. Greater improvement may have been seen if full acclimation was undertaken. In addition, no further enhancement of performance was seen as a result of acclimated individuals precooling prior to performance, but this did produce a higher sweat loss.

### BEVERAGE TEMPERATURE, MUSCLE ACTIVATION AND FATIGUE AT ELEVATED CORE BODY TEMPERATURES

Burdon, C.1, Schmidt, C.1, Johnson, N.1, Chapman, P.2, O'Connor, H.1

1 USyd (Sydney, Australia), 2: ACU (Sydney, Australia).

Introduction: Cold receptor stimulation (through the use of ice slushy, menthol or cold neck collar) has recently been shown to elicit performance benefits during exercise tests in the heat [1, 2, 3]. However the contribution of peripheral and central fatigue reduction to this benefit is unclear. This study aimed to measure the effect of ice slushy versus thermoneutral beverage ingestion on maximal voluntary isometric contraction (MVIC) performance using active and inactive muscles and to measure peripheral and central fatigue at elevated core body temperatures. Method: Eight active participants (5M, 3F) performed three 45s MVICs of the elbow flexors and knee extensors in a reclined position (hips, knees & elbow at 90°) at ~37.5°C, 38.5°C and 39.5°C. Two carbon rubber electrodes were placed over the quadriceps and biceps brachii for percutaneous electrical muscle stimulation 5s before and at 15, 30 and 44s during the MVIC. To increase rectal temperature ( $T_r$ ) participants cycled in 40°C and 50% relative humidity at 60% Work Max. Immediately prior to each MVIC, participants consumed 50g of ice slushy (-1°C, ICE) or thermoneutral drink (38°C, CON) made from 7.4% carbohydrate beverage. Participants consumed water (19°C) during exercise to maintain body mass. Maximal force production ( $F_{max}$ ) was established at a familiarisation trial using 3s MVICs. Results: Participants cycled for  $22 \pm 5$  and  $20 \pm 7$  min to reach 38.5°C and 39.5°C respectively. Weight change was minimal (~400g) but similar between ICE and CON ( $p = 0.24$ ). Quadriceps mean force decreased from  $302 \pm 180$ N to  $232 \pm 151$ N at 39.5°C ( $p < 0.001$ ). Quadriceps % $F_{max}$  decreased at high  $T_r$  ( $14.6 \pm 13.1\%$ ,  $p = 0.05$ ). Quadriceps peripheral fatigue increased by  $4.0 \pm 7.6\%$  ( $p = 0.02$ ) and central fatigue increased by  $10.6 \pm 11.7\%$  ( $p = 0.06$ ) when  $T_r$  was elevated to 39.5°C. Biceps mean force decreased from  $179 \pm 67$ N to  $148 \pm 65$ N at 39.5°C ( $p < 0.001$ ). Peripheral and central fatigue were not significantly increased at 39.5°C ( $6.9 \pm 8.3\%$   $p = 0.92$  &  $1.9 \pm 22.3\%$   $p = 0.17$  respectively). No variable was significantly different between ICE and CON trials. Discussion: The MVIC caused significant peripheral and central fatigue and mean force output decreased with elevated  $T_r$  for both muscle groups. However, only the active (quadriceps) (not inactive biceps) showed decreased  $F_{max}$  when  $T_r$  was elevated. Therefore, increases in peripheral and central fatigue with elevated  $T_r$  was observed only with the active muscle group. Ice slushy ingestion failed to ameliorate the possibly overwhelming effect of heat on central fatigue and muscle force production. References: 1 Siegel, R, et al. (2011). *Eur J Appl Physiol*: 111(10): 2517-24. 2 Mundel, T, et al. (2010). *Eur J Appl Physiol*, 109(1): 59-65. 3 Tyler, CJ, et al. (2011). *J Athlet Train* 46(1): 61-8.

### ONE HOUR VARIABLE POWER CYCLING IMPAIRS SUBSEQUENT RUN PERFORMANCE

Etzebarria, N.

Loughborough University - University of Canberra

Etzebarria, N.1,2, Anson, JM.2, Pyne, DB.2,3 and Ferguson, RA.1 1: Loughborough University, UK, 2: University of Canberra, Australia, 3: Australian Institute of Sport, Australia. Introduction The cycle section in triathlon is influenced by race tactics, terrain and course-technicality often resulting in a pattern of highly variable power output. The extent to which these factors affect the subsequent running performance is unclear. We aimed to determine how a 1 h triathlon-specific cycling trial (with a highly variable power distribution) affects subsequent run performance and how an individual's cycling power profile relates to any decrement in run performance after variable power cycling. Methods After ethical approval was obtained, twelve well-trained male triathletes (age  $28 \pm 5$  y; peak  $4.9 \pm 0.5$  L.min<sup>-1</sup>; body mass  $73.5 \pm 7.7$  kg, mean  $\pm$  SD) performed an initial incremental cycle ergometer test to determine their maximal aerobic power (MAP). Subjects also completed a series of six maximal effort cycling intervals (6 s, 15 s, 30 s, 1 min, 4 min, and 10 min) to establish their power/duration relationship (power profile). Subsequently, each subject performed two experimental 1 h cycle-run trials on different days at either triathlon-specific variable (VAR) or constant (CON) power (both equivalent to 65% of MAP) followed by a 9.3 km run at race-pace (four laps of a road course). Subjects also completed a control 9.3 km run with no preceding exercise (NO-EX). Blood lactate (BLa), rating of perceived exertion (RPE) and heart rate (HR) were measured at 20, 40 and 60 min during the cycle trials. The split and total times for the 9.3 km run were also recorded. Results The overall 9.3 km run time was substantially slower ( $42 \pm 37$  s, mean  $\pm$  90% confidence limits (CL); standardised difference  $0.21 \pm 0.19$ ) after VAR ( $35:39 \pm 3:19$  min:s, mean  $\pm$  SD) compared with CON ( $34:57 \pm 2:50$  min:s). The decrement after VAR appeared primarily in the early stages of the run ( $35 \pm 20$  s, mean  $\pm$  90% CL slower after 2 laps). Both runs after the cycle exercise were substantially slower than NO-EX ( $33:49 \pm 2:33$  min:s). During the 1 h cycling mean BLa ( $8.2 \pm 2.6$  vs.  $3.3 \pm 1.5$  mM), HR ( $159 \pm 15$  vs.  $155 \pm 13$  bpm) and RPE ( $6.9 \pm 1.1$  vs.  $6.2 \pm 1.5$  units) were substantially higher after VAR compared with CON. Subjects with higher peak power output during the 6 and 15 s efforts, and higher mean power in the 1 and 4 min efforts, had the lowest reduction ( $0.32-0.39 \pm \sim 0.45$ ,  $r$ -value  $\pm$  90% CL) in run time after VAR. Discussion Cycling courses with a variable power profile are likely to result in an impaired ability to maintain performance during a subsequent run. Triathletes should aim to improve short-term peak power and medium length

mean power to minimise the impact of variable power cycling, and limit the decrease in running ability during the early stages of the subsequent run at race-pace.

### THE EFFECT OF PACING STRATEGY ON MUSCLE FATIGUE AND TECHNIQUE IN 1500M SPEED SKATING AND CYCLING

Stoter, I.K.1, MacIntosh, B.R.3, Fletcher, J.R.3, Pootz, S.3, Zijdewind, I.2, Hettinga, F.J.1

*University of Groningen*

The effect of pacing strategy on muscle fatigue and technique in 1500m speed skating and cycling Stoter, I.K. (1), MacIntosh B.R. (3), Fletcher J.R. (3), Pootz S. (3), Zijdewind I. (2) and Hettinga F.J. (1) 1) Center of Human Movement Sciences 2) Department of Neuroscience, University Medical Center of the University of Groningen, the Netherlands 3) Human Performance Laboratory, Faculty of Kinesiology, University of Calgary, Calgary, Canada Objective Theoretically, faster end times are expected when performing a fast start in a 1500m time trial in speed skating as well as in cycling. In practice this appears to be particularly true in cycling, but not as much in speed skating. A variable crouched position requiring isometric contraction distinguishes speed skating from cycling and may impact optimal pacing strategy. This study investigates differences in pacing strategy between speed skating and cycling when a faster start is instructed and whether these differences can be explained by underlying mechanisms of fatigue and technique. Method Nine well trained male speed skaters and nine well trained male cyclists performed two 1500m time trials in their sport of expertise. Athletes were instructed to start faster (FS) or slower (SS) than they were accustomed to. Velocity (V) per 100m was measured during each trial. Before and after the trial, maximal voluntary contraction (MVC), voluntary activation (VA) and rest twitch (RT) were measured to get insight into the central and peripheral contribution to muscle fatigue. Knee and trunk angles per 200m were measured in speed skating only to track changes in technique and aerodynamics. Results The SS trials showed similar pacing strategies in both sports. In the FS trials cyclists performed a more explosive 300m-start (V-mean 45.68 km/h, SD 3.30) than speed skaters (V-mean 42.31 km/h, SD 1.18) resulting in different pacing patterns. Though these starts were indeed faster than the instructed slower starts no difference in end times was found within sports. Both sports showed a significant decrease in MVC (12.6%) and RT (27.4%), but only cycling showed a decrease in VA (5.4%). In speed skating, knee angles were similar in both trials, but higher trunk angles were found in the FS trial. Conclusion Similar pacing instructions resulted in different pacing strategies in the FS trial of both sports. Cyclists start faster, resulting in central and peripheral contribution to muscle fatigue, where in speed skating peripheral contribution seems to be dominant. Speed skaters seem to attribute part of their energy resources to maintain knee angles and thereby their technical ability. This might be the cause of the different pacing strategies in speed skating and in cycling and might afford interesting possibilities to study regulation systems. References 1) Hettinga, F. J. et al. (2012). *Br J Sports Med*, 46(1), 30-35. 2) Hettinga, F. J. et al. (2011). *Br J Sports Med*, 45(1), 30-35.

### ORAL CONTRACEPTION AND ENERGY INTAKE IN WOMEN: IMPACT ON SUBSTRATE OXIDATION DURING EXERCISE

Isacco, L., Thivel, D., Meddahi Pelle, A., Zouhal, H., Duclos, M., Duche, P., Boisseau, N.

*Blaise Pascal University*

Oral contraception and energy intake in women: impact on substrate oxidation during exercise Isacco L1, Thivel D1, Meddahi Pelle A2, Zouhal H3, Duclos M4, Duche P1, Boisseau N1 1: University Blaise Pascal (Clermont-Ferrand, France), 2: INSERM unit (Paris, France), 3: Rennes University (Rennes, France), 4: Auvergne University, INRA, CHU (Clermont-Ferrand, France). Introduction Separately, oral contraception (OC) and energy intake (EI) may play a role in fuel selection during exercise in women (Bonen et al., 1991; Bemben et al., 1992; Jeukendrup et al., 2003). However no study dealt with the potential interaction of OC and EI in women during exercise. The aim of this study was to investigate the effect of OC in fed and fast conditions on substrate oxidation, metabolic and hormonal responses in normal weight women during exercise. Methods Substrate oxidation (Respiratory Exchange Ratio, fat and carbohydrate oxidation rates), metabolic (glycerol, free fatty acids, glucose) and hormonal (insulin, adrenaline and noradrenaline) responses were determined in 21 women: 10 regularly menstruating women (OC-) and 11 women using OC (OC+: low dose monophasic pill; ethinyl estradiol  $\leq 30 \mu\text{g}$ ) during a 45min exercise (65% of  $\text{VO}_2\text{max}$ ) in fast and postprandial states. Results At rest, OC+ women presented higher LDL-C, total cholesterol and triglyceride concentrations as compared to OC- ones. OC status had no influence on substrate oxidation, metabolic and hormonal responses during exercise. In fast state, whatever the OC status, women exhibited greater reliance on fat than in postprandial condition. This occurred in presence of lower plasma insulin concentrations and higher plasma FFA and glycerol levels. Discussion The results indicated that the use of low dose monophasic OC did not modify fuel selection, metabolic and hormonal responses to exercise in women. Bonen et al. (1991) found an increase in CHO oxidation during exercise in OC- as compared to OC+, and Casazza et al. underlined an increase in lipid mobilization in OC+ subjects. These discrepancies between our study and those results may arise from different protocol designs, OC formulations and exercise modalities. Fast condition, compared to fed one, decreased CHO oxidation during exercise leading to a greater lipid mobilization and utilization whatever the OC status. Thus, in women, fed or fast condition had a greater impact on substrate oxidation during exercise than OC status. This study also showed that regarding basal lipid profile, OC+ presented an higher atherogenic profile than OC-. A prospective study comparing pre and post treatment in a same female group could allow us to conclude to OC effects on lipid and glycaemic profiles. References Bonen A, Haynes F, Graham T. (1991). *JAP*, 70, 1917-1927. Bemben D, Boileau, R, Bahr J, Nelson R, Misner J. (1992) *MSSE* 24, 434-441. Casazza G, Jacobs K, Suh S, Miller B, Horning M, Brooks G. (2004) *JAP*, 97, 302-309. Jeukendrup A. (2003) *Biochem Soc Trans*, 31, 1270-1273.

### PHYSIOLOGICAL AND BIOMECHANICAL DIFFERENCES IN NORTH AFRICAN AND EUROPEAN HIGH LEVEL ENDURANCE RUNNERS AT DIFFERENT VELOCITIES

Santos-Concejero, J.1,2, Granados, C.1, Irazusta, J.2, Bidaurrazaga-Letona, I.1, Zabala-Lili, J.1, Gil, S.M.1

*University of the Basque Country*

Introduction Studies aimed at clarifying the superior performance of African runners have only been undertaken on athletes of East and South African origin (1, 2). The physiological responses to exercise in North African athletes remain poorly understood; therefore, the purpose of the current study was to investigate the physiological responses in North African and European Caucasian runners at different velocities. Methods Eight North African ( $29.9 \pm 6.6$  years and  $31.2 \pm 1.1$  min 10-km race time) and fourteen European ( $27.8 \pm 6.4$  years and  $31.7 \pm 1.4$  min) middle- and long-distance high level runners participated in this study. All subjects completed a maximal incremental running test at 1% slope on a treadmill, starting at 9 km/h without previous warm up. The velocity increased by 1.5 km/h every 4 minutes until exhaustion, with 1 minute of recovery between stages. During the test, physiological and biomechanical parameters and rating of perceived exertion (RPE) were assessed. Results North African runners presented lower values in the respiratory exchange ratio at 16.5

km/h and 18 km/h and also a lower RPE at 18 km/h ( $P < 0.05$ ). However, European runners showed a lower oxygen uptake and a higher propulsive subphase during the stance phase of the gait cycle at 19.5 km/h ( $P < 0.05$ ). Discussion The present study provides evidence that North African athletes have an enhanced fat oxidation capacity and a lower perceived exertion compared to European runners, which implies an advantage for long distance running (2, 3). On the other hand, European athletes displayed a lower energy cost of running probably due to their better biomechanical running pattern. Thus, the observed differences would be compensated, explaining why both groups were of the same athletic level despite the observed physiological and psychological advantages of North African runners. References 1. Saltin B, Kim CK, Terrados N, Larsen H, Svendsen J, Rolf CJ. Morphology, enzyme activities and buffer capacity in leg muscles of Kenyan and Scandinavian runners. *Scand J Med Sci Sports*. 5(4): 222-230, 1995. 2. Weston AR, Mbambo Z, Myburgh KH. Running economy of African and Caucasian distance runners. *Med Sci Sports Exerc*. 32: 1130-1134, 2000. 3. Baker J, Horton S. East African running dominance revisited: a role for stereotype threat?. *Br J Sports Med*. 37: 553-555, 2003. Acknowledgments This study has been supported by the Basque Government Scholarship to JS (BF108.51) and by the Department of Physical Education and Sport, University of the Basque Country, UPV/EHU.

### **GENDER DIFFERENCES IN MAXIMAL STRENGTH IMPROVEMENT AND MUSCLE FIBER CHARACTERISTICS AFTER 8 WEEKS OF RESISTANCE TRAINING.**

Moro, T., Pacelli, F.Q., Toniolo, L., Canato, M., Cancellara, P., Miotti, D., Reggiani, C., Paoli, A.

*University of Padova*

Introduction It is well known that heavy resistance training (RT) promotes skeletal muscle hypertrophy (Andersen & Aagaard 2010). In particular, some studies have shown that this kind of training tends to decrease the expression of MHC IIx and MHC I and, at the same time, increase the expression of MHC IIa. But gender differences in such kind of changes are not known. The aim of this study was to analyse the differences in gender response after two months of RT. Furthermore, we wanted to compare the changes in latissimus dorsi muscle fibres characteristics with the mechanical measurement of fibres. Methods Eighteen healthy volunteers participated in 8-week progressive resistance training for upper limbs muscles. One repetition maximal test was performed and mechanical and myosin characterization (Pietrangelo et al. 2009) of latissimus dorsi muscle fibres were analysed pre and post-training. We used a fine needle biopsy technique that allowed us to obtain about 4 mg of muscle sample (Paoli et al. 2010). Results The increase in 1RM after 8-weeks of training was significantly greater in women (+24%) compared to men (+13%). The electrophoretic analysis of muscle fibers showed some changes in MHC expression. We observed an increase in MHC IIa (male +13% and female +33%) and a decrease in MHC IIx (male -8% and female -26%) while the MHC I expression in male tends to decrease (-5%) and in female tends to increase (+6%). Interestingly, the two-way ANOVA analysis (time x gender) showed a gender significant difference for female only in MHC IIa expression. The mechanical analysis of single fibres showed that training increased significantly the cross sectional area (CSA) and fibre strength in male and muscle fibre tension both in male and female. Discussion The greater increase of 1RM performance with a substantial unchanged fibre CSA in female subjects could be explained by an improved motor units recruitment whilst males response to training seems oriented to hypertrophy. Moreover, also myosin changes showed a gender related difference. Taken together our results suggest that resistance training effects on muscle are gender specific and more work is needed to explain this difference. References Paoli A, Pacelli QF, Toniolo L, Miotti D, Reggiani C. (2010). *J Surg Res*, 2010 164(2), e257-63. Andersen JL, Aagaard P. (2010). *Scand J Med Sci Sports*, 20(2), 32-8. Pietrangelo T, Toniolo L, Paoli A, Fulle S, Pugliesi C, Fanò G, Reggiani C. (2009). *Int J Immunopathol Pharmacol*, 22(2), 427-36.

### **THE EFFECT OF DIFFERENT TIME REST PERIODS AFTER WARM-UP ON RUNNING PERFORMANCE AT 110% OF VO<sub>2</sub>MAX TO EXHAUSTION.**

Skaugen, M.

*Norwegian School Of Sports Sciences*

The effect of different time rest periods after warm-up on running performance at 110% of VO<sub>2</sub>max to exhaustion. Skaugen, M & Ingjer, F. Norwegian School of Sport Sciences Introduction Active warm up normally improves physiological performance and exercise capacity mainly because of an increase in core and muscle temperature, and also an increase in perfusion of oxygen. Less attention has been focused on the time between the end of warming up and start of training or competition with the aim to improve performance. To improve performance, according to Bishop et al., (2003) that recovery period should be less than ~5 min. Only a few previous existing studies have examined the effect of different rest intervals after warm-up on subsequent high intensity performance. The aim of this study was to utilize a new intervention protocol that identifies important selected physiological variables that effect performance by using a warm-up protocol that may be incorporated in sports training. Methods Six endurance trained athletes (mean±SD: 26 ±4 yrs, VO<sub>2</sub>max of 72.6 ±6.67 l.min<sup>-1</sup>.kg<sup>-1</sup>) performed an initial VO<sub>2</sub>max test followed by 3 randomized tests of 20 min treadmill warm-up at a moderate intensity. After the warm up, the subjects rested for either 30s, 3, or 10 min before starting an all out run to exhaustion at a speed representing 110% of VO<sub>2</sub>max. The subjects also performed an identical criterion test but without the warm-up. The following physiological variables were measured: oxygen uptake (VO<sub>2</sub>), heart rate (HR), blood lactate concentration (LA), minute ventilation (VE), respiratory exchange ratio (RER), indirect oximetry (SaO<sub>2</sub>), and rectal temperature (Tr) were measured in all the performance tests. Results Time to exhaustion increased significantly ( $P < 0.05$ ) when using a warm-up following a rest interval of 30s (190±46.5s), 3 min (188±52.2s) and 10 min (190±44.1s) compared to no warm-up (122±37.4s). No statistical difference in time to exhaustion was observed between the tests using the 3 rest periods ( $P > 0.6$ ). Tr decreased significantly by -0.12°C and -0.28°C when subjects rested for 3 and 10 min ( $P < 0.05$ ). There was also significant difference for RER ( $P < 0.05$ ) between no warm-up and 3 and 10 min rest interval tests. No significant difference was observed in peak values for VO<sub>2</sub>, HR, VE, LA, and SaO<sub>2</sub> in performance tests using the 3 rest periods. Discussion Although a significant decrease in Tr was observed during various rest periods, the minor decreases in Tr resulting from 3 and 10 min tests seem not to have influenced the performance negatively. In practice, the importance of relatively short rest periods (<5 min) to enhance performance are likely not as relevant as previously suggested in the literature. Further studies are needed to elucidate the results of this and other studies. References: Bishop, D. (2003). Warm Up II: performance changes following active warm up and how to structure the warm up. *Sports medicine*, 33(7), 483-498.



**HEAD-TO-HEAD COMPARISON BETWEEN ACTIGRAPH 7164 AND GTIM ACCELEROMETERS IN ADOLESCENTS**

Tanha, T., Tornberg, A.B., Wollmer, P., Dencker, M.

*Clinical Sciences*

Head-to-head comparison between Actigraph 7164 and GTIM accelerometers in adolescents Tina Tanha 1, Åsa B Tornberg 1,2,3, Per Wollmer 1, Magnus Dencker 1 1) Dept of Clinical Sciences, Unit of Clinical Physiology and Nuclear Medicine, Skåne University Hospital, Malmö, Sweden. 2) Department of Health Sciences, Division of Physiotherapy, Lund University, Sweden. 3) Department of Clinical Sciences, Genetic & Molecular Epidemiology Unit, Lund University Diabetes Center, Skåne University Hospital, Malmö, Sweden Corresponding author: Tina Tanha, MD Dept of Clinical Sciences, Malmö Clinical Physiology and Nuclear Medicine unit Skåne University Hospital 205 02 Malmö, Sweden E-mail: tina.tanha@skane.se Phone: +46 40-338701 Fax +46 40-338768 Introduction: We compared, head-to-head, the old generation Actigraph model 7164 with the new generation Actigraph GTIM accelerometer. Methods: A total of 15 randomly selected teenagers (8 girls and 7 boys) were investigated. They performed a treadmill test wearing the two kinds of accelerometers around the waist simultaneously. The treadmill test consisted of three different levels of speed 4, 6 and 8 km/h for four consecutive minutes. Results: Accelerometer counts for the Actigraph GTIM vs. the Actigraph 7164 were at 4 km/h 21.6±12.9 vs. 26.5±11.5 counts, at 6 km/h 56.0±23.2 vs. 62.9±25.6 counts and at 8 km/h 142.6±37.2 vs. 156.4±34.9 counts (p<0.01 for all levels of speed). Discussion: Data from the old generation Actigraph 7164 and the new generation Actigraph GTIM accelerometers differ, where the Actigraph GTIM generates 10-23% lower values. These results need to be taken into consideration when using these devices.

**CONTRIBUTION OF ORGANS AND TISSUE OF FAT-FREE MASS ON RESTING ENERGY EXPENDITURE IN COLLEGE MALE ATHLETES**

Oshima, S.1, Miyauchi, S.1, Asaka, M.1, Kawano, H.2, Taguchi, M.2, Torii, S.2, Higuchi, M.2

*Waseda University*

Introduction Fat-free mass (FFM) is often utilized to estimate resting energy expenditure (REE) for athletes, however the validity of using FFM to estimate REE has not been fully investigated. Our previous study showed that the consistency of REE/FFM for male athletes in spite of different FFM was due to the steadiness of % contribution of the organ-tissue compartments to FFM (1). At the same time, FFM contains various internal organs with relatively high metabolic rates. Therefore, the purpose of this study was to evaluate the contribution of organs and tissue of FFM on REE in college male athletes. Methods There were thirty-two college male American football players participated in this study. REE was measured (REEm) by indirect calorimetry, and % body fat and bone mineral content were measured by dual x-ray absorptiometry. Mass of brain, liver, and kidney were obtained by MRI technique and mass of heart was estimated based on the measurements taken by echocardiography. REE was estimated (REEe) based on the two models, one using the four organ-tissue compartments and the other using seven organs and tissue. The specific metabolic rates of these organs and tissue were taken from the literatures (2, 3) Results and Discussion The average body weight and FFM were 80.8 ± 11.9 kg (Range: 63.7 to 106.0 kg) and 67.3 ± 7.8 kg (56.9 to 84.2 kg), respectively. The average REEm was 1841 ± 228 kcal and the REE/FFM was 27.4 ± 1.6 kcal/kg/day. There was no association found between REE/FFM and FFM. The mass of liver, kidney, and heart significantly positively correlated with FFM, on the other hand, brain did not. Consequently, the % contribution of brain mass to FFM was negatively correlated with FFM (r=-0.80, p<0.001), although the % contribution of liver, kidney, and heart mass did not have any correlation with FFM. However, since the % residual mass which include all the internal organs to FFM was consistent, the influence of reduction in % brain/FFM on REE was expected to be small. There were no significant difference between the REEm and REEe using either of the estimation models. In conclusion, the REE/FFM was steady regardless of FFM due to the consistency of percentage contribution of organs and tissue mass to FFM, and thus FFM was the reliable measurement to estimate REE for athletes. References 1)Satomi O. et al, (2011). J Nutr Sci and Vitaminol 57(6): 394-400 2)Elia M., (1992). Raven Press: 61-80 3)Heymsfield SB. et al, (2002). Am J Physiol Endocrinol Metab 282: E132-E138

**14:45 - 15:45****Poster presentations****PP-PM11 Physiology 3****DONATION OF 450 ML BLOOD AND TEMPORARY IMPACT ON PHYSICAL PERFORMANCE IN PHYSICALLY ACTIVE MEN**

Kraag Ziegler, A., Grand, J., Magnussen, K., Dela, F., Helge, J.W.

*Copenhagen University*

Donation of 450 ml blood and temporary impact on physical performance in men Ziegler A. K.1, Grand J.1, Magnussen K.2, Dela F.1, Helge J. W.1 1: University of Copenhagen, Center of Healthy Aging (Denmark), 2: Dept. of Clinical Immunology, and Blood Centre Rigshospitalet/Hvidovre (Denmark) Introduction: It is well accepted that donation of blood negatively affects maximal oxygen consumption (VO2max) and endurance, with endurance being reduced the most. Only few studies have investigated the impact of a standard 450 ml blood donation on physical performance and hemoglobin (hgb) conc. and the recovery of physical performance shows considerable variation from 3-28 days. Therefore this study aimed to measure the temporary impact of blood donation on physical performance, measured as VO2max and time trial (TT) performance in physically active men, while also observing time until normalization of hematological parameters. Method: 16 male blood donors were included. To determine VO2max a standard incremental bicycle ergometer VO2max test was performed. Pulmonary respiration was measured using an automated online system (Jaeger Oxycon Pro). After a 30 minute break endurance was tested using a self paced 3 km all out TT. Subjects were verbally encouraged to ensure an all out run. To assess baseline physical performance, subjects were tested 2 times prior to blood donation, and the highest scored values were used as baseline performance. Subjects were then tested 3, 7, 14, and 28 days after blood donation. At baseline, day 3, 7, 14, 21, 28, 42, blood samples were taken to analyze hgb, iron status (ferritin) and hematologic profile. Results: VO2max declined by 6.7 % from 48.9±2.1 ml O2 /kg/min (mean±SEM) to 45.6±2.1 ml O2 /kg/min at day 3 compared to baseline. Subsequently VO2max gradually increased to 48.8±2.2 ml O2 /kg/min, at day 28 after bloodletting, thereby returning to baseline. The 3 km TT performance declined by 5.6 % from 13:55±00:46

minutes at baseline to  $14:42 \pm 01:12$  minutes at day 3. At day 14 TT performance was  $13:52 \pm 00:59$  minutes and not different from baseline. B-hgb was reduced by 9 % from  $9.6 \text{ mM} \pm 0.17$  at control to  $8.8 \pm 0.14 \text{ mM}$  at day 3. After this B-hgb increased gradually, but was not at baseline even at day 42 ( $9.4 \pm 0.17 \text{ mM} - 2.1 \%$  below baseline). P-Ferritin declined 54 % from  $61.5 \pm 7.8 \mu\text{g/l}$  at baseline to  $28.3 \pm 3.7 \mu\text{g/l}$  at day 14 and remained reduced below baseline throughout the study. Discussion: In the present study TT performance was back to baseline at day 14 and  $\text{VO}_2\text{max}$  at day 28, even though B-hgb and P-ferritin conc. remained below baseline for the duration of the entire study. It is apparent that the plasma volume expansion after blood donation and the concomitant increase in B-hgb conc. from day 3 and onwards were sufficient to restore endurance TT performance already after 14 days and  $\text{VO}_2\text{max}$  after 28 days. In conclusion we provide a time course for the recovery of physical capacity after blood donation and reveal a dissociation in the recovery time of endurance performance,  $\text{VO}_2\text{max}$  and B-hgb.

### CORRELATION OF INCREASED MYOCARD VOLUME AND IMPROVED EXERCISE PERFORMANCE IN MICE AFTER TREADMILL TRAINING

Rieger, G.1, Gubser, M.1, Klohs, J.2, Hoppeler, H.1, Vogel, J.2, Baum, O.1

*1 Institute of Anatomy, University of Bern, Switzerland; 2 Institute of Veterinary Physiology, University of Zürich, Switzerland*

**Introduction** In human, physiologic cardiac hypertrophy is a well-established phenomenon in response to endurance exercise. Due to the limitation in resolution of imaging techniques the relationship between heart size and exercise performance in mice has not been documented so far. **Methods** Eight C57BL/6-mice (12 weeks old) were subjected to a 3-week period of treadmill exercise, consisting of five 45-min units per week. The training program was initiated at a speed of 16 m/min and an incline of 5-degrees of the treadmill. The velocity and the incline were then increased on a weekly basis to maximum values of 20 m/min and 9-degrees. Two performance tests were conducted before and after the training to determine peak power outcome (PPO) and time-to-exhaustion (TTE) of the mice in response to the training. To monitor the sizes of the hearts *in vivo*, the mice were subjected to magnetic resonance imaging (MRI) in a small animal MR system Bruker PharmaScan 47/16 (Bruker, BioSpin MRI, Ettlingen, Germany) operating at 200 MHz before and after the training period. In anesthetized mice, a cine FLASH sequence of the mediastinum was recorded using the self-gating technique IntraGate (ParaVision 5.0, Bruker BioSpin MRI) with TE/TR = 1.8/57 ms and a RF pulse angle of 10 degrees. Eight serial sections of the hearts with 1 mm thickness were acquired in horizontal orientation (image size: 2.5 x 2.5 cm, matrix size: 256 x 256 resulting in a pixel resolution of 98 x 98  $\mu\text{m}^2$ ). One section of the cine FLASH sequence from the middle part of the heart was used to identify the time points of maximal and minimal ventricular expansion. At these time points the area of the left ventricle and the left myocardium was measured on the eight MRI sections. By multiplying the sum of the heart areas in these MRI sections with the thickness of slices (Cavalieri-approach) to obtain the volumes of the left ventricle and left myocardium were calculated. The myocardium volume was defined as the average calculated from the end-diastolic and end-diastolic volume (EDV and ESV). Results Treadmill training induced a significant ( $P \leq 0.05$ ) increase in PPO (+9%) and TTE (+91%) of the mice. Myocardium volume was significantly ( $P \leq 0.05$ ) increased (+10%), while EDV (-0.1%) and ESV (+0.4%), stroke volume (+0.2%) and ejection volume (+0.1%) were only non-significantly ( $P > 0.05$ ) altered in the mice after the training. TTE and myocardium volume were significantly ( $P \leq 0.05$ ) correlated ( $r = 0.94$ ). **Discussion** The increases in TTE were significantly correlated to the changes in myocardium volume. Thus, combining the results from the exercise test and the high-resolution small animal MRI represents a sufficient approach e.g. to quantify the impact of substances on cardiac hypertrophy in mice. GR and MG as well as JV and OB contributed equally to this study

### EVALUATION OF TRAINING LOAD WITH HEART RATE VARIABILITY: A NOVEL INDEX FOR FIELD USE

Saboul, D., Balducci, P., Pialoux, V., Hautier, C.

*université Lyon 1*

**EVALUATION OF TRAINING LOAD WITH HEART RATE VARIABILITY: A NOVEL INDEX FOR FIELD USE** Saboul, D.1-2, Balducci, P.1, Pialoux, V.1, Hautier, C.1 1: CRIS- Université Lyon 1 (Lyon, France), 2: Almerys (Clermont-Ferrand, France) **Introduction** Evaluation of training load (TL) is an important actual topic for coaches. In practice, methods proposed by Banister (TRIMP) or Foster (RPE) are commonly used although both methods present advantages and disadvantages (Borresen et al., 2009). Recent studies reported relationship between post-exercise heart rate variability (HRV) recovery and TL (Kaikkonen et al., 2011). The aim of this study was to observe dynamic of post-exercise HRV recovery after different training sessions (TS). The final objective was to validate a novel HRV index that may be used by coaches and athletes to assess TL. **Methods** Eight healthy male runners performed randomly 4 TS of different duration and intensity. TL is evaluated using Foster and Banister methods. In addition, HRV measurements were performed respectively 5 minutes before TS, 5 and 30 minutes after TS. We calculated a new HRV index (TLHRV) based on ratio between the HRV decrease during TS and HRV increase during recovery. Correlations between TLHRV, Banister and Foster TL indexes were tested. Results HRV significantly decreased 5 minutes after exercise whatever the TS. Conversely, HRV significantly re-increased during the 30 minutes of the recovery phase. There were no significant differences between HRV measured before each TS. By contrast, there were significant differences between HRV measured immediately and 30 minutes after TS. The TL estimates were significantly different between TS whatever the calculation method. In addition, TLHRV was significantly correlated with Foster ( $R=0.61; p=0.0002$ ) and Banister ( $R=0.48; p=0.005$ ) methods. Moreover, Foster and Banister methods were also correlated ( $R=0.46; p=0.009$ ). **Discussion** This study confirms that immediately post-exercise HRV responded according to exercise intensity (Kaikkonen et al., 2011). In addition, we can hypothesize that HRV 30 minutes after TS provides information on fatigue induced by exercise. Consequently, TLHRV formula likely takes into account the dynamics of HRV recovery with both the disturbance and the return to homeostasis balance. Significant relationships between this new TLHRV method and the validated Foster and Banister methods suggest that this tool may provide a strongly objective TL index incorporating physiological and psychological impact of training session. **References** Borresen J, and Lambert MI. The quantification of training load, the training response and the effect on performance. *Sports medicine* Auckland, N.Z. 2009;39(9):779-95. Kaikkonen P, Hynynen E, Mann T, Rusko H, and Nummela A. Heart rate variability is related to training load variables in interval running exercises. *Eur J Appl Physiol*. 2011;101:1007/s00421-011-2031-z.

### BRAIN BLOOD FLOW DURING MORNING AND AFTERNOON ROWING PERFORMANCE

Faull, O.K., Cotter, J.D., Lucas, S.J.E.

*University of Otago*

**Introduction** Regulating brain blood flow acutely and chronically has important implications for exercise performance. Despite evidence of circadian rhythms in cerebral blood flow (CBF), blood pressure (BP), cerebrovascular responsiveness to carbon dioxide ( $\text{CO}_2$ ) and cerebrovascular autoregulation, all of which peak in the afternoon, the combined influence of these underlying circadian rhythms for exercise

performance is yet to be explored, despite performances in several sports being reported to peak in the early evening. We aimed to compare the CBF responses to rowing exercise at different times of day, since rowing has large haemodynamic effects and it is performed at opposing ends of a day. We hypothesised that a higher CBF and improved regulation in the afternoon would be positively related to maximal rowing performance. Methods Twelve trained male rowers completed an incremental rowing exercise protocol and a 2000-m maximal rowing ergometer test in the morning (7 am) and afternoon (4 pm), one week apart. Middle cerebral artery velocity blood flow (MCAv) and cerebral (prefrontal) and muscular (vastus lateralis) tissue oxygenation were recorded continuously using Transcranial Doppler sonography and Near Infrared Spectroscopy (NIRS), respectively. Heart rate and partial pressure of end-tidal carbon dioxide (PETCO<sub>2</sub>) were also measured throughout. Results Maximal rowing ergometer time trial performance was faster (3.4 s; 95% CI 0.9-5.8 s) in the afternoon; however MCAv remained consistent between the two trials during maximal exercise (~1 cm/s difference;  $p = 0.60$ ). Resting MCAv and BP also showed no time of day differences (~1 cm/s and 1.1 mm Hg differences;  $p > 0.05$ ), and neither did prefrontal haemodynamics during time trials. MCAv increased from rest ( $68 \pm 12$  cm/s (SD)) during all intensities of exercise ( $80 \pm 11$ ;  $81 \pm 12$ ;  $80 \pm 11$ ;  $84 \pm 13$  cm/s for 50%, 75%, 2000-m max and 30 s max, respectively), despite significant decreases in PETCO<sub>2</sub> ( $42 \pm 2$ ;  $40 \pm 2$ ;  $34 \pm 2$ ,  $36 \pm 3$  mm Hg, respectively) from rest (40 mm Hg). Prefrontal oxygenated haemoglobin decreased consistently across 2000 m at both times of day (morning:  $208 \pm 117 \mu\text{M}\cdot\text{cm}$  in the morning; afternoon  $276 \pm 177 \mu\text{M}\cdot\text{cm}$ ;  $p = 0.11$ ), whereas in the muscle it dropped more in the afternoon ( $238 \pm 96$  vs  $137 \pm 66 \mu\text{M}\cdot\text{cm}$ ;  $p < 0.01$ ). Conclusion 2000-m rowing ergometer performance was better in the afternoon, but this was not in conjunction with any differences in MCAv or cerebral oxygenation at rest or during maximal exercise. We suggest that changes in peripheral metabolism and contraction velocities, due to possible circadian increases in muscle temperature, contributed to the better afternoon performance. In addition, rowing performance did not produce the inverted-U profile of brain blood flow with exercise intensity that is observed in other sports.

### EXERCISE FOR FATTY LIVER DISEASE: IMPACT ON MICROVASCULAR HEALTH

Pugh, C.J.A., Cuthbertson, D.J., Sprung, V.S., Kemp, G.J., Green, D.J., Cable, N.T., Jones, H.I

*Liverpool John Moores University*

**INTRODUCTION** Although non-alcoholic fatty liver disease (NAFLD) is associated with liver-related pathology, the leading causes of mortality and morbidity relate to macro- and micro-vascular disease. Cutaneous microvascular function is a surrogate index of preclinical microvascular disease, but has not been previously examined in NAFLD patients. We hypothesised that nitric oxide (NO)-mediated cutaneous vasodilator function would be impaired in obese NAFLD patients, compared with obese matched controls, and that exercise training would induce a greater improvement in cutaneous vasodilator function than clinical conventional care. **METHODS** NO-mediated vasodilation in cutaneous microvessels was examined in 13 NAFLD patients (7 males, 6 females,  $50 \pm 3y, 31 \pm 1\text{kg}/\text{m}^2$ ) and 7 matched controls (3 males, 4 females,  $48 \pm 4y, 30 \pm 2\text{kg}/\text{m}^2$ ) using laser Doppler flowmetry combined with intra-dermal microdialysis of L-NG-monomethyl arginine to assay the NO dilator system response to forearm heating. Magnetic resonance imaging and <sup>1</sup>H spectroscopy quantified abdominal visceral and hepatic fat respectively and cardiorespiratory fitness was also assessed. NAFLD patients ( $n=11$ ) were then randomly assigned to 16-weeks of supervised moderate intensity exercise training ( $n=6$ ) or conventional care ( $n=5$ ). Baseline characteristics between groups were compared using independent t-tests. The effects of exercise were compared using analysis of covariance. Cutaneous blood flow data is presented as %CVCmax and data are reported as mean $\pm$ SE. **RESULTS** Hepatic ( $28.8 \pm 5.3$  vs.  $3.6 \pm 0.7\%$ ;  $P=0.0004$ ) and abdominal visceral ( $4.8 \pm 0.4$  vs.  $3.8 \pm 0.7$ ;  $P=0.05$ ) fat were elevated in NAFLD patients compared with controls. The NO contribution to cutaneous blood flow in response to heating was not different between NAFLD patients and controls ( $P=0.47$ ). Cardiorespiratory fitness was significantly greater following exercise training compared with conventional care, as was the contribution of NO to cutaneous blood flow at rest ( $3.3 \pm 2.5$  vs.  $-5.8 \pm 2.7\%$ CVCmax;  $P=0.04$ ) and in response to heating ( $42^\circ\text{C}$ ) ( $22.5 \pm 9.7$  vs.  $-18.0 \pm 8.1\%$ CVCmax;  $P=0.05$ ). There was no difference in BMI or fat deposition ( $P>0.05$ ) between interventions. **DISCUSSION** This is the first study to demonstrate that exercise training improves microvascular function via upregulation of the anti-atherogenic molecule NO in NAFLD patients. The benefit of supervised exercise training compared with conventional care, strongly supports a role for exercise in the prevention of CVD in NAFLD.

### MACRO- AND MICROVASCULAR ADAPTATIONS IN RESPONSE TO RESISTANCE TRAINING

Cocks, M.I, Shepherd, S.I, Tipton, K.D.2, Shaw, C.S.1, Wagenmakers, A.J.M.1

*1University of Birmingham, 2University of Stirling*

Resistance training (RT) has recently been added to physical activity guidelines due to its effects on muscular strength and insulin sensitivity, promoting and maintaining health and independence. However its effect on the vasculature is understudied. The few studies to investigate RT's effect on vascular health suggest that it has either no or a negative effect. It has been suggested that the effect of training may differ between the micro- and macrovasculature. As a result we aimed to use an integrative approach to investigate both micro- and macrovascular adaptations following 6 weeks RT. Eight previously sedentary males (age  $20 \pm 0.4y$ , BMI  $24.5 \pm 0.9 \text{kg}\cdot\text{m}^{-2}$ ) completed 6 weeks of whole body progressive RT 3 times per week. Insulin sensitivity was measured using an OGTT. Central and peripheral pulse wave velocity (PWV) and systemic wave reflections (augmentation index @75 bpm) were measured using applanation tonometry (SphygmoCor®). Filtration capacity was assessed using plethysmography. Finally muscle biopsies were taken from the vastus lateralis and eNOS content, phosphorylation (eNOS Ser1177) and NOX2 content were assessed in the muscle microvascular endothelium and sarcolemma (NOX2 only) using quantitative immunofluorescence microscopy. High eNOS content is seen in lean healthy and fit individuals, while NOX2 is high in obesity, cardiovascular disease and metabolic syndrome. Capillary density was also determined using immunofluorescence microscopy. Muscular strength assessed using 1RM and insulin sensitivity were increased following training ( $P < 0.05$ ). In addition, RT significantly reduced resting blood pressure and augmentation index @75 bpm ( $P < 0.05$ ). No difference was seen in central ( $P = 0.934$ ) or peripheral PWV ( $P = 0.708$ ). All measures of capillarization (capillary density  $P = 0.715$ ; capillary contact  $P = 0.716$ ) and filtration capacity ( $P = 0.333$ ) did not change following RT. Skeletal muscle microvascular eNOS content ( $P = 0.091$ ) and basal eNOS phosphorylation ( $P = 0.075$ ) did not change. Finally both endothelial ( $P = 0.319$ ) and membrane ( $P = 0.164$ ) NOX2 contents did not change. As previously documented RT was effective at increasing muscular strength and insulin sensitivity. In addition RT also improved blood pressure and systemic wave reflection. However, unlike endurance and high intensity intermittent training RT had no effect on central artery stiffness, skeletal muscle capillarization or skeletal muscle microvascular eNOS content. In conclusion RT is an effective method of improving insulin sensitivity and muscular strength, but is not effective to improve micro- and macrovascular function and health.

## ALTERED LV MECHANICS DURING EXERCISE ACROSS THE MENSTRUAL CYCLE

Nio, A.Q.X.1, Stöhr, E.J.1, Meah, V.1, Stemberge, M.1, Gaze, D.2, Shave, R.1

1: Cardiff Metropolitan University, UK; 2: St George's Healthcare NHS Trust, UK

**Introduction** Changes in estradiol across the menstrual cycle influence vascular function, but the impact on cardiac function at rest is still unclear. Even less is known about its effects on cardiac function during exercise. The purpose of this study was to examine left ventricular (LV) function and the underlying LV twist mechanics during the early-follicular (EF; low estradiol) and late-follicular (LF; high estradiol) phases of the menstrual cycle. **Methods** Seven healthy females (mean±SD; age 25±3 years; height 164.9±6.2 cm; body mass 62.3±5.0 kg), with regular menstrual cycles (25–32 days) performed 70% supine cycling exercise (116±31 W) during EF (Day 3–5) and LF (Day 10–14). Plasma volume was calculated using haemoglobin concentration and haematocrit. Serum estradiol and progesterone concentrations were analysed by automated immunoassay. Systolic blood pressure (SBP; FinometerPRO), cardiac output, heart rate, stroke volume, ejection fraction, LV volumes, basal and apical rotation and rotation velocity, twist and twisting velocity (2D speckle tracking echocardiography) were assessed at rest and during exercise. T-tests were used to compare EF and LF at rest and 70% exercise. Alpha was set at 0.1. **Results** Plasma volume did not change between EF and LF (-2±12%Δ). Estradiol concentration was higher during LF than EF (179.2±51.4 vs. 42.2±18.0 pg/mL; p<0.01). Progesterone concentration was similar between phases (EF 0.3±0.0 vs. LF 3.7±5.4 ng/mL; p=0.18). At rest, SBP (116±12 vs. 126±9 mmHg; p=0.03), cardiac output (3.32±0.71 vs. 3.59±0.76 L; p=0.08), end-diastolic volume (97±15 vs. 102±16 mL; p=0.04) and peak untwisting velocity (-87±32 vs. -110±19 deg/s; p=0.06) were lower during LF than EF. In contrast, resting heart rate, stroke volume, ejection fraction, end-systolic volume, basal and apical rotation and rotation velocity, twist and twisting velocity were not different between phases. During exercise, the resting differences in SBP, LV function and LV twist mechanics were not present. However, exercise-induced increases in SBP (53±19 vs. 40±19 mmHg; p=0.07) and peak apical systolic rotation velocity (69.1±42.2 vs. 27.9±44.8 deg/s; p=0.03) were greater during LF than EF. **Discussion** This is the first study to compare LV function and the underlying LV twist mechanics at rest and during exercise between the EF and LF phases of the menstrual cycle. Reduced SBP, cardiac output and end-diastolic volume at rest during LF may reflect the vasodilatory effect of elevated estradiol. Interestingly, with exercise, baseline differences were no longer apparent. In order to meet the metabolic demands of exercise and mitigate the resting differences observed between phases, apical rotation velocity may have increased to enhance systolic function.

## REPEATED SUPRA-MAXIMAL SPRINT CYCLING INDUCES ENDOTHELIAL STRESS IN HEALTHY YOUNG MALES

Kirk, R.J., Peart, D.J., Madden, L.A., Vince, R.V.

University of Hull

**Introduction** Endothelial microparticles (EMP), analysed with specific antibodies by flow cytometry provide information on the state of the endothelium (1). EMP are released either through cellular activation, injury, stress, or during apoptosis or necrosis (1). Importantly, EMP are found in the plasma of healthy subjects, being constantly shed into the circulation, as well as in various pathological conditions (2). Few studies have investigated the exercise-induced stress response on EMP release. The aim of this study was to quantify changes in biomarkers of vascular endothelium as a result of high intensity sprint cycling exercise in young healthy subjects. **Methods** Seven active males volunteered for the study (22 ± 3 years, 1.82 ± 0.06 m, 81.3 ± 8.4 kg, Peak Power Output (PPO) 300 ± 22 W) and performed high intensity cycling on 3 separate visits. A PPO test and familiarisation was completed in visit 1, while sessions 2 and 3 were randomised exercise trials performed under placebo (sodium chloride (PLAC); capsules containing 0.045g.kg.BW-1 NaCl) or experimental (sodium bicarbonate (BICARB); capsules containing 0.03g.kg.BW-1 NaHCO<sub>3</sub>) conditions. Subjects completed 10 sets of 15-sec cycle sprints at 120% PPO, each separated by 45-sec of active recovery. Endothelial function was assessed by EMP using CD-105+MP and vascular cell adhesion molecule (VCAM-1+MP) as biological markers at rest (T0) and immediately (TEND), 90-min (T90) and 180-min (T180) post-exercise. **Results** A significant increase in both markers was evident for each cycling condition from TEND to T90 (p<0.05) with no significant differences between conditions. There was a trend for EMP to return to basal levels at 180-min, with significance in CD-105+MP BICARB group, and VCAM-1+MP PLAC group (p<0.05). Data was combined regardless of condition, displaying a significant time effect for markers (p<0.001). **Discussion** Repeated supra-maximal exercise was capable of increasing the concentration of EMP when compared with those levels at rest. Additionally, the levels of EMP had returned to resting values after 180-min of recovery. The significant increase in CD-105+MP and VCAM-1+MP may be caused by increased oxidative and endothelial shear stress (3). However, the endothelium activation appears to resolve rapidly in recovery. An additional finding was no attenuation in the EMP response following NaHCO<sub>3</sub> ingestion, suggesting EMP release is not particularly sensitive to any alterations in blood pH. **References** 1. Vince, R. et al. *Europ J App Physiol* 2009, 105:507-13. 2. Freyssinet, J. J *Thromb Haemost* 2003, 1:1655-62. 3. Lehoux, S et al. *J Intern Med* 2006, 259: 381-92.

## HEART RATE RESPONSES DURING FOUR DIFFERENT EXERCISE PROTOCOLS IN PATIENTS WITH CORONARY ARTERY DISEASE

Currie, K.D., McKelvie, R.S., MacDonald, M.J.

McMaster University

**HEART RATE RESPONSES DURING FOUR DIFFERENT EXERCISE PROTOCOLS IN PATIENTS WITH CORONARY ARTERY DISEASE** Currie, K.D.1, McKelvie, R.S.1-3, MacDonald, M.J.1 1: Department of Kinesiology, McMaster University (Hamilton, Canada), 2: Department of Medicine, McMaster University (Hamilton, Canada), 3: Hamilton Health Sciences (Hamilton, Canada) **Introduction** Cardiac rehabilitation programs typically prescribe moderate-intensity endurance exercise (END) given its proven ability to improve the health of patients with coronary artery disease (CAD) (Hansen et al., 2012). Interval exercise has emerged as an alternative prescription for cardiac rehabilitation (Cornish et al., 2011); however, there is no consensus on the optimal duration and intensity of the intervals. This study examined the acute heart rate responses to 4 different exercise protocols in order to compare their respective cardiovascular stimulation in patients with CAD. **Methods** Nine men and one woman with documented CAD participated in 4 testing sessions. Heart rate was measured continuously during each exercise protocol using a single-lead ECG, and mean and peak heart rates were determined from 5-second averages. The 4 exercise protocols included END, aerobic-interval exercise (AIE), sprint-interval exercise (SIE), and high-intensity interval exercise (HIE). END involved 30 minutes of continuous cycling at 55% peak power output (PPO). AIE involved 4 x 4-minute intervals at 80% PPO interspersed with 3.5-minute intervals at 35% PPO. SIE involved 4 x 30-second intervals at 95% PPO separated by 3-minute intervals at 10% PPO. HIE involved 10 x 1-minute intervals at 80% PPO separated by 1-minute intervals at 10% PPO. **Results** Peak heart rates were significantly different between exercise protocols (p=0.003). SIE elicited the lowest peak heart rate (115 ± 24 bpm) and AIE elicited the highest peak heart rate (136 ± 27 bpm), compared to END (130 ± 26 bpm) and HIE (126 ± 26 bpm). Mean heart rates were also different between

groups ( $p=0.0001$ ), with AIE ( $120 \pm 22$  bpm) and END ( $117 \pm 22$ ) eliciting the highest means, followed by HIE ( $111 \pm 20$  bpm), then SIE ( $100 \pm 22$  bpm). All 10 participants completed the SIE and HIE protocols. Only 50% of participants were capable of completing the AIE protocol, and 80% completed the END protocol. Failure to complete the exercise protocol was due to volitional fatigue. Discussion As anticipated, different exercise intensities and durations elicited different heart rate responses. While the peak and mean heart rate results suggest AIE provides the greatest cardiovascular load, the feasibility of the exercise protocol is questionable due to the increased rate of failure to complete the protocol. Future investigations of the acute and chronic effects of different interval exercise protocols are needed to decipher the optimal exercise prescription for patients with CAD. References Cornish et al. (2011). *Eur J Appl Physiol*, 111, 579-589. Hansen et al. (2012). *Sports Med*, 42, 11-30.

### CARDIAC AUTONOMIC FUNCTION IN RESPONSE TO SHORT-TIME HIGH-INTENSITY INTERVAL TRAINING

Kiviniemi, A.M.1, Hannukainen, J.C.2, Savolainen, A.2, Eskelinen, J.J.2, Virtanen, K.A.2, Tulppo, M.P.1, Kalliokoski, K.K.2

1: *Verve Research (Oulu, Finland)*, 2: *Turku PET Centre, University of Turku (Turku, Finland)*

**Introduction** High-intensity, short-time anaerobic interval training (HIT, 4 – 6 x 30 s all-out cycling efforts) has been shown to improve aerobic fitness within two weeks similarly to aerobic exercise training. However, the effects of HIT on cardiac autonomic function are unclear. Recent findings suggest that anaerobic exercise, such as HIT, impairs the acute post-exercise vagal reactivation compared to aerobic exercise that may suggest HIT causing larger strain on autonomic nervous system. The aim of the present study was to assess the autonomic adaptations to HIT and the relationship between the improvement in aerobic fitness and tolerance of autonomic nervous system to HIT exercises. **Methods** Nine healthy men (age:  $48 \pm 5$  years, BMI:  $26 \pm 3$ ,  $VO_{2max}$ :  $33.9 \pm 3.8$  mL/kg/min) underwent two-week progressive (from 4 to 6 bouts per session) HIT program including six training sessions. Maximal oxygen consumption ( $VO_{2max}$ ) was measured at pre and post training conditions by bicycle ergometer test. The subjects recorded R-R intervals (RS800, Polar Electro, Kempele, Finland) at supine (5 min) and standing position (5 min) every morning during the intervention at home (from  $\geq 2$  days before first to 3 days after last HIT session). Mean heart rate (HR) and vagal HR variability (SD1 from Poincaré plot) were analyzed for both position and their responses to standing were also calculated. The values of pre and post training days were averaged to evaluate training adaptations. Secondly, the acute responses to each HIT exercise (the change from training day to post training day) were calculated and averaged within each subject. Results  $VO_{2max}$  improved from  $2.81 \pm 0.37$  to  $2.92 \pm 0.34$  L/min ( $p < 0.05$ , range of response:  $-0.13 - +0.25$  L/min). After HIT intervention, no changes occurred in HR and SD1 at either position or in their responses to standing (e.g. for supine position  $57 \pm 7$  vs.  $55 \pm 7$  bpm and  $25 \pm 11$  vs.  $31 \pm 19$  ms, respectively,  $p = ns$  for both). Also, these measures did not change significantly from training day to post training day averaged over all sessions for each subject. The HR response to standing was  $19 \pm 6$  and  $18 \pm 7$  bpm for training and post training day, respectively ( $p = ns$ ). The change in HR response to standing from training to post training day correlated with the change in  $VO_{2max}$  ( $r = -0.95$ ,  $p < 0.01$ ). Those subjects whose HR response to standing increased after HIT session showed impaired training response in  $VO_{2max}$ . **Discussion** Short-time high-intensity interval training over two weeks seems not to cause adaptations in cardiac autonomic function. However, the change in the orthostatic response of HR from training day to post training day seems to be associated with the training response in aerobic fitness. The change in orthostatic HR response after training day may identify subjects who gain larger benefits from short-time high-intensity interval training.

### NIGHT AND POST-EXERCISE CARDIAC AUTONOMIC CONTROL IN FUNCTIONAL OVERREACHING.

Dupuy, O., Bherer, L., Audiffren, M., Bosquet, L.

*Université de Poitiers*

**Night and post-exercise cardiac autonomic control in functional overreaching.** Olivier Dupuy<sup>1,2</sup>, Louis Bherer<sup>3,4</sup>, Michel Audiffren<sup>1,2</sup> & Laurent Bosquet<sup>1,4</sup> <sup>1</sup>Faculté des Sciences du Sport. Université de Poitiers. <sup>2</sup>Centre de Recherche sur la Cognition et l'Apprentissage, CNRS. Université de Poitiers. <sup>3</sup>Département de Psychologie. Université du Québec à Montréal. <sup>4</sup>Centre de recherche - Institut universitaire de gériatrie de Montréal. **Introduction** Peak performance in sport requires training loads that will occasionally push human body adaptation possibilities to their limits. Overtraining syndrome (OTS) is an important menace on performances and health in athletes. OTS results when appears an imbalance between the training and/or not training stress and sufficient recovery, which could lead to an unexplained underperformance. Functional Overreaching (FOR) and Non Functional Overreaching (NFOR) are physical states reached just before OTS on the continuum, but the line between the two is very thin. It is therefore very important to validate markers to prevent the development of NFOR. Heart rate variability and/or heart rate recovery could be such a marker. The primary purpose of this study was to evaluate the effect of a two-week overload period immediately followed by a one-week taper period on the autonomic control of heart rate during the night or after exercise cessation **Methods** Eleven male endurance athletes increased their usual training volume by 100% for two weeks (overload), and decreased it by 50% for 1 week (taper). A maximal graded exercise test and a constant speed test at 85% of peak treadmill speed both followed by a 10-min passive recovery period were performed at baseline and after each period. Heart rate variability was also measured during the overall night or during slow wave sleep **Results** All participants were considered as overreached based on performance, physiological and psychological criteria. We found a decrease of cardiac parasympathetic control during slow wave sleep ( $HFnu = 61.3 \pm 11.7$  vs  $50.0 \pm 10.1\%$ ,  $p < 0.05$ ) but not during the overall night period (4h period after the bed time), as well as a faster heart rate recovery following the maximal graded exercise test ( $\tau = 61.8 \pm 14.5$  vs  $54.7 \pm 9.0$  s,  $p < 0.05$ ), but not after the constant speed test, after the overload period. There was a return to baseline for both measures after the taper period. **Conclusion** These findings clearly underscore the relevance of monitoring cardiac autonomic control in the follow-up of athletes, but also that care should be taken in selecting the most sensitive measures, since cardiac autonomic control is not affected uniformly by overload training.

14:45 - 15:45

## Poster presentations

## PP-PM12 Physiology 4

**POST- EXERCISE COLD WATER IMMERSION: EFFECT ON CORE TEMPERATURE AND MELATONIN RESPONSES**

Robey, E., Dawson, B., Halson, S., Goodman, C., Gregson, W., Eastwood, P.

*The University of Western Australia*

Post- exercise cold water immersion: effect on core temperature and melatonin responses Robey, E.1, Dawson, B.1, Halson, S.2, Goodman, C.3, Gregson, W.4 and Eastwood, P.5 1: SSEH UWA (Perth, Australia) 2: AIS (Canberra, Australia) 3: WAIS (Perth, Australia) 4: RISES LJMU (Liverpool, United Kingdom) 5: CSS UWA (Perth, Australia) Introduction Many athletes regularly complete training sessions in the early evening, followed by cold water immersion (CWI), which can be beneficial to subsequent (24-48 h) performance (Vaile et al., 2008). Most studies that have investigated CWI have shown that core temperature markedly decreases after CWI (Gregson et al., 2011; Sramek et al., 2000; Vaile et al., 2008). Core body temperature and melatonin levels also vary with normal daily circadian rhythms (Weinert and Waterhouse, 2007). It is possible that CWI completed after evening exercise affects this normal circadian rhythm of melatonin secretion and core temperature. Methods 10 male cyclists completed two evening (~1800 h) fatiguing cycling trials followed by a 15 min CWI (14°C) or thermoneutral water immersion (TWI; 34°C), and were then monitored for 90 min post-immersion. Cycling involved 15 min at 75% peak power, followed by a 15 min time trial. Core (rectal) temperature, heart rate and salivary melatonin were measured over this period. Results Core temperature was not different between the two conditions pre-exercise (~37.4°C), post-exercise (~39°C) or immediately post-immersion (~37.7°C). Core temperatures in both conditions were significantly ( $p<0.05$ ) below pre-exercise levels at 60 and 90 min post-immersion. However, core temperature was significantly lower after CWI than TWI from 30 min ( $36.84 \pm 0.24$  vs  $37.42 \pm 0.40^\circ\text{C}$ ,  $p<0.05$ ) until 90 min ( $36.64 \pm 0.24$  vs  $36.95 \pm 0.43^\circ\text{C}$ ,  $p<0.05$ ) post-immersion. Salivary melatonin levels significantly increased ( $p<0.05$ ) from post-exercise (~5 pM) to 90 min post-immersion (~8.3 pM), but were not different between conditions. At 30 and 90 min post-immersion heart rate was significantly lower (~5-10 bpm,  $p<0.01$ ) after CWI than TWI. Discussion These results show that undertaking either CWI or TWI post-exercise in the evening lowers core temperature below baseline for at least 90 min, however the magnitude of decrease is significantly greater following CWI. The usual evening increase in melatonin is unaffected by exercise or post-exercise water immersion undertaken between ~1800 and ~2000h. References Gregson W, Black MA, Jones H, Milson J, Morton J, Dawson B, Atkinson G, Green DJ (2011) Am J Sports Med doi:10.1177/0363546510395497 Sramek P, Simeckova M, Jansky L, Savlikova J, Vybiral S (2000) Eur J Appl Physiol 81, 436-442 Vaile J, Halson S, Gill N, Dawson B (2008) Int J Sports Med 29:539 - 544 Weinert D, Waterhouse J (2007) Physiol Behav 90:246-256

**NEUROMUSCULAR ELECTRICAL STIMULATION INCREASES MUSCLE PROTEIN SYNTHESIS RATES IN TYPE 2 DIABETIC MEN**

Burd, N.A., Wall, B.T., Dirks, M.L., Verdijk, L.B., Snijders, T., Hansen, D., Senden, J.M., Vranckx, P., Dendale, P., van Loon, L.J.C.

*Maastricht University*

Introduction Neuromuscular electrical stimulation (NMES) is suggested to serve as viable substitute to physical activity during compromised conditions that impose muscle disuse (illness or injury). However, limited information is available on whether NMES affects acute molecular and cellular responses involved in the regulation of muscle mass. Thus, we aimed to determine the influence of NMES on mixed muscle protein synthesis rates and gene expression of key proteins involved in the regulation of muscle protein turnover. Methods Six sedentary, type 2 diabetic men (age:  $70 \pm 1$  y, BMI:  $26.5 \pm 1.0$  kg·m<sup>-2</sup>) received a primed, constant infusion of L-[ring-<sup>13</sup>C<sub>6</sub>]phenylalanine and 60 min of one legged NMES. Biopsies of the vastus lateralis were obtained at 0, 2, and 4 h after NMES to measure mixed muscle protein synthesis rates and muscle mRNA responses in the unstimulated (CON) and stimulated (STIM) leg. The NMES protocol consisted of a pulse duration of 500  $\mu\text{s}$ , pulse frequency of 60 Hz, and a 3 sec contraction – 3 sec relaxation time. Results Muscle protein synthesis rates were increased by 21% and 64% above CON at 0-2 h and 2-4 h in the STIM leg, respectively (both  $P<0.05$ ). Similarly, the cumulative MPS response (0-4 h) was greater ( $P=0.02$ ) in the STIM leg ( $0.049 \pm 0.008$  %·h<sup>-1</sup>) as compared to CON leg ( $0.039 \pm 0.008$  %·h<sup>-1</sup>). There were no differences in muscle mRNA responses of mTOR, p70S6K, FAK, FOXO1, MAFBx, MuRF1, or myogenin in the CON or STIM conditions. Myostatin mRNA demonstrated a biphasic pattern of expression in the STIM condition with a 3-fold increase at 2 h and a decline at 4 h as compared to the CON condition. Conversely, muscle MyoD expression trended to decrease immediately at 0 h and trended to increase at 4 h in the STIM leg as opposed to the CON leg (both,  $P<0.10$ ). Summary Our data demonstrate that NMES stimulates mixed muscle protein synthesis rates and inhibits muscle myostatin expression in human skeletal muscle. This work provides insight into the capacity of NMES to stimulate acute anabolic responses that allow net muscle protein accretion. These data lend credence to the use of NMES to attenuate muscle protein loss during periods of muscle disuse.

**FAT OXIDATION KINETICS DURING EXERCISE IN OBESE INDIVIDUALS**

Lanzi, S., Codecasa, F., Cornacchia, M., Maestrini, S., Salvadori, A., Malatesta, D.

*ISSUL, University of Lausanne, CH, Istituto Auxologico Italiano, Verbania, I*

Introduction An impaired ability to oxidize fat may be a factor in the obesity's aetiology (3). Moreover, the exercise intensity (Fatmax) eliciting the maximal fat oxidation rate (MFO) was lower in obese (O) compared with lean (L) individuals (4). However, difference in fat oxidation rate (FOR) during exercise between O and L remains equivocal and little is known about FORs during high intensities (>60% V'O<sub>2</sub>peak) in O compared with L. This study aimed to characterize fat oxidation kinetics over a large range of intensities in L and O. Methods 12 healthy L [body mass index (BMI):  $22.8 \pm 0.4$ ] and 16 healthy O men [BMI:  $38.9 \pm 1.4$ ] performed submaximal incremental test (Incr) to determine whole-body fat oxidation kinetics using indirect calorimetry. After a 15-min resting period (Rest) and 10-min warm-up at 20% of maximal power output (MPO, determined by a maximal incremental test), the power output was increased by 7.5% MPO every 6-min until respiratory exchange ratio reached 1.0. Venous lactate and glucose and plasma concentration of epinephrine (E), norepinephrine

(NE), insulin and non-esterified fatty acid (NEFA) were assessed at each step. A mathematical model (SIN) (1), including three variables (dilatation, symmetry, translation), was used to characterize fat oxidation (normalized by fat-free mass) kinetics and to determine Fatmax and MFO. Results FOR at Rest and MFO were not significantly different between groups ( $p \geq 0.1$ ). FORs were similar from 20-60%  $\dot{V}O_2$  peak ( $p \geq 0.1$ ) and significantly lower from 65-85%  $\dot{V}O_2$  peak in O than in L ( $p \leq 0.04$ ). Fatmax was significantly lower in O than in L ( $46.5 \pm 2.5$  vs  $56.7 \pm 1.9$  %  $\dot{V}O_2$  peak respectively;  $p = 0.005$ ). Fat oxidation kinetics was characterized by similar translation ( $p = 0.2$ ), significantly lower dilatation ( $p = 0.001$ ) and tended to a left-shift symmetry in O compared with L ( $p = 0.09$ ). Plasma E, insulin and NEFA were significantly higher in L compared to O ( $p \leq 0.04$ ). There were no significant differences in glucose, lactate and plasma NE between groups ( $p \geq 0.2$ ). Conclusion The study showed that O presented a lower Fatmax and a lower reliance on fat oxidation at high, but not at moderate, intensities. This may be linked to a: i) higher levels of insulin and lower E concentrations in O, which may induce blunted lipolysis; ii) higher percentage of type II and a lower percentage of type I fibres (5), and iii) decreased mitochondrial content (2), which may reduce FORs at high intensities and Fatmax. These findings may have implications for an appropriate exercise intensity prescription for optimize fat oxidation in O. References 1. Chenevire et al. *Med Sci Sports Exerc.* 2009 2. Holloway et al. *Am J Clin Nutr.* 2009 3. Kelley et al. *Am J Physiol.* 1999 4. Perez-Martin et al. *Diabetes Metab.* 2001 5. Tanner et al. *Am J Physiol Endocrinol Metab.* 2002

### SPRINT TRAINING IN HYPOXIA PROMOTES AEROBIC CAPACITY AND PHOSPHOFRUCTOKINASE ACTIVITY.

Puype, J.

*KULeuven*

Joke Puype<sup>1</sup>, Karen Van Proeyen<sup>1</sup>, Bert Ackaert<sup>1</sup>, Jean-marc Raymackers<sup>2</sup>, Karolina Szlufcik<sup>1</sup>, Louise Deldicque<sup>1</sup>, Monique Ramaekers<sup>1</sup> and Peter Hespel<sup>1</sup>. <sup>1</sup> Research Centre for Exercise and Health, KU Leuven, Belgium; <sup>2</sup> Institute of Neuroscience, U. C. Louvain, Louvain-la-Neuve, Belgium. Introduction Contradictory findings are reported regarding whether exercise training in hypoxia may further stimulate training-induced adaptations compared with similar training in normoxia. Although there are different possibilities to profit from the hypoxic stimulus, the strategy of "live low-train high" or so called "intermittent hypoxic training" is receiving major attention (Vogt et al., 2001). In this study we compared the effects of 6 weeks sprint interval training (SIT) in normoxia or in hypoxia on exercise performance. Muscle glycolytic and oxidative capacity were analysed as well. Methods Healthy male volunteers (19-36yrs) performed SIT (3d/week, 4-9 x 30-s sprints) under either hypoxic (3000m;  $FiO_2$  14.5%  $O_2$ ; HYP, n=10) or normoxic (0m;  $FiO_2$  ~ 20.9%  $O_2$ ; NOR, n=9) conditions. The control group did not train (CON, n=10). Before and after the training period the subjects performed a maximal incremental exercise test followed by a 10' time trial in normoxia and hypoxia, in addition a needle biopsy was taken from the m.vastus lateralis Results Compared with CON, maximal power output was enhanced in HYP (+5-7%,  $P < 0.05$ ), but not in NOR, as measured at sea level as well as at moderate altitude. Moreover, HYP increased the workload corresponding with the onset of blood lactate accumulation in normoxia compared with NOR ( $P < 0.05$ ) and CON ( $P < 0.01$ ). Nevertheless, HYP and NOR produced similar improvements (~5%) in both 10-min time trial performance and mean power output in a 30-s sprint. Interestingly, muscle phosphofructokinase activity was stimulated by 60% in HYP and was higher than NOR following SIT ( $P < 0.05$ ). The activity of citrate synthase was not differently affected by NOR and HYP. Discussion Our data demonstrates that intermittent sprint training in hypoxia is an effective strategy to increase whole-body oxidative capacity at sea level and at altitude as well as to enhance glycolytic enzyme activity in skeletal muscle. The increase in PFK activity may be caused by a HIF-1 $\alpha$  dependent mechanism because HIF-1 $\alpha$  triggers PFK transcription (Wenger, 2002). Vogt M., Hoppeler H. (2010). Progress in cardiovascular diseases 52: 525-533. Wenger R. H. (2002). *FASEB J.* 16:1151-1162.

### INTRA- AND INTER-MUSCLE DIFFERENCES IN ARCHITECTURAL CHANGES OF THE QUADRICEPS FEMORIS INDUCED BY RESISTANCE TRAINING

Ema, R.1, Wakahara, T.1, Miyamoto, N.1, Kanehisa, H.2, Yanai, T.1, Kawakami, Y.1

*1: Waseda University (Tokorozawa, Japan), 2: National Institute of Fitness and Sports in KANOYA (Kanoya, Japan)*

Introduction Muscle architecture is the property of skeletal muscles that determines muscle functions. Architectural parameters such as muscle thickness and pennation angle change as a result of resistance training, but findings are not consistent among studies for the quadriceps femoris. This might be due to intra- and intermuscular differences in the training-induced changes in architectural profiles. We tested this by comparing the resistance training-induced changes in muscle architecture among the four muscles and between different regions within each muscle of the quadriceps femoris. Methods Eleven healthy men completed a resistance training program of unilateral knee extensions for 12 weeks (3 days / week, 8 reps x 5 sets / day at 80% of 1RM). Before and after the training period, muscle thicknesses, fascicle lengths, and pennation angles of the four muscles (2 - 4 regions per each muscle) were measured using ultrasonography. Anatomical cross-sectional areas (ACSAs) at the same positions as the ultrasound measurements were also determined from magnetic resonance images. Results Relative increases in the ACSAs of the vastus lateralis and the rectus femoris and in the muscle thickness of the rectus femoris in the distal region were significantly higher than those in the proximal region (e.g. for ACSA, vastus lateralis:  $12 \pm 8\%$  vs.  $9 \pm 7\%$ , rectus femoris:  $28 \pm 14\%$  vs.  $19 \pm 7\%$ ). Relative increases in the muscle thickness and pennation angle of the vastus intermedius in the medial region were significantly higher than those in the lateral region. Relative increases in the ACSA, muscle thickness, and pennation angle of the rectus femoris were significantly higher than those of the vasti. Discussion The present study shows that intra- and inter-muscle differences exist in the architectural changes of the quadriceps femoris induced by resistance training. This might be attributable to the regional differences in muscle activation during exercise, because Wakahara et al. (in press) indicated that those corresponded to the regional differences of muscle hypertrophy of the triceps brachii. The inter-muscle difference in the increase in pennation angle matched with that of muscle hypertrophy. This could influence force-producing capacity of the muscles after training. Our results indicate that the training-induced changes in the muscle architecture of the quadriceps femoris should be assessed by taking into consideration inter- as well as intramuscular differences. References Wakahara T, Miyamoto N, Sugisaki N, Murata K, Kanehisa H, Kawakami Y, Fukunaga T, Yanai T. (in press). *Eur J Appl Physiol.*

### LONG-RANGE CORRELATIONS IN MOTOR UNIT DISCHARGE VARIABILITY REVEALED BY FRACTAL ANALYSIS

Yoshii, H., Nagata, K., Kouzaki, M.

*Kyoto University*

Introduction During muscle activity, motor unit (MU) discharge is not periodically constant but irregularly fluctuates. This MU discharge variability may reflect not only force or movement production but also force or movement fluctuations. Since the MU discharge variability is non-stationary, it is difficult to quantify the time-correlation of MU discharge variability. Thus, MU discharge variability has not been

thoroughly quantified, and the physiological mechanisms behind it remain as yet unknown. Therefore, the purpose of the present study is to examine the time-correlation of MU discharge variability by using fractal analysis. Methods Six healthy male participants were required to perform sustained planter flexion for 10 minutes. The target force was ~5% of MVC. A bipolar fine-wire electrode was inserted into lateral and medial soleus to record motor unit action potential (MUAP). MU discharge rate time series was discriminated from recorded MUAP time series (Kouzaki et al. 2012). The strength of long-range correlation of MU discharge interval was assessed by 'α' values in detrended fluctuation analysis (DFA) (Peng et al. 1994): white noise corresponds to an α of 0.5 whereas pink noise corresponds to an α of 1. An α value between 0.5 and 1 indicates long-range correlations such that any given MU discharge interval is dependent on a MU discharge interval at remote previous times. Results and Discussion From DFA results, a value was about  $0.80 \pm 0.09$ , indicating that the time characteristic of MU discharge has long-range correlations. When a time series has long-range correlations, the fluctuations of it indicate the anti-persistent behavior. Thus, present result suggests that the forces or movements produced by MU discharge are maintained at a certain level. In conclusion, DFA revealed the existence of feedback control in motor activity by the determining the quantity of MU discharge rate variability. References Kouzaki M, Kimura T, Yoshitake Y, Hayashi T, Moritani T. (2012). *Neurosci Letts*, in Press. Peng CK, Buldyrev SV, Havlin S, Simons M, Stanley HE, Goldberger AL. (1994). *Phys Rev. E* 49: 1691-1695

### THE INFLUENCE OF SEX, AGE AND HERITABILITY ON HUMAN SKELETAL MUSCLE CARNOSINE CONTENT

Baguet, A., Everaert, I., Achten, E., Thomis, M., Derave, W.

*University Ghent*

**Introduction** The dipeptide carnosine is found in high concentrations in human skeletal muscle and shows large inter-individual differences. Sex and age are determining factors, however systematic studies investigating the sex effects on muscle carnosine content throughout the human lifespan are lacking. Despite the large inter-individual variation, the intra-individual variation is limited. The question may be asked whether the carnosine content is a muscle characteristic, which may be largely genetically determined. **Methods** A total of 263 healthy male and female subjects of 9-83 y were divided into 5 different age groups; Prepubertal Children (PC), Adolescents (A), Young Adults (YA), Middle Adults (MA) and Elderly (E). We included 25 monozygotic and 22 dizygotic twin pairs among the entire study population to study heritability. The carnosine content was measured non-invasively in the gastrocnemius medialis and soleus by proton magnetic resonance spectroscopy (1H-MRS). **Results** In boys, carnosine content was significantly higher (gastrocnemius: 22.9 %; soleus: 44.6 %) in A compared to PC, while it did not differ in girls. A decrease (~16 %) was observed both in males and females from YA to MA. However, elderly did not have lower carnosine levels in comparison with MA. Higher correlations were found in monozygotic ( $r=0.86$ ) compared to dizygotic ( $r=0.51$ ) twins, in soleus muscle, but not in gastrocnemius. **Conclusion** In conclusion, this study found an effect of puberty on muscle carnosine content in males, but not in females. Muscle carnosine decreased mainly during early adulthood and hardly from adulthood to elderly. High intra-twin correlations were observed, but muscle-dependent differences preclude clear conclusions towards heritability. **References** Baguet A, Reyngoudt H, Poltier A, Everaert I, Callens S, Achten E, Derave W (2009). Carnosine loading and washout in human skeletal muscles. *J Appl Physiol* 106: 837-842. Everaert I, Mooyaert A, Baguet A, Zutinic A, Baelde H, Achten E, Taes Y, De Heer E, Derave W (2010). Vegetarianism, female gender and increasing age, but not CNNDP1 genotype are associated with reduced muscle carnosine levels in humans. *Amino Acids* 40: 1221-1229. Penafiel R, Ruzafa C, Monserrat F, Cremades A (2004). Gender-related differences in carnosine, anserine and lysine content of murine skeletal muscle. *Amino Acids* 26: 53-58.

### PROLONGED EXERCISE COMBINED WITH CALORIC RESTRICTION: GLOBAL INCREASE OF MUSCULAR MAXIMAL FAT OXIDATION AND BASAL AMPK PHOSPHORYLATION MOSTLY MEDIATED BY NEUROENDOCRINE EFFECTS.

Ponce-Gonzales, J.G.1, Losa-Reyna, J.I, Rodriguez-García, L.I, Guadalupe-Grau, A.1, Santana, A.1, Holmberg, H.C.2, Calbet, J.A.L.1

1.- *University of Las Palmas de Gran Canaria.* 2.- *SWSRC, Mid Sweden University.*

Skeletal muscle AMPK (AMP-activated protein kinase) stimulates glucose uptake and fatty acid oxidation. It is activated by events that increase the AMP/ATP ratio as exercise, fasting or caloric restriction. Caloric restriction, likely through PGC-1α and SIRT1, induces mitochondrial biogenesis, which in turn facilitates fat oxidation. **Aim:** To determine the mechanisms responsible for the increase in muscle fat oxidation capacity when prolonged exercise (PE) and caloric restriction (CR) are combined and, more specifically, to determine the role played by locally exercise-triggered and global neuroendocrine mechanisms. **Methods:** Basal AMPK phosphorylation, PGC-1α, SIRT1 and SIRT3 protein expression were determined by Western blot before (PRE), after four days of PE+CR and after three days of control diet and reduced exercise (10,000 steps/day; CD), in 15 overweight healthy volunteers. Muscle biopsies were obtained from both deltoideus muscles and one of the vastus lateralis. During PE+CR, subjects combined CR with 45 min of one-arm cranking (at 15% of their maximal intensity) followed by 8h walking at 3.5 km/h (30-35 km) each day. Subjects were randomly assigned to a Protein group (n=8) or Sucrose group (n=7), attending to the ingestion of 0.8 g per kg of body weight of either whey protein or sucrose per day, respectively. **Results:** Maximal muscle fat oxidation was increased in all muscles, but more in the legs than in the arms (P<0.05). AMPK phosphorylation was increased in all muscles after PE+CR (P<0.05), and remained elevated after CD (P<0.05). No changes were observed in SIRT1. In contrast, SIRT3 protein expression was reduced after PE+CR and CD (both, P<0.05). PGC-1α was reduced after CD (P<0.05 vs PRE). The level of AMPK phosphorylation was greater in the arm than in the leg muscles, however, PGC-1α and SIRT3 protein expression was higher in the leg than in the arm muscles. Insulin and leptin sensitivity were dramatically improved. No significant differences in signaling were observed among supplementation groups or between muscles. **Conclusion:** Neuroendocrine factors predominate over local muscle activity to induce the elevation of basal AMPK phosphorylation and the reduction of PGC-1α and SIRT3 protein expression, in response to PE+CR. An elevation of PGC1α protein expression is not required to increase muscle fat oxidation capacity in response to caloric restriction combined with exercise in humans. The increase in AMPK phosphorylation could explain part of the improvement in leptin and insulin sensitivity. *Granted by DEP2010-21866.*

### EXPRESSION OF CATALASE AND IMPROVED MITOCHONDRIAL FUNCTION, METABOLISM OF GLUCOSE AND FATTY ACIDS IN MUSCLE CELLS RESISTANT TO INSULIN

Barbosa, M.R., Alberici, L.C., Kettelhut, I.C., Sampaio, I.H., Silveira, L.R.

*UNIVERSIDADE FEDERAL DE SÃO CARLOS*

Reactive oxygen species (ROS) are involved in various physiological processes in skeletal muscle. However, the high availability of fatty acids (FAs) induces insulin resistance. The pathogenesis of insulin resistance involves disorders of lipid metabolism. Although the mecha-



nism is still unclear, high levels of ROS are involved in the condition of insulin resistance. Therefore, we examined whether the reduction of mitochondrial capacity and the insulin response imposed by the high availability of fatty acids are associated with an increase of intracellular hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>). METHODS The skeletal muscle cells were isolated from quadriceps muscle from Wistar rats and cultured in DMEM medium. The cells were transfected with pcDNA3 plasmid in medium containing Lipofectamine (1:4). After differentiation, the cells were exposed to the palmitic acid (700µM) during 72h. After this period, the cells were collected and the CAT content and mRNA were determined as a control experiment. In addition, the citrate synthase activity (CS) and the mRNA level of PGC1α were examined as mitochondrial biogenesis factors. Protein content of insulin receptor (IR) and Akt defined by the Western Blotting. The extracellular ROS production were determined by Amplex fluorescent probe. Whereas the oxygen consumption was measured at presence of glucose (5.6 mM) with or without insulin (0.1U) using a Clark-type electrode. In addition, glucose uptake and fatty acids oxidation determined by radioactive method. The catalase transfection was successfully transfected as indicated by catalase mRNA and content (p<0.05). The palmitic acid treatment markedly reduced the citrate synthase activity as well as the mRNA levels of PGC1α (p<0.05). This effect was accompanied by an elevated production of H<sub>2</sub>O<sub>2</sub> but reduction of oxygen consumption, glucose uptake and fatty acid oxidation (p<0.05). In addition, the levels of PGC1α, PPARβ, phosphorylated Akt and citrate lyase were markedly reduced. However, the catalase transfection was observed to attenuate this effect (p<0.05). Our results showed that elevated fatty acid availability reduces mitochondrial oxygen consumption favoring ROS production and insulin resistance. The improvement in the oxidative capacity of the cells by CAT overexpression improved mitochondrial biogenesis, oxygen consumption, as well as glucose uptake, suggesting that the control of intracellular ROS is an important therapeutic target in protecting against type 2 diabetes in muscle cells. Research support: FAPESP, CNPq, and CAPES References: HIRABARA et al., J Cell Physiol. 222(1):187-94, 2010; LYNGE et al., J Physiol. 537(Pt 2):597-605, 2001; SILVEIRA et al., J Cell Physiol., 217:1-12, 2008;

### DOES CARDIORESPIRATORY FITNESS MODIFY THE ASSOCIATION OF LOW BIRTH WEIGHT WITH INSULIN RESISTANCE?

Aoyama, T.1, Tsushita, K.2, Miyatake, N.3, Numata, T.4, Miyachi, M.5, Tabata, I.5,6, Cao, Z.B.1, Sakamoto, S.1, Higuchi, M.1  
1: Waseda University, 2: Aichi Comprehensive Health Science Center, 3: Kagawa University, 4: Okayama Health Foundation, 5: National Institute of Health and Nutrition, 6: Ritsumeikan University

Introduction Low birth weight, a proxy for fetal underdevelopment, has been established as an important risk factor for insulin resistance later in life (Hales et al., 2001). Recently, high level of cardiorespiratory fitness (CRF) has been recognized as an important factor in the prevention of insulin resistance. However, few studies investigated whether CRF could attenuate the insulin resistance associated with low birth weight (Laaksonen et al., 2003). The aim of this study was to examine the association of birth weight with insulin resistance, and how the association is influenced by CRF. Methods Subjects included 336 Japanese aged 20 to 59 years (males, 129 and females, 237). They had participated in our previous research, in which maximal oxygen uptake (VO<sub>2</sub>max), insulin resistance, and potential confounders such as abdominal circumference, blood pressure, triglycerides, HDL cholesterol, blood glucose, and smoking status were measured. Insulin resistance was assessed by the homeostasis model assessment of insulin resistance (HOMA-R), which is calculated according to the following: Fasting glucose (mg/dL) × fasting insulin (µU/mL) / 405. In this study, birth weight was obtained by mail-survey. A questionnaire was sent to participant using reply-paid envelopes. They were asked to provide their birth weights, either through Maternal and Child Health Notebook records or their mother's memory. The reply rate of this survey was 41% and the completed questionnaires of subjects were 336. Results Birth weight was inversely correlated with HOMA-R (P < 0.01) in the partial correlation analysis controlling for sex and age. Multiple linear regression analysis revealed that birth weight was associated with HOMA-R (β = -0.15, P < 0.01) even after adjustment for abdominal circumference, blood pressure, triglycerides, HDL cholesterol, and smoking status. Further adjustments for VO<sub>2</sub>max did not attenuate the relationship between birth weight and HOMA-R (β = -0.16, P < 0.001), although VO<sub>2</sub>max (β = -0.29, P < 0.001) was a stronger predictor of HOMA-R than birth weight. Discussion Insulin resistance is the major metabolic disorder in the early stages of development of type 2 diabetes or metabolic syndrome. This study indicates that low birth weight is associated with increased insulin resistance in Japanese adults, suggesting that low birth weight may be a cause of diabetes or metabolic syndrome later in life. Our study also suggests that lifelong influence of low birth weight on insulin resistance could not be offset by lifestyle modification such as increasing CRF. However, increase in CRF may improve insulin resistance independently of their low birth weight. References Hales CN, Barker DJ. (2001). Br Med Bull, 60, 5-20. Laaksonen DE, Lakka HM, Lynch J, Lakka TA, Niskanen L, Rauramaa R, Salonen JT, Kauhanen J. (2003). Diabetes Care, 26(7), 2156-2164.

14:45 - 15:45

## Poster presentations

### PP-PM13 Physiology 5

#### SALIVARY SECRETORY IMMUNOGLOBULIN A INCREASES AFTER YOGA EXERCISE

Eda, N., Shimizu, K., Suzuki, S., Tanabe, Y., Lee, E., Akama, T.

Waseda University

Objective Salivary secretory immunoglobulin A (SIgA) is useful as an immunological indicator of the risk of upper respiratory tract infection and a stress marker. It was reported that relaxation, such as watching a humorous video and listening to classical music, increased salivary SIgA secretion. We hypothesized that yoga exercise aimed at relaxation might enhance SIgA secretion. The aim of this study was to determine the effects of yoga exercise on mucosal immune function by estimating salivary SIgA. Methods 29 healthy adults (59.7 ± 12.1 yr; 2 males, 27 females) participated in this study. Each of them was at rest for 90 min on the first day, and performed yoga exercise for 90 min on the second day. During yoga exercise, they first massaged their legs and pressed acupressure points for 20 min. Then, they held yoga poses (Warrior Pose, Extended Triangle Pose, Downward-Facing Dog etc.) for 65 min, and finally lay supine (Corpse Pose) for 5min. Saliva samples stimulated by chewing a sterile cotton at a frequency of 60/60s were collected. SIgA concentration was measured using enzyme-linked immunosorbent assay (ELISA), and SIgA secretion rate was calculated by multiplying SIgA concentration by saliva flow rate. Mental states were assessed using the Profile of Mood States (POMS) - Brief Form. Measurements were carried out before and after rest and yoga exercise. Results Saliva flow rate showed no significant change by rest and yoga exercise. SIgA concentration (before

yoga;  $27.8 \pm 11.9$   $\mu\text{g/ml}$ , after yoga;  $32.8 \pm 14.2$   $\mu\text{g/ml}$ ) and SIgA secretion rate (before yoga;  $39.2 \pm 29.8$   $\mu\text{g/min}$ , after yoga;  $49.8 \pm 36.9$   $\mu\text{g/min}$ ) significantly increased after yoga exercise ( $p < 0.05$ ). The mood scores of Tension-Anxiety (T-A), Depression-Dejection (D), and Anger-Hostility (A-H) were significantly lower after yoga exercise (T-A;  $36.6 \pm 3.4$ , D;  $41.1 \pm 3.8$ , A-H;  $37.7 \pm 1.8$ ) than before that (T-A;  $39.1 \pm 5.5$ , D;  $42.9 \pm 5.4$ , A-H;  $39.7 \pm 5.1$ ;  $p < 0.05$ ). Discussion In this study, salivary SIgA concentration and SIgA secretion rate significantly increased after yoga exercise. It has been reported that salivary SIgA decreased after high-intensity exercise, but showed no significant difference after low-intensity exercise. The mood scores of T-A, D, and A-H improved after yoga exercise, and these results agreed with previous studies. Therefore, in this study, it is possible that the effect of relaxation increased salivary SIgA concentration and SIgA secretion rate after yoga exercise. Conclusion In summary, we conclude that yoga exercise aimed at relaxation might improve the mood states and enhance mucosal immune function.

### ORAL-RESPIRATORY MUCOSAL IMMUNE RESPONSES DURING A MULTI-STAGE ULTRA-MARATHON COMPETITION IN HOT AMBIENT CONDITIONS.

Gill, S.1, Barrett, E.1, Freeth, E.1, Waterman, J.1, Marczak, S.1, Teixeira, A.3, Rama, L.3, Costa, R.J.S.1,2

Coventry University, UK; Coimbra University, Portugal.

Introduction: Endurance running has previously been linked with disturbances to mucosal immunity. The aim was to determine the effects of a multi-stage, ultra-marathon (MSUM) competition conducted over five consecutive days totalling 230km in hot ambient conditions ( $T_{\text{max}} 36.8 \pm 3.6^\circ\text{C}$ , RH 35%) on oral-respiratory mucosal immune responses. Methods: On each of the 5 stage days, unstimulated saliva and whole blood samples of ultra-endurance runners (UER  $n=37$ ; Control (CON)  $n=13$ ) were collected pre-stage, immediately post-stage and during recovery. Illness symptoms were monitored during and four weeks after competition. Salivary immunoglobulin A (IgA),  $\alpha$ -amylase, lysozyme and cortisol were determined by ELISA. Plasma osmolality (Posm) was determined by freeze-point osmometry. Data were analysed using a repeated measures ANOVA with post hoc HSD. Results: Saliva flow rate (SFR) was lower on pre-Stage 5 compared with pre-Stage 1 ( $p < 0.01$ ). Post-stage decreases in SFR were only observed on Stage 2 ( $p < 0.01$  vs. pre-stage). Post-stage decreases in salivary IgA concentration were observed on Stage 5 only ( $p < 0.01$  vs. pre), while salivary IgA secretion rate decreased post-Stage 2 and 5 ( $p < 0.01$  vs. pre). Salivary  $\alpha$ -amylase concentration and secretion rate increased post-Stage 1 to 3 (additionally Stage 5 for secretion rate;  $p < 0.01$  vs. pre). Salivary lysozyme concentration increased post-Stage 2 and 4 ( $p < 0.05$  vs. pre), while salivary lysozyme secretion rate increased post-Stage 5 only ( $p < 0.01$  vs. pre). Salivary cortisol concentration was lower pre-Stage 5 compared with pre-Stage 1 ( $p < 0.01$ ), and lower post-Stage 2, 3 and 5 compared with post-Stage 1 ( $p < 0.01$ ). Increases in Posm were observed post-stage throughout all stages ( $p < 0.01$  vs. pre), but remained within normal physiological range throughout MSUM (except for post-Stage 4, 298mOsmol/kg). UER presented higher SFR, salivary IgA and amylase secretion rates during Stage 3 recovery compared with CON ( $p < 0.05$ ). Additionally, higher salivary cortisol levels pre-Stage 1 and 3 were observed ( $p < 0.05$  vs. CON). Conclusion: Both neuroendocrine activity and hydration status may have contributed to fluctuations in SFR observed. Prevention of any substantial depressions in salivary IgA,  $\alpha$ -amylase and lysozyme responses pre-stage, post-stage, and during recovery along the MUSM competition may have adequately protected the oral-respiratory mucosal tract, as reflected by the low prevalence of illness symptoms reported ( $n=1$ ) during and the month following MSUM competition.

### SALIVARY HORMONES, IGA AND PERFORMANCE DURING INTENSE TRAINING AND TAPERING IN JUDO ATHLETES

Papacosta, E.1, Gleeson, M.1, Nassis, G.P.2

1: Loughborough University, UK, 2: Faculty of Physical Education and Sport Science, National and Kapodistrian University of Athens, Greece

Introduction Judo is a demanding combat sport that incorporates periods of intensified training in order to be able to optimise performance. Therefore, the need for tapering periods during the lead up to competition is essential. The aims of this study were to identify the time-course of change of selected salivary hormones, mucosal immunity, mood state and performance capacity during a 2-week taper in judo athletes, and to examine the diurnal variation in salivary testosterone (sT), cortisol (sC) and IgA (SIgA). Methods Eleven male judo athletes (mean $\pm$ SD: age  $20 \pm 6$  years;  $\text{VO}_2\text{max}$   $57.2 \pm 7.2$   $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ; training experience  $8.5 \pm 4.7$  years) completed 5 weeks of training: 1 week of normal training (NORM), 2 weeks of intensified training (INT) and 2 weeks of exponential tapering (TAPER). Five times in total during the study period, subjects completed once per week a vertical and horizontal countermovement jump tests, a grip strength test, a Special Judo fitness test (SJFT), a multistage fitness test (MSFT) and a 3x300-m run test and anthropometric measurement. During this time, subjects also completed questionnaires to assess mood state and muscle soreness. Two daily saliva samples (at 07:00 and 19:00) were collected at the end of each week during NORM and INT and every day during TAPER. Results TAPER resulted in increased morning sT, decreased evening sC, lower muscle soreness and enhanced mood state (all  $p < 0.05$ ). A significant 7.0% improvement in 3x300-m performance time and 6.9% improvement in the vertical countermovement jump were also observed during TAPER. No significant changes were found in the SJFT and MSFT. Enhancements in 3x300-m and vertical jump performance were accompanied by an increased evening sT/C ratio and morning and evening SIgA secretion rate (all  $p < 0.01$ ). A diurnal variation in salivary markers was evident, with the higher values of sT, sC and SIgA absolute concentrations and secretion rate in the morning. Discussion This study has identified that TAPER increased sT, reduced sC and muscle soreness and enhanced mood state in trained judo athletes, and these results are similar to the findings of tapering in cyclists (Zehsaz et al., 2011). The improvements in anaerobic performance and power of lower extremities were concomitant with increased sT/C ratio and enhanced mucosal immunity. This study indicates that changes in salivary hormones, muscle soreness and mood state precede the improvements in performance and mucosal immunity. Furthermore, this study has shown that responses of sT, sC and SIgA absolute concentrations and secretion rate display a diurnal variation with the higher values in the morning, which are in agreement with previous studies in endurance athletes (Gleeson et al., 2001; Dimitriou et al., 2002) References Zehsaz F, Azarbaijani MA, Farhangimaleki N, Tiidus P. (2011) Eur J Sports Sci 11, 183-190 Gleeson M, Bishop NC, Sterne VL, Hawkins AJ. (2001) Med Sci Sports Exer S33, ISEI abstract pp 54 Dimitriou L, Sharp NCC, Doherty M. (2002) Br J Sports Med 36, 260-264 Med 36, 260-264

## FUNCTIONAL ANALYSIS OF TFE3, THE ENERGY METABOLISM RELATED TRANSCRIPTION FACTOR, IN SKELETAL MUSCLES.

Naka, A.1, Iida, K.2, Iwasaki, H.1, Nakagawa, Y.1, Yamada, N.1, Shimano, H.1

1. University of Tsukuba, 2. Ochanomizu University

**Introduction** TFE3 is a basic helix-loop-helix transcription factor that has been recently noticed as a regulator of metabolic genes. Adenovirus-mediated expression of TFE3 in liver led to metabolic consequences, such as upregulation of metabolic genes, activation of various insulin signaling molecules and enhancement of glycogen synthesis (Nakagawa et al.). However, action mechanisms of TFE3 in other organ have not been clarified yet. Skeletal muscle is another important organ for energy metabolism which is related to energy production for exercise. Therefore, in this study, we investigated the effects that TFE3 brings on skeletal muscles. **Methods** To accomplish the objective of this study, we generated mice overexpressing muscle-specific TFE3. We compared the metabolic changes, gene expressions, histological findings and exercise capacity in this transgenic mice (Tg) with those in Wild type mice. Results Hk2 (hexokinase 2), Glut4 (glucose transporter 4) and Gys1 (glycogen synthase 1) expression significantly increased in Tg mice muscles. Concomitant with the enhancement of these genes expression, muscle glycogen stores were increased and exercise endurance capacity was enhanced in Tg mice. Expression of genes, such as Hk2, Glut4 and Gys1 were further enhanced in Tg muscles after 4 weeks of training. Consequently, insulin sensitivity was enhanced in Tg mice, and exhibited better improvement after 4 weeks of exercise training. Tg mice also exhibited enhanced expression of genes involved in insulin signaling and its downstream actions as Irs-2 (insulin receptor substrate-2) and Insig-1 (insulin-induced gene-1). **Conclusions** The findings in the present study suggest that TFE3 is a potential transcriptional regulator of muscle glucose metabolism. This potential role of TFE3 suggests that it may be used for treating metabolic diseases, as well as increasing endurance in sport. **References** 1. Nakagawa Y, Shimano H, Yoshikawa T, Ide T, Tamura M, Furusawa M, Yamamoto T, Inoue N, Matsuzaka T, Takahashi A, Hasty AH, Suzuki H, Sone H, Toyoshima H, Yahagi N, and Yamada N. (2006). *Nat Med*, 12, 107-113. 2. Iwasaki H, Naka A, Iida KT, Nakagawa Y, Matsuzaka T, Ishii KA, Kobayashi K, Takahashi A, Yatoh S, Yahagi N, Sone H, Suzuki H, Yamada N, Shimano H. *Am J Physiol Endocrinol Metab.* in press.

## MATRIX METALLOPROTEINASE GENES ON CHROMOSOME 11Q22 AND RANGE OF MOTION

Burger, M., O'Connell, K., Raleigh, S.M., Posthumus, M., Collins, M.

University of Cape Town

**Matrix Metalloproteinase Genes on Chromosome 11q22 and Range of Motion** Burger, MC.1, O'Connell, K.1, Raleigh, SM.3, Posthumus, M.1, Collins, M.2,1 1: MRC/UCT Research Unit for Exercise Science & Sports Medicine, University of Cape Town, 2: South African Medical Research Council, Cape Town, South Africa, 3: Division of Health & Life Sciences, University of Northampton, UK **INTRODUCTION** A recent heritability study has demonstrated that human range of motion (ROM) has a substantial genetic component [1]. Furthermore, the COL5A1 BstUI RFLP has now been identified as the first gene variant to be associated with human ROM [2]. Other musculoskeletal soft tissue coding and/or signalling genes may also associate with ROM measurements. Therefore the aim of this study was to investigate the association between these four MMP gene variants and ROM measurements, including sit-and-reach (SR), straight leg raise (SLR) and total rotation of the shoulder (ShTR) in physically active individuals. **METHODS** Three hundred and thirty-four physically active Caucasians were included in this study. All participants were genotyped, using a Taqman assay, for the MMP1 1G/2G rs1799750, MMP3 A/G rs679620, MMP10 C/T rs486055 and MMP12 A/G rs2276109 variants. SR, SLR and ShTR ROM tests were performed on all participants and investigated for genotype effects. Significance was accepted  $p < 0.05$ . **RESULTS** There were no significant differences between the MMP1 (SR, mm: 1G1G 267±110, n=79; 1G2G 265±116, n=170; 2G2G 282±110, n=64;  $p=0.507$ ), MMP3 (SR, mm: AA 265±114, n=81; AG 277±102, n=160; GG 257±120, n=88;  $p=0.078$ ), MMP10 (SR, mm: CC 267±114mm, n=222; CT 273±102, n=70; TT 252±125, n=16;  $p=0.923$ ), MMP12 (SR, mm: AA 265±110, n=147; AG 270±110, n=61; GG 331±61, n=7;  $p=0.321$ ) genotypes and the SR ROM measures. In addition there were no significant genotype effects on SLR and ShTR. No haplotype- or age-genotype interaction with ROM was observed. It was interesting to note that individuals with the minor MMP12 rs2276109 GG genotype seemed to be much more flexible for all measurements (SR, mm: GG 331±61, n=7; AA+AG 266±110, n=308;  $p=0.135$ ), however, due to the sample size, this finding was not significant. **CONCLUSION** The MMP1, MMP3, MMP10 and MMP12 genes were not associated with ROM in this study. Due to the observed trends and rarity of the MMP12 GG genotype, a further analysis with a larger sample size is required. **REFERENCES** 1. Battié, M.C., Levalahti, E., Videman, T., Burton, K. & Kaprio, J. (2009). *Journal of applied physiology* 104, 379-85. 2. Collins, M., Mokone, G.G., September, A.V., van der Merwe, L. & Schwellnus, M.P. (2009). *Scandinavian journal of medicine & science in sports* 19, 803-10.

## EFFECTS OF ACUTE ENDURANCE EXERCISE ON GENE EXPRESSION IN SKELETAL MUSCLE: SEARCH FOR PUTATIVE MYOKINES

Catoire, M., Mensink, M., Boekschoten, M.V., Müller, M., Schrauwen, P., Kersten, S.

Wageningen University

**Background:** Exercise is known to be a powerful way to prevent and treat type 2 diabetes mellitus. Skeletal muscle is the predominant organ impacted by exercise but many of the metabolic changes induced by exercise may involve the liver. An important question is how exercise- or better skeletal muscle contraction - can alter hepatic function and insulin action. It is hypothesized that myokines play an important role in the cross-talk between skeletal muscle and liver. Since only a few myokines are known so far, identifying unknown myokines might provide valuable information for future research on the pathogenesis and treatment of type 2 diabetes mellitus. The aim of this study was to investigate the effect of acute endurance exercise on gene expression in skeletal muscle, with a focus on potential myokines, and to assess the importance of local and systemic effects of exercise on gene expression in skeletal muscle. **Methods:** Nine healthy, male subjects (40-60 years) cycled for one hour with one leg at a submaximal rate. The passive leg served as control. Before and after exercising, muscle biopsies were taken from both legs and analyzed with microarray to determine which genes changed in response to exercise. **Results:** One-legged cycling induced a significant change in 761 genes ( $p < 0.01$ ), of which 594 were significantly upregulated and 167 genes were downregulated. In contrast, in the control leg only 235 genes changed significantly ( $p < 0.01$ ; 165 upregulated, 70 downregulated). There was an overlap of 63 genes between both legs. In the exercising leg the top 3 regulated genes all belonged to the NR4A transcription factor family, with a highest fold change of 25 (NR4A2). In the non-exercising leg the top 3 consisted of ANGPTL4, PDK4 and ZNF750, with the highest fold change of 2.1 for ANGPTL4. Genes coding for potentially secreted proteins were (amongst others): ANGPTL4, THBS1 (both legs), CYR61, MCP-1, VEGFA and CX3CL1 (exercising leg). **Conclusion:** Exercise-induced gene expression changes are the result of both systemic and local stimuli. The NR4A transcription factor family are potential regulators of the

adaptive processes that take place in skeletal muscle during and after exercise. Several putative myokines are identified that are involved in processes such as angiogenesis, growth, insulin signaling and lipid metabolism.

### ACE I/D POLYMORPHISM AND ACTN3 R577X POLYMORPHISM AFFECTS MUSCULAR STRENGTH AND FUNCTIONAL CAPACITY IN RESPONSE TO HIGH-SPEED POWER TRAINING IN OLDER CAUCASIAN WOMEN

Pereira, A., Silva, A., Costa, A., Bastos, E., Marques, M.

UNIVERSIDADE DE TRAS OS MONTES

**Introduction** The angiotensin-converting enzyme (ACE) and the alpha-actinin-3 (ACTN3) gene have been associated with power phenotypes and have been suggested to influence skeletal muscle function in response to strength training (Lima et al. 2010). There is a paucity of research data concerning exercise training-induced adaptations in older population. The purpose of this study was to investigate the possible associations between ACE I/D and ACTN3 (R/X) polymorphisms and maximum strength, power and muscle function in older Caucasian women and their adaptation during 12-weeks of high speed power training. **Methods** Older women (n=139; age= 62.5+/-8.1; ID:n=52; DD:n=52; II:n=35 and RX:n=54; RR:n=52; XX:n=33) realized a period of intervention consisted of 40% of one repetition maximum (1RM) to 75% and 3 sets 4-12 reps in countermovement jump (CMJ) (Pereira et al., 2012). Strength was measured dynamically in leg extension exercise (1RMLE), power was evaluated by CMJ and functional capacity was recorded by sit to stand test (STS). ACE I/D and ACTN3 R/X polymorphisms were determined by polymerase chain reaction. Significant differences were performed by ANOVA (means±SD). The trainingxgenotype effects were analyzed by repeated-measures ANOVA. Results Whole body was independent of ACE and ACTN3 genotypes. At baseline no significant effects of both ACE and ACTN-3 genotype were found for all considered strength parameters. Genotype effect for ACE showed no statistically difference only in 1RMLE (P=0.187). But subjects with genotype DD had higher maximal strength than others after the high-speed power training. Although, genotype effect for ACTN3 showed significant effects for all measures: 1RMLE (p=0.011), CMJ (p=0.050) and STS (p=0.033). RR genotype exhibited a positive and a prevalence of strength (1RMLE: 33.1±6.4), power (CMJ: 0.164±0.02) and functional capacity (31.3±4.7) comparing to RX and XX genotypes. The combined influence of ACE DD+ACTN3 RR vs. ACE II+ACTN3 XX polymorphisms was also studied. In response to high-speed power training, the results showed that the D-allele carriers and R-allele combination seems to induce significant increases but only for 1RMLE. **Discussion** These data suggest that ACE genotype is not associated with muscle strength adaptation to high-speed power training. On the other hand, strength training response seems to be significantly affected by the presence of the ACTN-3 RR genotype alone or in combination with the ACE DD genotype in older Caucasian women's. The results provide a novel insight that these genetic variations may interact to determine muscle performance in older women. Lima, R. M., Leite, T. K., Pereira, R. W., Rabelo, H. T., Roth, S. M., & Oliveira, R. J. (2010). ACE and ACTN3 Genotypes in Older Women: Muscular Phenotypes. *Int J Sports Med*, 31, 1-7 Pereira A, Izquierdo M, Silva AJ, Costa AM, Bastos E, González-Badillo JJ, Marques MC. (2012). Effects of high-speed power training on functional capacity and muscle performance in older women. *Exp. Gerontol.* (2012) (accepted). doi:10.1016/j.exger.2011.12.010

### DIFFERENCES IN NATURAL KILLER CELL NUMBERS BETWEEN ELITE KAYAKERS AND NON-ATHLETES

Borges, G.F.1,4, Rama, L.1, Rosado, F.1, Alves, F.2, Santos, A.1, Gomes, B.1, Massart, A.1, Pedreiro, S.3, Paiva, A.3, Teixeira, A.M.2

1: FCDEF-UC (Coimbra-Portugal), 2: FMH-UTL (Lisbon, Portugal), 3: HC (Coimbra, Portugal), 4: ISB-UFAM (Brazil).

**Introduction** Prolonged strenuous exercise has been associated with a depression of immune function. At rest immune function in athletes compared with non-athletes has more similarities than disparities. However, there is a need for more studies that specify subsets and relates to specific times of the training. **Aim** The objective of this study was to see if chronic training was able to produce sustained differences in the peripheral blood cells in leukocytes subpopulations (WBC, granulocytes, monocytes, total lymphocytes, B and T lymphocytes, CD4+ and CD8+ T cells and NK cells) of athletes (kayakers) after a rest period of 6 weeks when compared to non-athletes. **Methods** The sample comprised 13 elite male kayakers, 20±3 years old, 75.0±7.9kg weight and 177.3±7.1cm stature. Their VO2max was 58.3±7.8 mL.kg.min<sup>-1</sup>. The non-athlete group comprised 7 healthy males, aged 18±1 years old, 81.3± 13.8 kg of weigh and 171.9±4.5cm stature. The athlete blood samples were collected at the beginning of the training season, after an off period of six weeks of training. To verify the differences between the athlete and non-athlete groups the Mann-Whitney U Test was used, and significance was set at P<0.05. **Results** No differences between the trained kayakers and the non-athletes were found at rest except for the total number and percentage of NK cells, namely in the CD3-CD56+CD8+ subset whose values were lower in the athletes. **Discussion** Our results seem to confirm that a reduction in NK cell numbers, especially in CD56+CD8+ subset even for longer periods of time. During exercise the number of circulating NK cells in the peripheral blood increases after one to two hours and then reduce to values that may be below the baseline (Del Giacco et al., 2001). The reduction in NK cell counts has been reported to persisted for up to seven days following exercise (Shek et al., 1994). The lower peripheral blood NK cell counts, especially CD3-CD56+CD8+ subset, in elite athletes may relate to reduced cellular production and cytotoxicity. On the other hand, this finding may reflect a chronic adaptation to training, suggesting that a decrease in the number of CD3-CD56+CD8+ cells could mean a lower risk of lysing autologous cells and decrease the inflammation status together with a redistribution of the NK cells into tissues for immune surveillance. **References** Del Giacco SR, et al. (2001). *Allergy* 56:215-223. Shek PN, et al. (1994). *France: CRSSA* : 121-137.

### THE AGT AND AGTR1 POLYMORPHISMS AND THEIR CONTRIBUTION TO PERFORMANCE-RELATED PHENOTYPES

Gineviciene, V., Jakaitienė, A., Milasius, K., Tubelis, L., Kucinskas, V.

Vilnius University

**Introduction** Among the individual components of renin-angiotensin system (RAS), the genes encoding angiotensinogen (AGT) and angiotensin-II receptor type1 (AGTR1) together with environmental factors play important role in physiological process. The significance of AGT C/T (C704T, Tre235Met) and AGTR1 A/C (3'UTR A1166C) polymorphisms is unknown in physical performance, anthropometric features, and for body composition in a population of athletes participating in different disciplines. **Methods** A total of 164 Lithuanian elite athletes (77endurance-oriented, 38power-oriented, 49"mixed group") and 240 healthy unrelated citizens (controls) were genotyped (PCR-RFLP). Vertical jump (counter-movement) test was used for the estimation of the short-term explosive muscle power (STEMP). Anaerobic alactic maximum power (AAMP) was estimated by the stair climbing test. Aerobic capacity function was determined using the maximum oxygen consumption (VO2max). Anthropometric measures were also estimated. **Results** There were no significant allele or genotype frequency differences between the athletes groups and the controls. The height, weight, muscle mass, handgrip strength and indices of functional

capacity STEMP, AAMP and VO<sub>2</sub>max were significantly different with respect to gender ( $p < 0.05$ ). Regression analysis for total athletes group showed that gender, fat mass and muscle mass have significant impact on AAMP ( $R^2 = 0.575$ ). The high muscle mass and low fat mass of an athlete lead to improved AAMP. There as STEMP and muscle mass (positive) are important describing AGTR1 A/C genotype ( $R^2 = 0.421$ ). High STEMP was observed of AGTR1 A/A genotype for men and of AGTR1 A/C genotype for women in speed/power-oriented sports. VO<sub>2</sub>max of athletes with AGTR1 A/A genotype was higher than of those carrying AGTR1 A/C and C/C genotypes ( $p < 0.05$ ). Discussion Reports on the RAS polymorphisms have to date focused on the AGT T allele and AGTR1 C allele, and its association with pathological events (cardiovascular complications). In the study, we employ an alternative way where the significance of AGT(C/T) and AGTR1(A/C) is accessed via their physiological effects in athletes. Statistical significance was reached for AGTR1(A/C) but not for AGT(C/T) polymorphism. We found that the influence of AGTR1 polymorphism on the physical capacity phenotype is different depending on gender and associated with a complex phenotypic characteristic. The athletes, carriers of the AGTR1 A/A genotypes, typically have better VO<sub>2</sub>max (aerobic capacity) as well as have better ability to achieve high muscle capacity indices when exercising short-term explosive muscle power tasks. Summarizing the results we conclude that in the Lithuanian athletes the AGTR1 genotypes show unique characteristics and the A allele of the AGTR1 might influence general sporting prowess.

## 14:45 - 15:45

### Poster presentations

#### PP-PM14 Training & Testing 2

##### WHAT PHYSICAL AND PERFORMANCE QUALITIES CHARACTERISE ELITE RUGBY SEVENS PLAYERS?

Higham, D.G.1,2,3, Pyne, D.B.1,2, Anson, J.M.2

1: Australian Institute of Sport (Canberra, Australia), 2: University of Canberra (Canberra, Australia), 3: Australian Rugby Union (Sydney, Australia)

Introduction Rugby sevens is a format of rugby union that has increased in popularity in recent years and will be contested at the Olympic Games from 2016. Marked differences in the specific demands of competition between 15-player rugby union and rugby sevens suggest the characteristics of high-level players in each format may also differ (Higham et al., 2011). Although the characteristics of 15-a-side rugby union players have been well defined, little information exists on rugby sevens players. We profiled the anthropometric, physiological and performance qualities of elite-level rugby sevens players, and quantified relationships between these characteristics. Methods Eighteen male international rugby sevens players undertook anthropometric (body mass, stature, sum of seven skinfolds, lean mass index), acceleration and speed (40-m sprint), muscular power (vertical jump), repeated-sprint ability (6 x 30-m sprint) and endurance (Yo-Yo intermittent recovery level 1 test and treadmill VO<sub>2</sub>max) testing. Associations between measurements were assessed by correlation analysis. Results Rugby sevens players had anthropometric characteristics (body mass  $89.7 \pm 7.6$  kg, stature  $1.83 \pm 0.06$  m, sum of skinfolds  $52.2 \pm 11.5$  mm; mean  $\pm$  SD) similar to backs in international 15-player rugby union. Acceleration and speed (40-m sprint  $5.11 \pm 0.15$  s), muscular power (vertical jump  $66 \pm 7$  cm), and endurance (VO<sub>2</sub>max  $53.8 \pm 3.4$  mL/kg/min) qualities were similar to, or better than, professional 15-a-side players. Coefficients of variation ranged from 2.5 to 22%. Relative VO<sub>2</sub>max was largely correlated with Yo-Yo distance ( $r = 0.60, 0.21$  to  $0.82$ ; 90% confidence interval) and moderately correlated with 40-m sprint time ( $r = -0.46, -0.75$  to  $-0.02$ ) and repeated-sprint ability ( $r = -0.38, -0.72$  to  $0.09$ ). A very large correlation was observed between velocity at VO<sub>2</sub>max and Yo-Yo distance ( $r = 0.89, 0.74$  to  $0.96$ ). Discussion Our findings provide an important first step toward the development of physical performance standards for players training to compete at the international level. International rugby sevens players require highly-developed speed, power and endurance to tolerate the demands of competition. The small between-athlete variability of characteristics in rugby sevens players highlights the need for relatively uniform physical and performance standards in contrast with 15-a-side teams. Simple field-based measures may be employed to assess training adaptations and prescribe velocity thresholds for performance monitoring in place of time-consuming and expensive laboratory-based tests. References Higham DG, Pyne DB, Anson JM, Eddy A. (2011). J Sci Med Sport, doi:10.1016/j.jsams.2011.11.256

##### STEROID HORMONE RESPONSE TO RUNNING AND CIRCUIT TRAINING EXERCISE IN TRAINED MEN UTILISING ELISA AND MASS SPECTROMETRY

Tanner, A.V., Nielsen, B.V., Allgrove, J.E.

University of Greenwich

Steroid hormone response to running and circuit training exercise in trained men utilising ELISA and mass spectrometry Tanner, A.V1; Nielsen B.V2 and Allgrove, J.E2 1: University of Hertfordshire, United Kingdom 2: University of Greenwich, United Kingdom Introduction Cortisol (C) and testosterone (T) are important biomarkers of acute and chronic stress (Urhausen et al., 1995). However, it is unclear how different forms of training affect the response of these hormones. Additionally mass spectrometry (MS) is currently widely used in pharmaceutical and health industries to measure small biomarkers; however use in sports research is limited. The purpose of this study was to examine the effect of various training sessions on salivary and plasma C and T in male runners and test the validity of MS to measure salivary stress hormones in exercise research. Methods 10 male runners completed the study. Four trials were completed: a) 30 min tempo run at lactate threshold (TEMP); b) 30 mins running alternating 3.5 mins at 90% and 2 mins at 30% VO<sub>2</sub>max (INT); c) 30 mins circuit training with 3x10 exercises of 30 secs with 30 secs recovery between exercises (CIR) and d) 30 mins rest (REST). Saliva and plasma samples were collected pre exercise and at 0, 15, 30 and 60 mins post exercise and rating of perceived exertion (RPE) and heart rate (HR) were recorded. Plasma and saliva samples were analysed for C and T with ELISA and saliva samples also with MS. Results Mean HR ( $\pm$ SD) was:  $161 \pm 7, 159 \pm 14, 130 \pm 12$  and  $63 \pm 1$  beats per minute for TEMP, INT, CIR and REST respectively with INT and TEMP higher than REST. Peak HR was higher in INT compared to CIR ( $p = 0.021$ ) and TEMP ( $p = 0.004$ ). Salivary C was higher in INT than REST ( $p = 0.004$ ) and remained elevated at 60 mins post exercise. Salivary T was higher than REST immediately post exercise in INT, TEMP and CIR ( $p < 0.05$ ). Overall, TEMP was higher than REST ( $p = 0.05$ ). Plasma and salivary measures were correlated in C ( $r = 0.813$ ) and T ( $r = 0.568$ ) with peaks occurring simultaneously. There was a strong correlation for salivary C measured with MS and ELISA ( $r = 0.934, p < 0.05$ ). Discussion This study found that an INT session elicited an increase in salivary C which is in agreement with previous research (Vuorimaa et al., 2008;

Hough et al., 2011). The study implied peak HR may indicate salivary C levels and could be a useful tool to assess training stress. Moreover, MS was revealed as a valid technique to measure the salivary C response to exercise and routine use in the exercise arena pursued. Further method development is required to reliably measure T with MS due to low assay sensitivity; however MS remains the gold standard in hospital and pharmaceutical analysis. References Hough JP, Papacosta E, Wraith E, Gleeson M. (2011). *J Strength Cond Res*, 25, 23-31 Urhausen A, Gabriel H, Kindermann W. (1995). *Sports Med*, 20 (4) 251-276 Vuorimaa T, Ahotupa M, Hakkinen K, Vasankari T. (2008). *Scand J Med Sci Sports*, 18, 565-72

### REPEATED SPRINT ABILITY TASK DEPENDENCY: THE EFFECT OF RUGBY UNION SPECIFIC TASKS

Morel, B.1, Hautier, C.1, Rouffet, D.2

*Université Claude Bernard Lyon 1*

1: CRIS (Lyon, France), 2: ISEAL (Victoria, Australia) Introduction The ability of team sport players to repeat maximal efforts, referred as Repeated Sprint Ability (RSA), strongly influences both individual and team performances. It has been shown that RSA is task dependent but it is still mainly studied using cycling or running protocols (Girard and al., 2010). This study proposes to investigate RSA of rugby players during specific rugby tasks as running sprints (RU) but also mauling (MA) and scrummaging (SC) which are repeated all over the game. Methods 8 rugby players performed three RSA tests interspersed by at least 48h. We used RSA test consisting in 5 repetitions of 5s maximal exertion interspersed with a 20s passive recovery. Three tasks were investigated: RU monitoring average speed, SC using a yoke with a force sensor to measure the average force production over the 5s repetitions and MA assessed with a moving yoke (on wheels) recording the distance of displacement to evaluate the average speed on 5s. To complete the performance data obtained, blood lactate accumulation, EMG recordings of the Vastus Lateralis and Rate of Perceived Exertion (RPE Borg scale) were recorded for each task. Results The repetition of RU, MA and SC induced a decrease in the performance associated of respectively 23%, 13% and 7%. Furthermore, an EMG level decrease was observed only during MA (21%) and SC (13%) while blood lactate accumulation was significant just for RU (9.2 mmol/L) and MA (8.8 mmol/L). Average RPE was higher during the repetition of SC (7.8) compared to MA (7.2) and RU (7.1). Discussion RSA induced performance decrease for the three tasks tested but the decrease was more important for scrummaging compared to running sprints. Mauling is intermediate as it didn't differ from both others situations. Furthermore it is interesting to observe that EMG loss is present only for scrummaging and mauling tasks while blood lactate accumulation was significant just for the dynamic tasks. These results are in line with previous studies which demonstrated that voluntary activation failure occurred during the repetition of isometric contractions while the repetition of concentric contraction leads fatigue from peripheral perturbation (Babault and al., 2006). Mauling (slow dynamic task) seems to be intermediate with scrummaging (static) and running sprints (fast dynamic). The three tasks tested on the same RSA test causes different level of fatigue and seem to be linked to different fatigue causes. Thus RSA seems to be task dependent for rugby activity which tends to indicate that specific tests have to be developed and used depending on the players role. References Babault N, Desbrosses K, Fabre MS, Michaut A, Pousson M. (2006). *J Appl Physiol*, 100: 780-785. Girard O, Mendez-Villanueva A, Bishop D. (2011). *Sports Medicine*, 41: 673-694.

### EVOLUTION OF SKIN TEMPERATURE AFTER AEROBIC TRAINING

Fernández-Cuevas, I.1, Sillero Quintana, M.1, García-Concepción, M.A.1, Gómez Carmona, P.1, Marins, J.2

*Technical University of Madrid (Universidad Politécnica de Madrid)*

Introduction Thermal response of skin temperature has been studied during exercise and immediately after (Merla, 2010). However, more studies about the influence of exercise on skin temperature through the time are required in order to better understand the impact of physical activity on thermoregulatory system and metabolism. The aim of this study was to evaluate the thermal response of skin temperature during and after aerobic exercise. Methods 15 physically active males (mean  $\pm$  SD: age, 22  $\pm$  3,34 yr; height, 178  $\pm$  0,04 cm; weight, 73,03  $\pm$  7,3 Kg) performed 45' of running on treadmill at a moderate intensity (60-75% HR). Skin temperatures were recorded before the exercise, immediately after, and 1, 2, 4 and 8 hours after the test by infrared camera (FLIR T335) in a standardised room, with controlled temperature (20,64  $\pm$  0,70C and 44  $\pm$  3% humidity), following the patterns set by Gómez Carmona et al. (2010) patented protocol. Skin temperatures from over 72 Region of Interest (ROI) were obtained using termotracker® software. An ANOVA analysis and post hoc Tukey analysis were carried out on the averaged temperatures by the moment of the measurement. RESULTS: The effects of the resistance training were different according to the considered area. In the upper limb, there were not found significant differences ( $p = 0.08$ ) within the 8 hours after the season training. Temperatures did not increase immediately after the training season (from 31.5  $\pm$  0.7  $^{\circ}$ C to 31.5  $\pm$  1.7  $^{\circ}$ C) but increased only 0,5  $^{\circ}$ C (32.0  $\pm$  0.7  $^{\circ}$ C) one hour after. Those values remained constant 8 hours after the training season (32.2  $\pm$  0.5  $^{\circ}$ C). In the lower limb, the averaged values increased significantly ( $p < 0,05$ ) immediately after the training season (from 30.1  $\pm$  0.9  $^{\circ}$ C to 31.1  $\pm$  0.9  $^{\circ}$ C), keeping similar values after one hour of recovery (31.1  $\pm$  0.7  $^{\circ}$ C), and then progressively reducing their values up to temperatures not significantly different from baseline 8 hours after the training. The abdominal area significantly ( $p < 0,05$ ) reduced his initial temperature after the training (from 32.7  $\pm$  1.04  $^{\circ}$ C to 31.4  $\pm$  1.7  $^{\circ}$ C), increasing significantly ( $p < 0,05$ ) the temperature after one hour of recovery (33.4  $\pm$  0.8  $^{\circ}$ C), and keeping significantly higher values ( $p < 0,05$ ) even 8 hours after the training season (33.8  $\pm$  0.7  $^{\circ}$ C). DISCUSSION: Ring (2000) suggested that the influence of exercise on skin temperature is up to 6 hours. However our results show that after 8 hours, skin temperature is still affected by exercise. It could be a relation with metabolism, and as Knab (2011) described, metabolism is affected by exercise up to 14 hours after, in that case, skin temperature could be also a metabolic indicator. Further investigation are required in order to go deeper on that topic References Gómez Carmona, P. M. (2010). Spain Patent No. P201031080 Merla, A (2010) *Ann Biomed Eng*, 38(1), 158-163. Ring, E., & Ammer, K. (2000) *Thermology International*, 10(1), 7-14. Knab, A. M. (2011) *Med Sci Sports Exerc*, 43(9), 1643-1648.

### COMPARISON OF PHYSIOLOGICAL RESPONSES IN INLINE-SPEEDSKATING TO RUNNING AND CYCLING. A SIMPLIFICATION OF EXERCISE TESTING?

Hildebrand, C., Mierau, J., Joisten, F., Strüder, H.K.

*German Sports University*

Introduction: Exercise testing is the basis for an individual targeted training and therefore indispensable in high performance sport. For optimal results, athletes are tested in a sport specific mode. However a specific inline-speedskating test poses some practical and methodological problems. Laboratory testing requires a special ergometer whereas field testing is only possible on a special skating track. Therefore, it was the aim of the study to investigate if results from more traditional exercise test in running or cycling can be transferred to

inline-speedskating. Methods: For this reason we examined five male athletes ( $29 \pm 3.9$  years,  $172.2 \pm 5.9$  cm and  $69.3 \pm 7.5$  kg) of the top national level. The subjects performed three incremental exhaustive tests (ergometer cycling (EC), field running (FR), field inline-speedskating (FIS)) in randomized order. The protocols were designed so that step duration and intensity increase were comparable. Oxygen uptake (VO<sub>2</sub>, absolute [l·min<sup>-1</sup>] and relative [ml·kg<sup>-1</sup>·min<sup>-1</sup>]), heart rate (HF [b·min<sup>-1</sup>]) and blood lactate concentration (LA [mmol/l]) were measured during each trial through a portable spirometry system (MetaMax 3B, Cortex, Germany). Results: Maximal values for absolute VO<sub>2</sub> ( $p=0.06$ ), LA ( $p=0.49$ ) and HF ( $p=0.63$ ) were not significantly different for all three exercise modes. Only the relative VO<sub>2</sub>max differed significantly ( $p=0.02$ ) between inline-speedskating (67.23) and cycling (82.04). At workloads corresponding to 2 and 4 mmol/l lactate no significant differences ( $p > 0.05$ ) could be revealed for HF or VO<sub>2</sub>. Even for HF and LA at respiratory thresholds (ventilator threshold, respiratory compensation point) no significant differences ( $p > 0.05$ ) could be detected. Conclusion: The results indicate that a cycling and running test revealed comparable physiological responses to an inline-speedskating test. Therefore we conclude that both a cycling and a running exercise test with the applied test protocol are a qualified alternative for an elaborate inline-speedskating test.

## EVALUATING THE CYCLIST'S VIBRATIONAL COMFORT DURING OUTDOOR FIELD TESTING

Vanwalleghem, J., Mortier, F., De Baere, I., Loccufier, M., Van Paepegem, W.  
Ghent University

Evaluating the cyclist's vibrational comfort during outdoor field testing Vanwalleghem J. (1), Mortier F. (1), De Baere I. (1), Loccufier M. (2), Van Paepegem W. (1) (1): DMSE (UGent, Belgium), (2): EESA (UGent, Belgium) Introduction The effect of vibrational exposure to sports activities has shown to have a negative influence on the performance of sportsmen. This superimposed vibration cannot be neglected during cycling, especially when cycling a cobblestones pavement. Because human comfort to vibrations is rather subjective, two methods exist to evaluate and quantify the vibrational comfort. The aim of this study is to set up an experimental test procedure for quantifying vibrational comfort and to find out which method is most appropriate for measuring comfort during cycling. Vibrational comfort and bicycle instrumentation The first evaluation method is written down in whole-body and hand-arm vibration standards (BS6841:1987), at which the acceleration level measured at the contact points between the cyclist and the bicycle is used for vibrational comfort evaluation. The second method is called 'absorbed power', which is a measure for the power lost by the human body due to vibrational exposure. Absorbed power is defined in terms of contact velocity and contact force at the contact points between the cyclist and the bicycle. The racing bicycle used for testing is equipped with acceleration and force sensors, each measuring the contact acceleration and contact force at the handlebar and the saddle in two orthogonal directions in plane of the bicycle. The contact velocity then results from integrating the acceleration signal. The entire data acquisition and storage system is packed in a backpack which is carried by the cyclist. Results The outdoor tests were performed with a Museeuw Flax 5 racing bicycle and a cycling speed of 30km/h is maintained over a 180m distance at both an asphalted and cobblestones pavement road (Mortier, 2011). The results were analysed using both evaluation methods and both show less comfort when cycling on cobblestones. If the cyclist is asked to handle the bicycle in such a way that his vibrational exposure decreases subjectively, this subjective feeling of increased comfort is also found in the results from the absorbed power method whereas the whole-body vibration method yields contrary findings. Another advantage of the absorbed power method is that power loss is expressed in Watt, which may be related to cycling performance. These initial tests have shown that the bicycle instrumentation is successful and future work can lead to conclusions on how comfort is related to e.g. tyre pressure, bicycle frame material, cycling position, etc. References BS 6841:1987, Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock. Frederik Mortier, 'Evaluation of the dynamic behaviour of composite racing bicycles through outdoor field testing,' Ghent University, Master's thesis 2010-2011.

## THE USE OF FREEPOWER® TO PREDICT 1RM

Comotto, S.1, Varalda, C.1, Di Muzio, D.1, Picerno, P.2, Piacentini, M.F.1  
1:University of Rome

THE USE OF FREEPOWER® TO PREDICT 1RM Comotto, S.1, Varalda, C.1, Di Muzio, D.1, Picerno, P.2 Piacentini, M.F.1 1:DISMUS (University Foro Italico, Italy) 2:SENSORIZE S.r.l., Rome, Italy Introduction To correctly prescribe a strength training program, it is essential to assess an individual's maximal strength (1RM). Determination of 1RM can be done directly and indirectly by prediction equations. The aim of the present study was to evaluate the validity and the reliability of the prediction of 1RM assessed with an inertial measurement unit during 4 different trials. Methods Six males ( $23 \pm 2$  yrs;  $76 \pm 11$  kg;  $177 \pm 6$  cm), all trained from different sports, with no experience in weight lifting, were recruited for the present study. The participants performed 4 trials (T1, T2, T3 and T4) for the upper (UL) and lower (LL) limbs, with a rest of minimum 2 days. The 1RM for UL was conducted at the chest press (Technogym, Gambettola, Italy) whereas the LL 1RM on a horizontal leg press (Technogym Gambettola, Italy). Each trial consisted in a direct measurement (1RM) and an indirect measurement for UL and LL. Tests on the same trial were randomized. The direct measurement was performed with an incremental test arriving at the load that participants could lift only once. The prediction of 1RM was assessed using FreePower (Sensorize S.r.l., Italy), a software that inputs acceleration data measured by a wireless inertial measurement unit fixed to the weight stack of the machine through a magnetic pocket. The software estimates 1RM by using a mathematical relationship between force, power and velocity measured in correspondence of at least three increasing loads. Repeated measures ANOVA ( $p < 0.05$ ) was used to evaluate differences between trials and between direct and indirect measurements. Intraclass correlation coefficients (ICC) were used to evaluate reliability. Retest correlation was measured by Pearson correlation coefficient ( $p < 0.05$ ). Results Differences emerged for 1RM between T1 and T2 ( $p < 0.05$ ) and T3 and T4, in both direct and indirect measurements for UL and LL. Thus, to evaluate the ICC only T3 and T4 were considered. A high ICC (range 0.973–0.998) were found for UL and LL in both direct and indirect measurements. In addition, the retest correlation was  $> 0.95$ . No differences emerged between direct and indirect measurements. Discussion Determination of 1RM is fundamental to prescribe correct resistance training programs in different sports. Direct 1RM measurement is time consuming, and may lead to muscle soreness as well as temporary deterioration of the function of the tested muscles. Differences founded for T1 and T2 demonstrate that a familiarization session is needed both for direct and indirect measurements. Since no differences emerged between direct and indirect measurements, results of this study demonstrated that FreePower is a reliable and useful device to determine 1RM. Acknowledgements: Sensorize s.r.l.

## RELATIONSHIPS BETWEEN MAXIMUM STRENGTH, SPRINT ABILITY AND RATE OF INCREASE IN SPRINT TIME IN 20-M SLED TOWING

Martínez-Valencia, M.A.1, Cánovas, J.F.2, Romero-Arenas, S.2, Linthorne, N.P.3, González-Ravé, J.M.1, Alcaraz, P.E.2

1: UCLM (Toledo, Spain); 2: UCAM (Murcia, Spain); 3: Brunel University (Uxbridge, United Kingdom)

Introduction Towing sled is one of many methods that have been implicated in the development of running speed, in this sense, it has been suggested that resisted sprint towing increases athlete's strength (Alcaraz et al., 2008). In this training method the load is adjusted to set the intensity of the exercise, and this weight is often set to a percentage of the athlete's body mass (Bm). Other authors (Murray et al., 2005) suggested that the athlete's sprint time increased linearly with increasing sled mass, but we hypothesized that the effect of the sled mass on athlete's sprint ability depends on strength or power variables. According to this suggestion, previous study (Murray et al., 2005) proposed assigning loads as a proportion of strength. In this respect, the aim of the study was to determine the relationship between maximum strength, sprint ability and rate of increase in sprint time. Methods Nine men active competitive athletes specialized in sprinting were recruited for the study ( $22.6 \pm 4.0$  years,  $1.83 \pm 0.04$  m, and  $72.4 \pm 8.0$  kg). The participants performed two tests in two days. The first day, 1-RM from a half-squat position, the last acceptable single repetition with the highest possible load was recorded. This load was also normalized by dividing by the participant's Bm. 48 hours after, seven 20-m sprints (unloaded sprints and sprints pulling resistances of 5, 10, 15, 20, 25 and 30% of Bm) from a standing start were done. The participants were placed 1-m behind the starting line. The resisted sprint trials were performed using a weighted sled attached to each athlete by a 2.7-m cord and waist harness, and an unlimited rest period was given between trials to minimize the effects of fatigue. The participant's unloaded and loaded sprint time were plotted against the load (%Bm), obtaining a straight line ( $y = mx + c$ ), the gradient of the line of best fit (m) was taken as the rate of increase in sprint time. Results A Pearson's Product moment correlation coefficient showed that there was no significant association ( $p \leq 0.05$ ) between 1 RM, also 1 RM/Bm, and rate of increase ( $1.80 \pm 0.36$  seconds per body mass). However, a significant correlation was found between unloaded sprint time and rate of increase ( $r = -0.74$ ). Discussion The lack of correlation to 1 RM may be explained by the stage of the season, the test was conducted at the end of the season. The effects of the sled-towing exercises on athlete's velocity profile may be due to the athlete's sprint ability in 20-m, suggesting that sled mass may be applied taking into account the individual sprint level of the athlete. References Alcaraz PE, Palao JM, Elvira JLL, Linthorne NP. (2008). *J Strength Cond Res*, 22(3), 890-897. Murray A, Aitchison TC, Ross G, Sutherland K, Watt I, McLean D, Grant S (2005). *J Sports Sci*, 23(9), 927-935.

## EFFECT OF DELAYED ONSET OF MASSAGE ON RECOVERY OF TIBIALIS ANTERIOR ACTIVE PROPERTIES FOLLOWING ECCENTRIC EXERCISE

Best, T.1, Butterfield, T.A.2, Zhao, Y.1, Zhang, X.1, Jarjoura, D.1, Haas, C.1

1: The Ohio State University (Columbus, Ohio, USA), 2: University of Kentucky (Lexington, Kentucky, USA)

Introduction Muscle soreness and weakness accompany intense or prolonged physical activity. Within 48 hours of injury, studies show that the majority of cells infiltrating muscle were macrophages (Clarkson and Sayers, 1999 & Fielding et al., 1993) and can therefore provide baseline comparisons for studying the effect of massage and its ability to modify muscle inflammation, weakness, and damage. In this study we extend our previous work by comparing the effect of immediate vs. delayed application of massage on peak torque recovery following intense eccentric exercise (EEX). Methods Eighteen skeletally mature New Zealand White rabbits were instrumented with peroneal nerve cuffs for stimulation of hindlimb tibialis anterior muscles. Following a bout of EEX, rabbits were assigned to a protocol of 0.5Hz, 10N, 15min massage applied immediately post exercise, 0.5Hz, 10N, 15min massage applied 48 hours post exercise, or exercised, non-massaged control. Using this design, six rabbits were tested under each of the three protocols. A torque-angle relationship was obtained for 21 tibiotarsal joint angles pre and post EEX and post four consecutive days of massage. Results EEX produced an average 49% ( $\pm 13\%$ ) decrease in peak isometric torque output ( $n=18$  hindlimbs; 6 immediate, 6 delay, and 6 exercised, non-massaged). Both immediate and delayed application of massage showed significant improvement of recovery of peak torque as compared to the exercised, non-massaged control ( $p=0.0005$  and  $p=0.0135$ , respectively). Immediate application of massage produced a significant 79% increase in peak torque recovery as compared to the exercised, non-massaged control ( $p=0.0005$ ). However, 48 hour delay of massage onset produced a significant 47% reduction of peak torque recovery compared to recovery produced by immediate application ( $p=0.0115$ ). Discussion While there is clinical significance of both immediate and delayed massage producing enhanced recovery compared to non-massaged control animals, massage beginning 48 hours post EEX had a significantly diminished effect in restoring function of EEX muscle compared to immediate massage. These data provide a starting point for linking the mechanical properties of skeletal muscle with physical therapies, and may shed light on the design and optimization of therapeutic massage based therapies for recovery from EEX in humans. References Clarkson PM, and Sayers SP. (1999). *Can J Appl Physiol.*, 23:234-248. Fielding RA, Manfredi TJ, Ding W, Fiatarone MA, Evan WJ, and Cannon JG. (1993). *Am J Physiol.*, 265:R166-R172. Acknowledgements Supported by NIH NCCAM R01AT004922 (TMB).

## DOSE-DEPENDENCY OF MASSAGE ON RECOVERY OF MUSCLE ACTIVE PROPERTIES FROM ECCENTRIC EXERCISE

Best, T.1, Butterfield, T.A.2, Zhao, Y.1, Zhang, X.1, Jarjoura, D.1, Haas, C.1

1: The Ohio State University (Columbus, Ohio, USA), 2: University of Kentucky (Lexington, Kentucky, USA)

Introduction Minimizing the symptoms of acute and chronic skeletal muscle pain and weakness is critical due muscle dysfunction causing high exercise attrition rates and the economic burden of physical inactivity (Macera et al., 2003 & Pratt et al., 2000). Treatment with alternative approaches (massage) has become increasingly common to mitigate exercise associated muscle pain and dysfunction. However, the mechanisms of action and optimal strategies have not been conclusively demonstrated (Cherkin et al., 2003 & Gordon et al., 2006). This study explored the effects of three massage parameters (frequency, magnitude and duration) on recovery of peak torque output following eccentric exercise (EEX). Methods Twenty four skeletally mature New Zealand White rabbits were instrumented with peroneal nerve cuffs for stimulation of hindlimb tibialis anterior muscles. Following a bout of EEX, rabbits were assigned to a massage protocol with frequency of 0.25 or 0.5 Hz at 5 or 10N for 15 or 30min. The contralateral hindlimb served as the EEX, non-massaged control. Using this design, three rabbits were tested under each of the eight protocols, which provided  $n=12$  rabbits for comparison of the high and low condition of each parameter. A torque-angle relationship was obtained for 21 tibiotarsal joint angles pre and post EEX and post four consecutive days of massage. Massage was performed via a customized device that allowed quantifiable, repeatable loading (Zeng et al., 2008). Results EEX produced an average 62% ( $\pm 13\%$ ) decrease in peak isometric torque ( $n=45$  hindlimbs; 24 massage, 21 exercised, non-massaged). There were differences on torque recovery between the two magnitudes ( $p=0.004$ ) and the two frequencies



( $p=0.012$ ), but no difference for the two durations. The 0.5Hz, 10N, 15min protocol produced greatest peak torque recovery, values approximately equal to pre-EEX. Discussion There were no significant interactions between or among the parameters, showing no dependence on the effect of these three parameters on torque recovery. This is the first evidence of a dose-response effect for magnitude and frequency of massage on recovery of in vivo active muscle properties following EEX. These results may help to explain the variability in human studies evaluating the efficacy of massage on recovery from EEX. References Butterfield, TA, et al. (2008) *Med. Sci. Sports Exerc* 40, 1289–1296. Cherkin DC, et al. (2003). *Annals of Int Medicine*. 138 (11): 898–906. Gordon C et al. (2006). *Arch Phys Med Rehabil.*, 87(1):145–47. Macera CA, et al. (2003). *Arthritis Rheum.*, 49:122–128. Pratt M, et al. (2000). *Physician and Sports Medicine*, 28:63–70. Zeng, H, et al. (2008) *J. Med. Devices* 2, 027530. Acknowledgements Supported by NIH NCCAM R01AT004922 (TMB).

### CHARACTERISTICS OF AGING AT THE GOLF SWING IN SIMILAR SCORE AMATEUR GOLFERS

Chikara, N., Tatsuya, U., Daisuke, Y., Akira, I.

*Osaka University of Health and Sports Sciences*

**Introduction** Physical fitness (e.g. muscle strength) decreases with aging. However, the golf score does not depend on the physical fitness and age, because senior golfers the contribution of the golf skill can be important for improving the golf score. Therefore, the purpose of this study was to examine the characteristics of golf swing for the adult amateur golfers with different age and similar golf score players. **Methods** A total of 15 male adult golfers (age: 36–74 years, average score:  $85.7 \pm 3.6$ ) were participated in this study. They performed a maximal swing with three clubs (a 1W, a 7I, a SW). They also performed 5 approach swings with a sand wedge assuming 10, 30, and 50 yards shot. The body and golf club position data were obtained by 3D motion capture system (Vicon. Vicon Motion Systems), and analyzed kinematic parameters of golf swing motion. Pearson's product-moment correlation coefficient was used to clarify the relation between the age and kinematic parameters. One-way analysis of variance (ANOVA) was used to consider the differences of kinematic parameters among the four age groups (aged: 36–45, 46–55, 56–65, and 66–75 years). Results Impact in the maximal swing, the club head speed at was negatively-correlated to age to all clubs (1W:  $r = -0.761$ ,  $p < 0.001$ , 7I:  $r = -0.699$ ,  $p < 0.01$ ; SW:  $r = -0.679$ ,  $p < 0.01$ ). Especially, the left hip rotation angle at impact was decreased with aging for the 1W ( $r = 0.601$ ,  $p < 0.05$ ). In the approach shot trials, the head speed at impact did not show any difference between age groups. Moreover, the coefficient of variation of head speed at impact was similar among all age. Discussion In general, the decrease in the head speed indicates the decrease in flying distance. Therefore, the result suggests that the flying distance in maximal shot was also decreased with aging. Moreover, the flying distance is considered to a first advantage to the golf score. However, the subjects in this study have a similar golf score in spite of a wide age group. Considering that the stability of flying distance at approach shot was not decreased with aging, we suggest that the skill to compensate for the decrease in the flying distance was the stability of distance and direction (e.g. maximal shot, approach shot and putting).

**14:45 - 15:45**

## Poster presentations

### PP-PM15 Physiology 6

#### CYTOKINE LEVELS ARE MODULATED AFTER ACUTE EXERCISE PERFORMANCE IN HYPOXIA

Lira, F.S., Machado, P.P., Santos, S.A., Silva, E.T., Caris, A., Oller do Nascimento, C.M., Oyama, L.M., Tufik, S., Santos, R.V.T., de Mello, M.T.

*Unifesp*

**Introduction** Cytokine, mainly interleukin 6 (IL-6), interleukin 10 (IL-10), and interleukin 1 receptor antagonist (IL-1ra) play a key role in the immune system and metabolism during periods of stress and rest. It is known that, during and after exercise cytokine levels are modulated. However, the concentration of these cytokines during and after exercise in the hypoxia exposure is unknown. Our hypothesis is that exercise performance in the hypoxia exposure may impair cytokine levels. **Methods** Eight male subjects were exposed to normobaric hypoxic exposure at 4,200 m or sea level and performance treadmill exercise for 1 hour (~ 50%  $VO_{2peak}$ ). Plasma levels of cytokine (IL-6, TNF- $\alpha$ , IL-10 and IL-1ra) were determined at rest, and immediately and 1 h after exercise bouts. Results No differences were found in performance parameters (heart rate, oxymetric, rating of perceived exertion). IL-6 levels were increased immediately and 1 hour after exercise than rest in both altitudes ( $p < 0.001$ ). Interestingly, increased levels of TNF- $\alpha$  and IL-10 immediately after exercise, as compared as rest and 1 hour after exercise, were observed only in the sea level ( $p < 0.05$ ). We also found that, IL-1ra levels were increased 1 hour after exercise in relation to rest and immediately after exercise in both altitudes ( $p < 0.05$ ). Discussion The inflammatory markers increased in serum, skeletal muscle and adipose tissue following exhaustive exercise is well-established (Petersen and Pedersen 2005, Rosa et al 2011). There is no data in the literature about the effect of the performance exercise in hypoxic exposure at 4,200 m upon cytokine levels. Our exercise sea level data are according with the literature, showing that cytokine levels are increased after acute exercise. However, the usual condition is impairing when exercise is performance in hypoxic exposure at 4,200 m. These alterations may, at least in part, contribute to the immunosuppression state. These findings can help to better knowing upon effects the hypoxic exercise regimen on immune system response. References Rosa JC, Lira FS, Eguchi R, Pimentel GD, Venâncio DP, Cunha CA, Oyama LM, De Mello MT, Seelaender M, do Nascimento CM. *J Cell Physiol*. 2011 Jun;226(6):1604-7. Petersen AM, Pedersen BK. *J Appl Physiol*. 2005 Apr;98(4):1154-62. Review.

#### 3 DAYS OF HEAT ACCLIMATION ATTENUATES THE MONOCYTE HSP70 RESPONSE FOLLOWING ACUTE HYPOXIC EXPOSURE IN HUMANS.

Lee, B.I, Emery, E.2, Hussain, A.1, James, R.1, Mackenzie, R.2, Thake, D.1

1: Coventry University (Coventry, UK), 2: University of Westminster (London, UK).

3 DAYS OF HEAT ACCLIMATION ATTENUATES THE MONOCYTE HSP70 RESPONSE FOLLOWING ACUTE HYPOXIC EXPOSURE IN HUMANS. Lee, B.I, Emery, E.2, Hussain, A.1, James, R.1, Mackenzie, R.2; Thake, D.1 1: Coventry University (Coventry, UK), 2: University of Westminster

(London, UK). Introduction Research has shown that adaptation to one environmental stressor can induce protective characteristics for exposure to a second, new stressor. This occurs via activation of common protective pathways, such as the cytoprotective heat shock protein family (HSP70) and is termed cross acclimation (Horowitz et al., 2007). To date no research has investigated cross-acclimation responses between heat and hypoxia in whole body humans. Thus the aim of this study was to determine whether the initial phase of heat acclimation could confer increased cellular tolerance to an acute hypoxic exposure in humans. Method 16 males were separated into two matched groups. Group A (mean  $\pm$  SD; Age  $21 \pm 2.7$  yrs; height  $1.85 \pm 0.08$  m; mass  $75.7 \pm 8.2$  kg; PPO  $289 \pm 52$  Watts; VO<sub>2</sub>peak;  $46.15 \pm 10$  ml.kg.min<sup>-1</sup>) completed 3 days of exercise heat acclimation; 60 minutes cycling at 50%VO<sub>2</sub>peak (Castle et al., 2011) in 40°C 20% RH. Group B (Age  $20 \pm 1.3$  yrs, height  $1.75 \pm 0.05$  m, mass  $76 \pm 10$  kg; PPO  $284 \pm 34$  Watts; VO<sub>2</sub>peak  $46.26 \pm 8$  ml.kg.min<sup>-1</sup>) completed 3 days of exercise training in 20°C, 40%RH. Each group completed a hypoxic stress test (HST; 15 minutes rest, 60 minutes cycling at 50%VO<sub>2</sub>peak at 3000m above sea level) one week before, and 48 hours following the final day of acclimation. Venous blood samples were collected pre and post each HST and pre and post acclimation on days 1 and 3 for determination of intracellular monocyte HSP70 concentrations via flow cytometry. Results There was no significant difference between group A and B in the percentage change from rest in HSP70 concentrations following the first HST ( $129 \pm 59$  Vs  $130 \pm 52\%$ ,  $p = 0.97$ ). Heat acclimation produced a significant increase in basal HSP70 in group A ( $p = 0.03$ ), with no change in group B ( $p = .218$ ). The percent change in HSP70 from rest following the second HST was significantly lower in group A Vs group B ( $100.1 \pm 13$  Vs  $133 \pm 33\%$ ,  $p = 0.02$ ). Discussion The 3-day acclimation period induced a significant increase in basal HSP70 in group A, with no change in group B. The HSP70 response following HST2 was attenuated for group A, possibly indicating improved tolerance and ability to cope with the hypoxic insult via increased reserves of HSP70. This may be due to increased cytoprotection via pathways up-regulated by adaptation to heat stress, and shared by hypoxia. Work examining the shared pathways involved, and how improved cytoprotection impacts on whole body human performance is ongoing in our laboratory. References Castle, P., Mackenzie, R., Maxwell, N; Webb, N., Watt, P (2011). Journal of Sports Sci, 29 (11) 1125-1134. Horowitz, M., Robinson, S (2007). Progress in Brain Research, 162, 433-446.

### EFFECT OF PROLONGED EXERCISE ON ORAL AND BLOOD NEUTROPHIL FUNCTION

Davison, G.I, Jones, A.W.2

1: University of Kent (UK); 2: Aberystwyth University (UK)

Introduction The response of blood neutrophils to prolonged and/or strenuous exercise has been extensively studied but there is very little research on subpopulations other than peripheral blood neutrophils. In one previous study (Müns, 1994) neutrophils were obtained from nasal lavage following a 20 km run, in which a significant post-exercise increase in neutrophil number and a significant post-exercise decrease in phagocytic activity was observed. Neutrophils obtained in this way may represent a more appropriate subpopulation to study in relation to upper respiratory illness in athletes but there is limited research in this area. Such studies are widespread in dentistry research, in which strong associations have been observed between oral neutrophil functions and oral infection. The aim of this study was to determine the effects of prolonged exercise on the number and function of neutrophils obtained from the oral cavity. Methods Nine healthy men participated in a prolonged exercise bout (2.5 h at ~55% maximal oxygen uptake). Oral neutrophils were obtained with methods modified from Lukac et al. (2003). Briefly, 20 ml saline was swilled in the mouth for 2 mins before expectoration. This was then concentrated 15 times by gentle centrifugation ( $450 \times g$ ) and replacing the supernatant with a smaller volume of buffer (HBSS). Saliva samples were also obtained and screened for blood contamination and any subject ( $n = 2$ ) with a positive sample was removed from the analysis giving  $n = 7$ . Blood samples were obtained pre- and post-exercise and both samples (blood and concentrated oral rinse) were used for determination of PMA-stimulated oxidative burst (OBA) by chemiluminescence assay. Results Blood neutrophil count was increased ~3-fold post-exercise ( $P < 0.001$ ) but there was no change in the oral samples ( $P = 0.164$ ). Mean oral neutrophil OBA did not decrease significantly post-exercise ( $15 \pm 37\%$  decrease,  $P = 0.167$ ) whereas the post-exercise decrease in blood neutrophil OBA was significant ( $30 \pm 19\%$  decrease,  $P = 0.003$ ). Moreover, an actual post-exercise decrease in oral neutrophil OBA was only evident in 4 of the 7 participants compared to the clear decrease of blood neutrophil OBA evident for all 7 participants. Discussion A significant post-exercise decrease was only evident in blood neutrophil stimulated OBA. These findings suggest that there is poor agreement between the oral and blood neutrophil responses to prolonged exercise. This highlights the importance of studying other subpopulations of immune cells (other than peripheral blood) in relation to illness and infection risk in athletes and further research is required. References Müns G. (1994). Int J Sports Med, 15, 96-99. Lukac J, Mravak-Stipetić M, Knezević M, Vrcek J, Sistig S, Ledinsky M, Kusić Z.J. (2003). Oral Pathol Med, 32, 271-4.

### LEUKOCYTE AND PLATELET COUNTS ELEVATED DUE TO ACUTE EXERCISE IN YOUNG SUBJECTS.

Alis, R.1, Romagnoli, M.1, Ibanez, S.1, Vaya, A.2

Universidad Catolica de Valencia

Leukocyte and platelet counts elevated due to acute exercise in young subjects. Alis, R.1; Romagnoli M.1; Ibañez, S.1, Vaya, A.2 1 Catholic University Valencia (Valencia, Spain). 2 La Fe University Hospital (Valencia, Spain) Introduction: Acute exercise causes transient ischaemia [1] especially in the muscle tissue being activate, resulting in local inflammation and leukocyte activation [2]. This study investigates the changes in leukocyte and platelet counts due to acute exercise in young subjects. Methods: The exercise protocol consists of a maximal incremental treadmill test (1 male 9 female,  $13,90 \pm 1,60$  years,) in fasting conditions. Blood samples were collected before and just after exercise from antecubital vein. Samples were analyzed in the first hour after extraction. Basic haematological parameters, white cell count, platelet count and red cell indices, including mean cell volume (MCV), mean haemoglobin concentration (MCH) and mean corpuscular haemoglobin concentration (MCHC) were measured in a Sysmex ME 8000 autoanalyser (TOA Medical Electronics, Japan). Fibrinogen content was measured using coagulometric techniques on an ACL-7000 autoanalyser (Instrumentation Laboratory, Italy). Differences between pre and post measures were assessed using multiple analyses of variance (MANOVA). Pearson's correlation coefficient was used to investigate relationships between variables. When data weren't normally distributed non parametric tests were used.  $p$  values  $< 0.05$  were considered as statistically significant. All values as mean  $\pm$  sd. Results: Platelet count augmented with exercise (pre:  $261,80 \pm 45,92$ , post:  $284,50 \pm 55,01$ ,  $p < 0,05$ ) leukocytes augmented as well (pre:  $6,41 \pm 1,19$   $10^3/\mu$ l, post:  $8,38 \pm 2,41$   $10^3/\mu$ l,  $p < 0,05$ ). We found a positive significant correlation between leukocyte and platelet count increment with exercise ( $r = 0,685$   $p = 0,029$ ). MCV augmented (pre:  $86,92 \pm 4,24$  fl, post:  $87,78 \pm 4,17$  fl,  $p < 0,05$ ) and MCHC decreased with exercise (pre:  $33,69 \pm 32,86$  g/dl, post:  $32,86 \pm 0,67$  g/dl,  $p < 0,05$ ). We found a positive correlation between the increase in leukocyte count and the decrease in MCHC ( $r = 0,635$   $p = 0,049$ ). Fibrinogen content decreased but not significantly with exercise. Change in fibrinogen was correlated with the rise in leukocyte count ( $r = 0,674$   $p = 0,033$ ) and platelet count ( $r = 0,740$   $p = 0,014$ ). Discussion As seen before leukocyte count [2] and platelet count [3] increases with exercise. The results points to an immune and inflammatory response to acute exercise in young subjects References 1. Camus, G., et al., Are

similar inflammatory factors involved in strenuous exercise and sepsis? *Intensive Care Medicine*, 1994. 20(8): p. 602-610. 2. Temiz, A., et al., Leukocyte activation, oxidant stress and red blood cell properties after acute, exhausting exercise in rats. *Clinical hemorheology and microcirculation*, 2000. 22(4): p. 253-259. 3. El-Sayed, M.S., et al., Blood hemostasis in exercise and training. *Medicine & Science in Sports & Exercise*, 2000. 32(5): p. 918-925.

### THE EFFECT OF ANTIOXIDANT SUPPLEMENTS ON THE HEAT SHOCK PROTEIN RESPONSE TO STRENGTH TRAINING

Sorstrom, A.N., Cumming, K.T., Paulsen, G., Raastad, T.

*Norwegian School of Sport Sciences*

**Background:** The heat shock protein (HSP) response to strength training is considered as an important adaptation to maintain homeostasis in muscle fibres, by preventing damage and restoring structures. Strength training has previously been shown to increase HSP content (Gjovaag & Dahl, 2006, Paulsen et al., 2011). Antioxidant supplements, typically used by athletes, may however blunt or abolish the heat shock protein response, as seen after endurance exercise (Jackson et al., 2004, Khassaf et al., 2003). The purpose of this study was to investigate the effect antioxidant supplementation (vitamin C and E) on HSP70 and AlphaB-crystallin content, after strength training in recreationally trained subjects. **Methods:** 25 recreationally trained subjects completed 10 weeks of strength training with either vitamin C (1000mg/day) and E (235mg/day) or placebo supplements in a randomised double blinded fashion. The subjects trained their knee-extensor muscles 2 times a week; 2-3 x 7-10RM per exercise (squat, knee-extension, leg press and lunges). Muscle biopsies were obtained from m. vastus lateralis before, 6 weeks in, and after the training period. The protein levels of HSP70 and AlphaB-crystallin were analysed by western blotting. **Results:** HSP70 and AlphaB-crystallin content changed in neither the placebo group nor the antioxidant group, after 6 or 10 weeks of strength training, and there were no significant changes between the groups ( $p \geq 0.05$ ). We are currently running analyses of samples from additional subjects. **Conclusion:** These preliminary data indicate that vitamin C and E supplementation have no effect on HSP70 and AlphaB-crystallin protein levels in muscles exposed to 10 weeks of strength training. The lack of HSP response to strength training contradicts previous studies. This might be related to the fact that the subjects recruited to this study were familiar with this mode of exercise. **References** Gjovaag (2006). *Eur J Appl Physiol*, 98:310-22. Jackson (2004). *Ann N Y Acad Sci*, 1031:158-68. Khassaf (2003). *J Physiol*, 549:645-52. Paulsen (2011). *Eur J Appl Physiol*, Epub ahead of print

### ACUTE AND LONG TERM HEAT SHOCK PROTEIN RESPONSES TO BLOOD FLOW RESTRICTED RESISTANCE TRAINING AND HEAVY LOAD STRENGTH TRAINING IN UNTRAINED FEMALE SUBJECTS

Cumming, K.T., Rønnestad, B.R., Ellefsen, S., Ugelstad, I., Raastad, T.

*1 Norwegian School of Sport Sciences, 2 Lillehammer University College*

**Introduction** Heat shock proteins (HSP) have cytoprotective properties, and respond to different cellular stress. The muscular HSP content increase after strenuous exercise, and the magnitude of the response is related to the type of stress put on the exercised muscle (1);2). Heavy load strength training (HLS) induces a high-mechanical stress, and increase HSP levels (3). However, little is known about the HSP response to blood flow restricted resistance training (BFR), which is characterised by low-loads (low mechanical stress), and high metabolic stress. The aim of this study was to compare the acute and long term HSP response to HLS and BFR in untrained women. **Methods** Nine untrained female subjects performed 12 weeks unilateral knee-extension training twice a week. One leg was exercised with partial BFR induced by a pressure cuff (90-100 mmHg), 5 sets to failure at 30 % of 1 RM (45s rest). The other leg exercised 3x 10-6 RM of HLS (90s rest). Muscle biopsies were sampled before and 1h after the first training bout and before and 1h after the last training bout for both legs and exercise protocols. Muscle biopsies were homogenised and extracted into cytosolic- and cytoskeletal fractions. Homogenates were analysed for  $\alpha$ -B-crystallin ( $\alpha$ Bc) and HSP70 by western blotting. **Results** Resting levels of cytosolic  $\alpha$ Bc and HSP70 was unchanged after 12 weeks of training, whereas cytoskeletal HSP70 levels increased by 102 $\pm$ 111% in the BFR trained leg. In the untrained state (after the first exercise bout) cytosolic  $\alpha$ Bc levels were acutely reduced by 36 $\pm$ 24 and 40 $\pm$ 31 % for HLS and BFR, respectively, with a concomitant increase in cytoskeletal fraction of 8 $\pm$ 6 and 19 $\pm$ 19% for HLS and BFR, respectively. HSP70 was unchanged 1h after the first exercise bout for both exercises and fractions. After 12 weeks of training the acute  $\alpha$ Bc response was abolished whereas an acute cytosolic HSP70 response was manifested as a 58 $\pm$ 69 % increase in the BFR leg and a 51 $\pm$ 25 % increase in the cytoskeletal fraction in the HLS leg 1 h after exercise. BFR and HLS increased 1RM knee-extension to similar extend (12 $\pm$ 7 and 12 $\pm$ 7 %, respectively) **Conclusion** In the untrained state, both exercise protocols induced an acute response of small heat shock proteins, probably reflecting acute protection of stressed myofibrillar proteins. This stress response was, however, abolished in the trained state, indicating increased exercise tolerability. After 12 weeks of training an increase was only found in the cytoskeletal HSP70 levels after BFR. **Reference list** 1) Folkesson (2008). *Acta Physiol*, 194:215-222 2) Paulsen (2009). *J Appl Physiol*, 107:570-582 3) Paulsen (2011). *Eur J Appl Physiol*, Epub ahead of print

### DIVERGENCE OF INTRACELLULAR AND EXTRACELLULAR HSP72 IN TYPE 2 DIABETES: DOES FAT MATTER?

Rodrigues-Krause, J.1,2, Krause, M.1,2, O'Hagan, C.3, De Vito, G.3, Boreham, C.3, Newsholme, P.2,5, Murphy, C.1, Colleran, G.1

*(1) ITT Dublin, Ireland; (2) UCD Conway Institute and (3) Institute for Sport and Health UCD; (5) Curtin University, Perth, Western Australia*

**Introduction:** Recent evidence indicates that Extracellular Heat Shock Protein 72kDa (eHSP72) is increased in both Type 1 and Type 2 Diabetes (T2DM), although the physiological role of this protein in the blood is still unknown. However, levels of intracellular HSP72 (iHSP72) are reduced in diabetic patients, which has been related to insulin resistance in skeletal muscle. Therefore, the aim of this preliminary study was to compare the levels of eHSP72 and iHSP72 in obese and non-obese individuals with and without T2DM. **Methods:** Fifteen sedentary male participants (7 obese controls (C) vs. 5 obese and 3 non-obese T2DM; age 54 $\pm$ 9 years) were selected according to their BMI (30kg/m<sup>2</sup> for obese and 23-27kg/m<sup>2</sup> for non-obese participants) and evaluated for fasted values of blood lipid profile, serum CRP (C-reactive protein), plasma eHSP72 and skeletal muscle iHSP72 and heat shock factor 1 (HSF-1). Body composition was measured by whole body DEXA and muscle biopsy (vastus lateralis) was performed via a micro biopsy. **Results:** As expected, fasting glucose and HbA1c (C=6 $\pm$ 0.2 vs. T2DM=7.3 $\pm$ 0.5%) were higher in T2DM. Body fat percentage was lower in the non-obese group (21.9 $\pm$ 3.1%) compared with obese controls (34.1 $\pm$ 4.1%) and obese T2DM (39.6 $\pm$ 3.6%). Insulin resistance was lower in non-obese T2DM when compared with the obese T2DM group as indicated by HOMA-IR results. In obese T2DM a higher level of eHSP70 was observed (0.227 $\pm$ 0.03ng/mL) compared with obese controls (0.13 $\pm$ 0.04ng/mL) and non-obese T2DM (0.154 $\pm$ 0.05ng/mL). Skeletal muscle iHSP72 and HSF-1 levels were reduced in T2DM, but non-obese subjects were associated with a smaller decrease than the obese T2DM. **Conclusion:** Obese diabetic participants were associated with higher eHSP70 compared to non-obese T2DM and obese control participants. The level of iHSP72 was

lower in obese T2DM, which was associated with a reduction of HSF-1. Since elevations of eHSP70 are linked with cardiovascular and pro-inflammatory complications, lower eHSP70 found in non-obese T2DM could indicate better control of the disease. Moreover, iHSP70 and HSF-1 levels were reduced in obese T2DM, and to a lesser extent in non-obese. These results indicate eHSP70 elevations and iHSP72/HSF-1 decrements in diabetic participants could be related to obesity and its complications, rather than with diabetes alone. Our data also suggest that eHSP72 may be a potential biomarker for diabetes control.

### THE INFLUENCE OF DAILY PHYSICAL ACTIVITY IN TOTAL ANTIOXIDANT CAPACITY AND OXIDATIVE DNA DAMAGE, IN HUMAN LYMPHOCYTES

Soares, J.P.1, Bento, T.2, Joao, P.1, Oliveira, M.M.3, Peixoto, F.4, Gaivao, I.5, Mota, M.P.1

*Universidade de Trás-os-Montes e Alto Douro*

1 UTAD, CIDESD, Vila Real – Portugal; 2 ESDRAM, Rio Maior – Portugal; 3 UTAD, CQ, Vila Real – Portugal; 4 UTAD, CITAB, Vila Real – Portugal; 5 UTAD, CECAV, Vila Real - Portugal  
**INTRODUCTION** The study of physical exercise benefits in health is well documented in the literature. Some of the proposed mechanisms that explain organism function enhancement are related with bioenergetics and mitochondria improvement, associated with decrease in ROS production and increase e antioxidant capacity. As a consequence, oxidative damage tends to decrease as an adaptation to chronic exercise. Despite this explanation, results are inconsistent and might be explained due to methodological issues. One of the main problems might be related with the lack of daily physical activity control. Indeed, considering the inclusion in a group of physical exercise may be insufficient to discriminate active and sedentary people. So, we aimed to estimate the influence of total daily physical activity (TDPA) in oxidative stress related variables (total antioxidant capacity and oxidative DNA damage).  
**METHODS** Thirty health men, nonsmokers, above 40 years old, integrated this study. 15 of these subjects had a moderate to vigorous daily physical activity and the remaining ones had sedentary to lower daily physical activity, according to the levels proposed by the ACSM (1). Daily physical activity was measured during at least 4 days to 7 days with an accelerometer (ActiGraph); total antioxidant capacity was measured in plasma with ABTS Assay; and oxidative DNA damage was quantified by comet assay with FPG enzyme formamidopyrimidine DNA glycosylase sites (FPG sites, oxidized purine bases). Independent-Samples T-test was used to analyze differences between groups, and significant level was set at  $p < 0.05$ .  
**RESULTS AND DISCUSSION** Our results revealed that the most active subjects tend to evidence higher antioxidant capacity, suggesting the importance of an active lifestyle in the increasing antioxidant protection. This could mean that the most active individuals are more capable to resist against oxidative stress. One of the possible consequences of oxidative stress is the DNA damage of various cells. Our results showed that the most active subjects tend to have less DNA damage, which seem in accordance to the results of the total antioxidant capacity.  
 1. Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., and Bauman, A. (2007) Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc*, 39, 1423-1434.

### MUSCLE FATIGUE EXPERIENCED DURING MAXIMAL ECCENTRIC EXERCISE IS PREDICTIVE OF THE PLASMA CREATINE KINASE RESPONSE

Hody, S.1, Rogister, B.1, Leprince, P.1, Wang, F.2, Croisier, J.L.3

*University of Liège*

**Introduction** Unaccustomed eccentric exercise may cause skeletal muscle damage leading to an increase in plasma creatine kinase (CK) activity. A wide variability among individuals in CK response to standardized lengthening contractions has been well described (Clarkson and Ebbeling, 1988). However, the reasons underlying this phenomenon have not yet been understood. Therefore, this study investigated a possible correlation between the changes in muscle damage indirect markers after an eccentric exercise and the decline in muscle performance during the exercise. **Methods** Healthy untrained male subjects ( $n=27$ ) performed an unilateral eccentric protocol consisting of three sets of 30 maximal isokinetic eccentric contractions of the knee extensor muscles, separated by a 30s rest phase. The muscular work was recorded using a Cybex Norm dynamometer to assess muscle fatigue by means of various fatigue indices. Markers of exercise-induced muscle damage (EIMD) including plasma CK activity, muscle soreness, and stiffness were measured before (pre) and 24hours after (post) exercise. Pearson's correlation coefficient was used to examine relationships between measured parameters. Results Large inter-subject variability was evident for both muscular work during exercise and changes in all markers of EIMD. In accordance with the conclusions of Chapman et al. (2008), we found that the cumulative work developed during the eccentric exercise session was not associated with changes in the markers of EIMD. More interestingly, the log (CKpost/CKpre) and muscle stiffness appeared to be closely correlated with the relative work decrease during the 3 sets of eccentric contractions ( $r=0.84$  and  $r=0.75$ , respectively). **Discussion** This is the first study to propose that the muscle fatigue profile during maximal eccentric protocol could predict the magnitude of the symptoms associated with muscle damage in humans. This original finding could be useful for researchers who apply intense eccentric protocols to immediately detect subjects having a higher risk of suffering from severe breakdown of muscle tissue, a condition known as rhabdomyolysis. In addition, the present data provide a valuable basis for mechanistic studies investigating the etiology of the large inter-subject variability to eccentric exercise. **References** Chapman DW, Newton MJ, Zainuddin Z, Sacco P, Nosaka K. (2008). *Br J Sports Med*, 42(7): 585-591. Clarkson PM, Ebbeling C. (1988). *Clin Sci (Lond)*, 75(3): 257-261.

### INFLUENCE OF HIGH TEMPERATURE AND INTENSE SELF-PACING CYCLING ON IMMUNE CELLS

Gomes, E.C.1,2, Oliveira, G.G.A.1, Nunes-Silva, A.2, Maia-Lima, A.1, Ramos, G.P.1, Pacheco, D.A.S.1, Goulart, K.N.O.1, Nunes-leite, M.M.S.1, Silami-Garcia, E.1, Teixeira, M.M.2

*Federal University of Minas Gerais*

High intensity exercise in a warm environment might elicit a higher physiological stress and, thus, mobilize a higher number of neutrophils and lymphocytes to the blood. The aim of this study was to investigate the effect of a warm environment on performance and total and differential blood cell count. **Methods:** 8 male cyclists (mean $\pm$ SD: 59 $\pm$ 9 mL O<sub>2</sub>/kg/min) performed, in a randomized order, two 30km time trials in an environmental chamber set at two different temperatures: warm trial (WT) 35°C and thermoneutral trial (TT) 25°C. Both environments had an average relative humidity of 68%. Blood samples were collected pre, post and 1h post-exercise. These samples were used to assess hematocrit, haemoglobin, total cell count, neutrophils and lymphocytes. The athletes' core temperature, heart rate (HR) and RPE were measured throughout the exercise protocol and they were allowed water ad libitum. Data related to the athletes' performance was analysed using 2-Sample t-test; all other data was analysed using General Linear Model ANOVA with Tukey's post-hoc

test (Minitab 15). Results: Athletes' performance was significantly impaired in the heat (mean, SD: WT 55.9±3.9 min; TT 61.0±3.8 min); nevertheless, the average HR was similar in both trials. The athletes initiated trials with a similar core temperature; however, in the heat, a significant increase in their core temperature was observed from km 14 onwards compared with the thermoneutral environment. Their core temperature at the end of the exercise was 39.4±0.6 (WT) compared to 38.6±0.4 (TT). The athletes did not finish the exercise dehydrated and there were no differences between trials: percentage of body weight loss 1.16% (TT) x 1.26% (WT). 1h post-exercise a significant increase in total cell count (TT 428±191 x 10<sup>5</sup>/ml, WT 464±181 x 10<sup>5</sup>/ml) and neutrophil (TT 272±110 x 10<sup>5</sup>/ml, WT 310±137 x 10<sup>5</sup>/ml) was observed compared with pre-exercise values (total cell count TT 262±79 x 10<sup>5</sup>/ml, WT 281±90 x 10<sup>5</sup>/ml; neutrophils TT 152±55 x 10<sup>5</sup>/ml; WT 148±38 x 10<sup>5</sup>/ml). Temperature did not affect these variables. Conclusions: Athletes' internal temperature was significantly higher during the trial in the hot environment, and this affected performance significantly. Nevertheless, the warm temperature did not interfere with the shift pattern of the immune cells analysed.

## 14:45 - 15:45

### Poster presentations

#### PP-SH02 Social Sciences and Humanities 1

##### ACUTE EFFECTS OF BRISK WALKING ON CHOCOLATE CRAVING AND VISUAL ATTENTIONAL BIAS AMONG NORMAL AND OVERWEIGHT REGULAR CHOCOLATE EATERS AFTER DIFFERENT ABSTINENT PERIODS

Oh, H., Taylor, A.H.

*University of Exeter*

**Introduction** Despite good intentions failure to self-regulate snacking is a common problem, leading to weight gain. A 15 min brisk walk reduces self-reported chocolate craving (Taylor & Oliver, 2009) and consumption (Oh & Taylor, 2012). The mechanisms are less clear but cues may trigger attentional bias (AB) to chocolate images, and exercise may acutely reduce AB. We were also interested in if the effects differ among normal and overweight people, and for short and long-term abstinence from snacking. **Methods** Twenty normal (BMI 22.4 ± 1.9 kg/m<sup>2</sup>) and 21 overweight (30.6 ± 4.4 kg/m<sup>2</sup>) abstaining regular chocolate eaters (>100 gms per day), and 17 females (22.7 ± 2.9 kg/m<sup>2</sup>) abstaining during Lent (for at least 1 week) were randomly assigned in a cross-over design to a 15 min-brisk walk or rest (on separate days) condition. AB was assessed pre and post-treatment using an adapted visual dot probe task, with chocolate/neutral images presented for 200ms (initial AB; IAB) or 1000ms (maintained AB; MAB) using e-prime. Reaction time (RT) to probes replacing neutral and chocolate-related images was used to calculate IAB and MAB. Subjective craving on a 100-mm Visual Analogue Scale (Smeets et al., 2009) was assessed at pre-, during-, immediately after, and 10 mins after treatment. Results A 3-way mixed ANOVA revealed no moderating effect of BMI status or abstinence status. Fully repeated 2-way ANOVAS revealed significant condition x time interactions for IAB (F(1, 57) = 6.4, p < 0.05). Post hoc paired t-tests showed that at post-treatment IAB (t(57) = 2.8, p < 0.01, ESd = 0.42) after the exercise condition was significantly lower than after the rest condition. A fully repeated 2-way ANOVA revealed a significant condition x time interaction (F(2.09, 118.94) = 14.62, p < 0.001) for chocolate craving. Post hoc t tests (with Bonferroni correction) revealed that the craving was significantly lower than the rest condition immediately after (t(57) = 3.67) and 10 mins after exercise (t(57) = 4.15), p < 0.001). **Discussion** A short bout of moderate intensity exercise reduced cravings and AB to chocolate cues, regardless of BMI and abstinence period. Physical activity appears to help self-control capacity and self-regulation, in the presence of salient cues and similar inhibitory effects have been shown among smokers, heavy alcohol drinkers and among addicted animals. Sedentary behaviour may be a risk factor for self-regulation of mood enhancing and rewarding behaviours. **References** Avena, N. M., Rada, P., & Hoebel, B. G. (2008). *Neuroscience & Biobehavioral Reviews*, 32, 20-39. Oh, H. & Taylor, A.H. (2012). *Appetite*, 58, 387-92. Smeets, E., Roefs, A., & Jansen, A. (2009). *Appetite*, 53, 370-375. Taylor, A. H., & Oliver, A. (2009). *Appetite*, 52, 155-160.

##### THE QUIET EYE: PRE-PROGRAMMING OR ONLINE CONTROL?

Vine, S.J., Lee, D., Moore, L.J., Wilson, M.R.

*University of Exeter*

**Introduction:** The Quiet Eye (QE; Vickers, 1996); a fixation that starts prior to the initiation of a movement and remains steady during the execution of the movement, underpins the accuracy and resilience of visuomotor skills. However, it is unclear whether the early (pre-programming of movement), or late (sensory feedback for the online control of movement) phase of the QE is most important for successful performance. The aim of this study was to examine if the proportion of the QE responsible for pre-programming and online control, varied during successful and unsuccessful putts under pressure. **Methods:** 55 expert golfers (mean handicap = 2.72, SD = 1.95) were asked to hole as many 5 ft putts as possible, until they missed. Anxiety was manipulated via financial incentives and non-contingent feedback, allowing for changes in QE to be assessed at the point of failure (the final, missed putt). Gaze was recorded using an ASL mobile eye tracker. Total QE (TQE), pre-programming QE (PPQE; duration of QE until fore-swing of the club) and online control QE (OCQE; duration of QE from initiation of fore-swing until contact) were calculated for the first, penultimate and final putts. Data were subjected to one-way repeated measures ANOVA. Significant effects were followed up with pair-wise comparison t-tests. **Results:** TQE was significantly shorter (both p < .001) for the final missed putt (M = 1564, SD = 802ms) compared to the first (M = 2245, SD = 976ms) and penultimate (M = 2175, SD = 819ms) putts. There was no main effect for PPQE (p = .21) suggesting that the duration of PPQE was consistent across all putts (M = 1443.42, SD = 786.48). OCQE was significantly shorter (both p < .001) for the final missed putt (M = 158, SD = 159ms) when compared to both the first (M = 310, SD = 108ms) and penultimate (M = 278, SD = 92ms) putts. **Conclusion:** The results suggest that the QE in golf putting provides late sensory information to support the online control of movement, potentially leading to a more precise contact between putter and ball. The association between reduced OCQE and performance failure supports previous research showing that QE fixation is 'cut short' under pressure (Vine & Wilson, 2010). Findings may shed light upon the debate surrounding the optimal timing of information pick-up in motor skills (Oudejans et al., 2002) and have implications for understanding the mechanisms that underpin the QE. **References:** Vickers, J.N. (1996). Visual control when aiming at a far target. *J Exp Psychol Human*, 2, 324-354. Vine, S.J. & Wilson, M.R. (2010). Quiet eye training expedites learning and helps to protect against stress. *J Applied Sp Psych*, 22 (4), 361-376. Oudejans, R.R.D., van

de Langenberg, R.W., & Hutter, R.I. (2002). Aiming at a far target under different viewing conditions: Visual control in basketball jump shooting. *Hum Movement Sci*, 21, 457 – 480.

## **ANALYSIS OF THE INCIDENTS REPORTED TO THE HOTLINE FOR SEXUAL HARASSMENT IN SPORT IN THE NETHERLANDS**

Vertommen, T., Schipper van Veldhoven, N., Van Den Eede, F., Sabbe, B.

*University of Antwerp*

**Background** The prevention policy of the Netherlands Olympic Committee\**Netherlands Sports Confederation (NOC\*NSF)* against sexual harassment in sports has been crucial for the social safety in the last decade. Rules of conduct were formulated for coaches and the NOC\*NSF hotline was installed. Victims and perpetrators of sexual harassment but also other (indirect involved) athletes, parents, coaches, board members of clubs and federations can reach this emergency telephone 24/7 for support, first relief and report on incidents. More support or advice, when necessary, is given by counselors for victims, sport organizations and (supposed) perpetrators. **Aim** The aim of this study is to analyze information on age, sex and position of victim and accused, form of harassment, circumstances and duration of the incidents, as reported in the registration forms to the hotline for sexual harassment in sport. **Method** In the decade 2001-2010, 601 reports of sexual harassment in sport are collected by the Project Sexual Harassment. The 601 registration forms have been analyzed and recoded into a dataset containing at least 323 actual incidents of sexual harassment. **Results** First results show that victims are in 48 per cent of the incidents younger than 16 years old and in 74 per cent younger than 20. Almost all of them (90%) are athletes, performing at all different levels. There is a variety of 46 different sport disciplines in the 323 incidents. The results also show that sexual harassments appears in many different forms, going from light verbal intimidation and unwanted functional touching to more severe forms as sexual abuse and rape. Correlation with other forms of non-sexual integrity violations is demonstrated. **Conclusion** The hierarchical relation between coaches and athletes is proven to be a risk factor for the onset and continuation of sexual harassment in any sport type. These results show the relevance of a diffuse set of prevention measures and will guide future policy.

## **CONTEXTUAL FACTORS IN MARTIAL ARTS AMONG YOUTH**

Vertonghen, J., Theeboom, M.

*Vrije Universiteit Brussel*

**Introduction** Although contrasting results are found regarding the presumed positive or negative effects of martial arts involvement among youth, little is known about the underlying conditions that give rise to these presumed effects. Many studies on the social-psychological outcomes of martial arts can be described as a "black box" testing approach, which means that the measurement of the outcomes of martial arts involvement is emphasised, while the context and actual processes that take place are not examined and remain somewhat mysterious. The aim of the present study was to analyse contextual factors that might influence social-psychological outcomes of martial arts as practised by youngsters. Based on the literature, the contextual factors in this study were defined as the type of guidance, structural qualities of martial arts, social context and participants' characteristics (Coalter, 2007; Holt, 2008; Mahoney & Stattin, 2000; Petitpas et al., 2005). **Methods** Youngsters practising aikido, judo, karate or kick-/Thai boxing (N=477, age=13.98±2.13years) as well as their parents (N=307) were assessed in terms of their goal orientations, physical aggressiveness, participation motives, psychosocial behaviour and social background. Next to this quantitative methodology, also a qualitative research design was set-up to take the type of guidance into account. In total, 20 aikido, karate or kick-/Thai boxing teachers were interviewed and observed in order to analyse different teaching approaches. **Results** Based on the results of the present study, it was found that depending on the type of martial art being practised, differences exist in several contextual factors: -Characteristics of participants: youngsters practising kick-/Thai boxing show more physical aggression and behavioural problems than judoka, aikidoka and karateka involved in this study. -Social context: kick-/Thai boxers are from a lower social class than the other martial artists involved in this study. -Type of guidance: differences were found in the teaching approach used by teachers of different martial arts as well as within one martial art. **Discussion** This study has provided a better understanding of several contextual factors that might influence social-psychological outcomes of martial arts involvement by young participants. Although further research would be relevant to explore interrelationships between the four contextual factors examined in this doctoral research and possible other factors, this study indicated that in order to formulate statements regarding outcomes of martial arts practice by young participants, the structural qualities of martial arts, type of guidance, participants' characteristics and social context have to be taken into consideration. **References** Coalter F (2007) *A wider social role for sport*. London, Routledge. Holt, N (2008) *Positive Youth Development Through Sport*, 9-23. London, Routledge. Mahoney J, Stattin H (2000) *J Adolescence*, 23, 113-127. Petitpas A, Cornelius A, Van Raalte J, Jones T (2005) *Sport Psychol*, 19, 63-80.

## **USING ATHLETES' WORLD RANKINGS TO ASSESS PERFORMANCE OF COUNTRIES**

Malcata, R.M.1,2, Vandenbogaerde, T.J.1, Hopkins, W.G.2

*Auckland University of Technology*

**Introduction** There is a need for valid and objective methods to track the sporting performance of countries. Using the sport of swimming, we have developed a method in which athletes' world rankings are combined into a country score. **Methods** Top 150 rankings in the 32 Olympic swimming events were downloaded for 1990 to 2011. Each rank was assigned an importance score based on the number of athletes on each rank who ever achieved the top rank. The score was the proportion of such athletes predicted with a logistic model relating rank to proportion, and the modelled proportion was closely approximated by 1/rank. Scores for each country's individual athletes were then summed over all events to determine a country's performance score, representing predicted number of athletes ever achieving top rank. The method was validated by correlating country scores with country medal counts at major competitions (World Championships and Olympics). Other measures of country performance were derived using proportions of athletes achieving any top-three rank and winning gold at major competitions. **Results** The mean correlation over the 22 years between medal count and country score based on 1/rank was 0.93. For scores based on logistically modelled top rank, top-three rank and gold, the correlations were 0.94, 0.92 and 0.95 respectively. With score-estimates based on 1/rank, the three countries with the highest scores in 2011 were USA (a score of 41 athletes in the 32 events), China (21) and Japan (18). In the Olympic year 2008, the top three countries were USA (45), Australia (23) and Japan (17), while China was fifth (9). Although USA was always ranked first over the 22 years, the gap between first and second has become much smaller (a difference of 37 in 1990 vs 20 in 2011). **Conclusion** We have successfully developed a valid and practical method for tracking the performance of a country in sports that have an annual or seasonal published list of individual world rankings. This meth-

od includes performances of athletes not winning medals and therefore allows for more comprehensive performance assessment than methods based on medal counts. The method will allow tracking and comparison of performance within and between countries and sports.

### CAREER PERFORMANCE TRAJECTORIES OF OLYMPIC SWIMMERS

Allen, S.V., Hopkins, W.G., Vandenberghe, T.J.

AUCKLAND UNIVERSITY OF TECHNOLOGY

**INTRODUCTION:** Assessing the progression of a swimmer's competitive performance against benchmarks is a key element in talent identification and development, but information about changes in performance of elite swimmers during their formative years is needed to inform these benchmarks. Here we report the effects of age on performance and estimates of performance progression required to attain peak performance at the elite level. **METHODS:** The swimmers were the top 16 in each event of the 2008 Olympics. Their age at the Olympics was  $21.5 \pm 3.5$  y and  $23.9 \pm 2.9$  y for females and males respectively (mean  $\pm$  SD). We searched the Web for annual best times of each swimmer from their earliest available competitive performance through to 2011 (4285 times in the 13 stroke and distance combinations for each sex, for 391 swimmers, over  $9.8 \pm 2.9$  y). Times were log-transformed for analysis of changes in performance as percentages using a mixed linear model that included an effect for better performance in Olympic years, an effect for the use of new-generation swimsuits in 2009, and the effect of age on each swimmer's times modelled as individual quadratic trajectories. The trajectories were used to estimate age of peak performance and progression of performance leading to the peak. **RESULTS:** Olympic years and swimsuits accounted for additional performance enhancements in all events of  $1.2 \pm 0.3$  % and  $1.1 \pm 0.5$  % respectively (mean  $\pm$  between-event SD). After adjustment for these effects, the trajectories for females and males predicted peak performance occurring at ages  $23.2 \pm 2.1$  y and  $24.7 \pm 2.3$  y respectively (mean  $\pm$  SD). Peak performance occurred at later ages for the shorter distances, with a difference of  $\sim 3$  y between the shortest and longest distances. Both sexes showed similar progressions to peak performance: over ten years  $11.6 \pm 6.4$  %, and over five years  $3.0 \pm 1.6$  %. **DISCUSSION:** The improvement off their trend that swimmers showed at the Olympics could be due to better preparation and higher motivation for this pinnacle event, but swimsuits probably also contributed in 2008, as they did in 2009. The surprising finding that peak performance occurred a year or two after the Olympics could be due to Olympic selection of athletes who are still seen to be improving. The range in age of peak performance for different distances presumably reflects different maturation of aerobic and anaerobic capacities and should be considered in event selection. The progression over ten years shows too much between-swimmer variability to allow identification of potential Olympic swimmers, but around five years out from an Olympics our progression data should be useful for talent identification.

### PSYCHOLOGICAL WORK WITHIN A HANDBALL TEAM

Keczei, D.

*Sport School of Debrecen*

**PSYCHOLOGICAL WORK WITHIN A HANDBALL TEAM** Keczei, D. 1, Rathonyi-Odor, K. 2, Borbely, A. 3 1: Sport School in Debrecen (Debrecen, Hungary) 2,3: University of Debrecen, (Debrecen, Hungary) Introduction In professional sports just one thing counts really, which is performance. For this reason, the development of performance is constantly needed, which can be realized if we harmonize physical, psychic and social attitudes. Several factors must cling together for a sportsman to gain success. The aim of this paper is to present the function, structure, dynamics and goals of a men handball team, and to demonstrate a three-month-long therapy and its results. **Methods** The object of the therapy was to clear up the situation, handling and solution of problems and achievement of ambitions. The therapy was divided into 3 parts: before playoff (team work, fill in some tests, personal therapy, feedback of results), during playoff (team work, personal therapy) and at the end of the season. The team filled in the following tests: self-made sociometrics questionnaire, then self-made questionnaire about roles, tasks and responsibility in the team and relationship with the coach and finally the Pierre-test. Results The work was successful because the team has been building, developing self-awareness and better understanding of each other. Our belief strengthened that each team would need psychological preparation for sport because in professional sport building up the personality of psychic functions, properties is very important, and the regulation of these factors. On the basis of the self-assessment test results we were able to show for the team the importance of faith, the attitude to a match, since if only two aspects, motivation and self-confidence are highlighted, even then the difference is very marked. We also drew attention to the fact that after winning or losing the game we can quantify what happens to their self-esteem, confidence and other psychological factors, depending on whether they are satisfied or dissatisfied with their performance. **Discussion** The players recognized the professionalism and competence of the coaches, problems inherent in human relations have also improved. The team understood that it is very important to focus on the desired task. Great progress was that the new leader nominated by the players was helped by us to adapt to the new role. According to the measurement of Pierre-test we developed the team's medium-low attention with Autogenic Training. In carrying out the exercises, due to the number of errors committed, and social situations occupied in the team, individual therapies have led to progress. References Berczik Krisztina (2002): Csapatportok. In: Lénárt Á.: Téthelyzetben. OSEI, Budapest. 113-118. Forsyth, Donelson R. (1990): Group Dynamics 2e. Pacific Grove CA.: Brooks Cole. Hardy, C. J. – Crace, R. K. (1997): Foundations of team-building: Introduction to the team-building primer. Journal of Applied Sport Psychology, 9, 1-10.

### IS THERE AN ASSOCIATION BETWEEN SOCIAL ACTIVITIES AND PHYSICAL FUNCTIONS IN OLDER JAPANESE ADULTS?

Tsunoda, K., Kitano, N., Mitsuishi, Y., Tsuji, T., Yoon, J.Y., Yoon, J., Saghadzadeh, M., Monma, T., Takeda, F., Okura, T.

*University of Tsukuba*

**Introduction** Although exercise helps maintain an older person's physical functions (PFs), little is known about the association between their social activities and their PFs. This cross-sectional study investigated associations of habitual exercise and social activities with the PFs of older adults. **Methods** Our study included 261 community-dwelling older Japanese adults ( $73.5 \pm 5.5$  years old) recruited in 2010 from a cohort study in Kasama City, Japan. We used seven items to assess exercise and social activities: 1) exercise, 2) visiting relatives' or friends' houses, 3) recreational activity except exercise, 4) learning activity, 5) visiting temples or shrines, 6) paid work, and 7) unpaid work. We divided responses for 1) and 2) into low frequency ('once a year or less' and 'several times a year'), middle frequency ('several times a month'), and high frequency activities ('several times a week' and 'every day or almost every day'). For responses 3) to 7), low frequency was 'once a year or less', middle frequency was 'several times a year', and high frequency was all other responses. For PFs, we measured grip strength, sit and reach (SR), functional reach (FR), timed up and go (TUG), manipulating pegs (PEG), and choice stepping reaction

time (CSRT). We divided participants into two equal groups based on each PF score. We used logistic regressions, controlling for age, gender, education, and income. Results Middle and high levels of exercise were significantly associated with high scores in FR (ORs= 3.22 and 1.87), TUG (ORs=2.45 and 1.91), and CSRT (ORs=2.50 and 3.46). A middle level of visiting relatives' or friends' houses was associated with FR (OR=1.90), and a high level was associated with CSRT (OR=2.92). Middle and high levels of learning activity were associated with CSRT (ORs=2.07 and 2.61). A middle level of learning activity was also associated with FR (OR=1.85), and a high level was associated with SR (OR= 2.77) and PEG (OR=2.52). Only a high level of paid work was associated with CSRT (OR=2.23), while middle and high levels of unpaid work were associated with CSRT (ORs=2.28 and 4.83). Discussion CSRT was associated with four of six social activities. Krueger et al. (2009) reported that social activity was strongly associated with cognitive function. CSRT is known to reflect not only PF, but also cognitive function (Pijnappels et al., 2010), which we observed with our associations. Our data suggests that social activities, as well as habitual exercise, are important for maintaining PFs in older adults. References Pijnappels M, Delbaere K, Sturnieks DL, Lord SR. (2010). Age Ageing, 39(1), 99-104. Krueger KR, Wilson RS, Kamenetsky JM, Barnes LL, Bienias JL, Bennett DA. (2009) Exp Aging Res, 35(1), 45-60.

## **RUNNING IN BEIJING – AN EXISTENTIAL INVESTIGATION OF CHALLENGED RUNNER IDENTITIES**

Ronkainen, N.1, Harrison, M.2, Ryba, T.V.1

1: Aarhus University, 2: University of Jyväskylä

Running in Beijing – an existential investigation of challenged runner identities Ronkainen, N, Harrison, M. and Ryba, T.V. Introduction Transnational migration is a growing phenomenon. While there is a growing body of research on migration in professional sports (Maguire and Falcous 2010), there is little work exploring non-professional athletes' migration experiences. In this research, we investigate non-elite Western runners' identity negotiations in their migration to Beijing, China. We examine the runner identity from historical and cultural perspectives, and discuss the contemporary running culture. Endurance running is a modernist pursuit with the emphasis on measured achievement (Chalmers 2006); Beijing with its heavy traffic and poor air quality is not favorable environment for these practices. Theory and method With existential psychology as our theoretical orientation, we explore the experiences in the light of fundamental existential questions such as, freedom, authenticity, loneliness and choice (Nesti 2004) and seek to understand how runner identity is negotiated when the everyday running practices are challenged. The ethnographic data was collected in two phases in 2011 and 2012 and includes participant observation, interviewing and first author's autoethnographic writing. Analysis In the first author's autoethnographic account two main themes emerged - the loss of control and isolation. Preliminary analyses on the interviews of other runners in Beijing revealed themes of realignment of meaning in running practices, running as a transnational culture and the great importance of local runner community. Some runners had found new positive dimensions from the challenge, while others talked about Beijing as solely a limitation. Discussion Our findings have several implications for sport psychology practitioners. First, all athletes encounter difficult times when they lose control over their sporting practices, such as injuries, transitions and burnout. Existential psychology is a suitable approach when working with athletes in these situations – it acknowledges isolation and questioning of meaning as fundamentals for human life, not pathology, and sees the encounter with hardship as potential for personal growth and authenticity. Second, knowledge of the discursive field of a specific sport sub-culture may enable practitioners to better understand the identity tensions athletes encounter. Third, based on the first author's autoethnography, we acknowledge the benefits of diary writing for athletes as a means of reflecting and understanding the boundary situations they encounter in their careers. References Chalmers, T. D. (2006). Emancipation Through Modernist Pursuits: The Discipline of Running. *Advances in Consumer Research*, 33, 15-20. Maguire, J. and Falcous, M. (2010). *Sport and Migration: Borders, Boundaries and Crossings*. New York: Routledge. Nesti, M. (2004). *Existential psychology and sport: Theory and application*. London: Routledge.

## **PRE-SEASON PLANNING STRATEGIES OF ITALIAN SERIE A CLUBS DURING 2009/10-2011/12 SOCCER SEASONS**

Francioni, F.

University of Rome

Introduction: In soccer, pre-season period is a fundamental phase of the entire annual periodization however there is a lack of information about how clubs plan it (Cadwell & Peters, 2009). Thus, the aim of present study was to analyze the pre-season planning of Italian Serie A (First League) clubs during three consecutive soccer seasons (2009/10; 2010/11; 2011/12). Methods: For each season investigated clubs were divided in three groups, according to the official ranking of the previous season: 1) 1-6 ranked (R1-6); 2) 7-17 ranked (R7-17); 3) the 3 clubs up-graded from Serie B (SB). Furthermore, clubs were divided in two geographical groups (i.e., northern and southern). A descriptive analysis was applied to investigate the following parameters: OS, duration of the off-season period (i.e., from the last official match of previous season to the first pre-season training); PP, overall duration of pre-season period (i.e., from the first training to the first official match); TC, number of days of the pre-season period spent in training camp; TP, duration of transition phase (i.e., from the last official match of previous season to the first one; FM, number of friendly matches played during the pre-season period. Results: In relation to the clubs' rank of the three seasons data showed a lower SD for TC and PP, which had a mean of 20±2 days (range: 18-21 days), 39±2 days (range: 38-41 days), respectively. Conversely, a higher SD was registered for TP and OS, which had a mean of 84±7 days (range: 77-91 days), 45±6 days (range: 39-50 days), respectively. Furthermore FM showed a mean of 6 matches. The same trend of data was showed also according to the geographical groups analysis. Discussion: These findings suggest that, independently by clubs' rank and geographical groups, clubs adopted very similar pre-season planning strategies for TC, PP and FM. This aspect can be explained by the training strategies (i.e. necessity and choices of coaches) and the economical support that each clubs receive (i.e. sponsors, paid camps, etc.). Conversely, the TP and OS gaps can be explained by the prestige (i.e. level of national and international competition) of clubs and the calendar constriction. References: Cadwell B.P & Peters D.M. (2009) *J Strength Cond Res*, 23, 1370-1377.



14:45 - 15:45

## Poster presentations

## PP-BN06 Sport Biomechanics 4 : Neuromuscular Aspects

**EFFECTS OF SLOW AND FAST STANDING BALANCE PERTURBATIONS ON H-REFLEX RESPONSE IN YOUNG AND ELDERLY MALES**

Piiirainen, J.M., Linnamo, V., Avela, J.

*University of Jyväskylä*

**INTRODUCTION** Synaptic transmission efficiency (H-reflex) between Ia afferent and motoneuron during static postural sway has been shown to decrease during ageing (Koceja et al. 1995). In addition, modulation of the H-reflex response seems to depend on the sway position and direction (Tokuno et al. 2008). However, it is not known how H-reflex is modulated during specific balance perturbations and if these modulations are age-related. Thus, the purpose of this study was to examine H-reflex response at different time points after sudden standing balance perturbation induced with two different accelerations in young and elderly males. **METHODS** Nine young (YOUNG, 27±3 years) and ten elderly (OLD, 68±3 years) males participated in this study. Standing balance perturbation was measured using custom build balance measurement device in SLOW (amplitude: 7.5cm, acceleration: 0.3m/s<sup>2</sup>, velocity 15cm/s) and FAST (amplitude: 7.5cm, acceleration: 4.0m/s<sup>2</sup>, velocity 25cm/s) conditions in anterior and posterior direction. H/M20% was measured and analysed 10ms, 30ms and 90ms after the onset of each perturbation in SLOW and FAST conditions. **RESULTS** During SLOW perturbation H/M20% was higher 10ms after the posterior (94%, p<.05) perturbation and 90ms after anterior (87%, p<.05) perturbation in YOUNG than in OLD. YOUNG had also slightly higher (n.s) H/M20% in four other time points. In FAST perturbations the differences were larger and YOUNG showed significantly higher H/M20% ratio 10ms and 30ms after both posterior and anterior perturbations (102-109%, p<.05). YOUNG had higher H/M20% in 30ms after the anterior (12%, p<.05) and posterior (23%, p<.05) perturbation in FAST than in SLOW, while no significant differences were observed in OLD. Both groups showed significantly reduced (YOUNG 91-92%, p<.01-.001 and OLD 75-84%, p<.01-.001) H/M20% 90ms after FAST anterior perturbation. **DISCUSSION** Elderly group had lower H-reflex response during both perturbation velocities. For young subjects H-reflex response was higher after the FAST perturbations than after SLOW ones, which was not observed in the elderly subjects. These differences might be due to age-related adaptability of the Ia-afferent pathway; for example higher pre-synaptic inhibition in elderly subjects (Morita et al. 1995). In any case, the mechanisms related to this phenomenon may impair balance control during sudden balance perturbations in elderly. **REFERENCES** 1. Koceja DM, et al. 1995. *Electroencephalogr Clin Neurophysiol.* 97(6):387-93. 2. Morita H, et al. 1995. *Exp Brain Res.* 104(1):167-70. 3. Tokuno CD, et al. 2008. *J Appl Physiol.* 104(5):1359-65

**DOES LOWER LIMB STRENGTH IS ASSOCIATED WITH MUSCLES RECRUITMENT DURING THE GAIT?**

Goncalves, M.

*São Paulo State University*

**Introduction** Lower limb strength declines with aging and it should be associated with an impaired functional performance during daily activities, such as, walking. In line of this, our study investigated the association between lower limb strength and the electromyographic (EMG) activation of trunk and lower limb muscles during walking. **Methods** Data of thirty seven older adult women were considered for this study. In the first visit in the data collect environment, hip, knee and ankle maximal voluntary joint torques were recorded. During the second visit in the data collect environment, volunteers were familiarized with the gait on treadmill at self-selected speed and were recorded 1-minute of gait on preferred treadmill walking speed. EMG signals were recorded at sample frequency of 2000 Hz on the muscles: internal oblique (IO), multifidus (MU), gluteus maximus (GM), biceps femoris (BF), rectus femoris (RF), tibialis anterior (TA) and gastrocnemius lateralis (GL). Strength was measured isokinetically at 120°/sec with five maximal repetitions and the concentric/concentric peak torque of hip, knee and ankle movement on sagittal plane was normalized by the mass of each volunteer. EMG signal was processed using full-wave rectification and a low pass filter (4th order and cut-off of 10 Hz) at the initial and final stance phase of ten first consecutive strides. Then, the linear envelop values were normalized by the mean of each muscle activation. We computed the Pearson and Spearman correlation coefficients to quantify the association between lower limb strength and EMG activation (significant level was set at p<0.05). **Results** Hip abduction strength were associated with TA activation during initial stance (p=0.02 and r=0.36) and with GM and MU activation at final stance (p=0.04 and r=-0.33; and p=0.01 and r=-0.4, respectively). Knee extensor strength is associated with RF activation at initial stance final stance (p=0.00 and r=-0.45; and p=0.02 and r=-0.37, respectively). Hip extensor strength was associated with RF activation at final stance (p=0.02 and r=-0.36). **Discussion** In older women a poor strength at knee extensor was associated with diminished recruitment of RF activation at initial stance which could reflect an impaired stability to reduce the anterior displacement of center of mass. The positive association between lower hip abduction strength and TA activation in initial stance could reflect a compensatory mechanism to maintain the stability. Therefore, older women with low knee extensor and hip abduction strength require higher levels of RF, MU and GM activation to push forward the center of mass at final stance. **Conclusion** The most novel aspect of this study is that older women with hip and knee impaired strength have changes in trunk, hip, knee and ankle muscles activation during walking. These changes in muscles recruitment could be related with a reduced stability during initial stance and an impaired capacity to move forward at the final stance and it could reduce the functional performance during walking.

**REACTION TIME ANALYSIS IN VISUAL RESPONSE USING ELECTROMYOGRAPHY AND ELECTROENCEPHALOGRAPHY**

Yotani, K.1, Tamaki, H.2, Nakamoto, H.1, Shibano, K.1, Yuki, A.3, Kirimoto, H.2, Kitada, K.4, Ogita, F.1, Mori, S.1

1: National Institute of Fitness and Sports, 2: Niigata University of Health and Welfare, 3: Aichi University of Education, 4: Ishikawa National College of Technology

**Introduction:** Visuo-motor related time (VMRT) can be calculated by subtracting the latency of motor-evoked potentials (MEPs) from pre-motor time (PMT) measured by electromyography (EMG) for simple reaction tasks (Yotani et al., 2011) and reflects the time elapsed from visual stimulation to the motor cortex through the visual cortex. Moreover, the peak latency in event-related potentials (ERPs) reflects the speed of information processing in the brain and can be recorded using electroencephalography (EEG). We assessed the relationship

between VMRT and the latency of ERP components (P300 [P3] and visual evoked potentials [VEP]) to visual stimulation. Method: Seven healthy male subjects (mean age, 24±3 yrs) were asked to flex the right thumb as quickly as possible in response to a visual signal. EEG was recorded on the scalp at Fz, Cz, Pz and Oz during the task, and EMG was recorded from the right flexor pollicis braevis muscle simultaneously with production of the light signal. MEP latency was measured from the flexor pollicis braevis muscle using transcranial magnetic stimulation (TMS). P3 latency was measured at Fz, Cz and Pz. Three VEP component latencies (P1, N1 and P2) were measured at Oz. In addition, VMRT was calculated as PMT minus MEP latency. Results: Significant positive correlations were observed between Fz-, Pz-P3 latency and VMRT ( $r=0.77-0.85$ ,  $P<0.05$ ), and no significant correlations were observed with the Cz-P3 latency. In the VEP, significant negative correlations were observed only between the Oz-P2 latency and VMRT ( $r=-0.76$ ,  $P<0.05$ ). Discussion/Conclusion: The ERP latencies of Fz-P3, Pz-P3 and Oz-P2 reflect the higher order brain processes. (Numata et al., 1998; Mehta et al., 2000). The results of the present study suggest that the VMRT is affected by those processing speed. References: Yotani K, Tamaki H, Yuki A, Kirimoto H, Kitada K, Ogita F, Takekura H. (2011). Response training shortens visuo-motor related time in athletes. *Int J Sports Med*, 32, 586-590. Numata K, Nakajima Y, Shimizu S. (1998). Right hemisphere dominance for figure recognition: A study of event related potentials to lateralized projection. *J Jpn Physic Ther Ass*, 25, 1-5. Mehta AD, Ulbert I, Schroeder CE. (2000). Intermodal selective attention in monkeys II: physiological mechanisms of modulation. *Cereb Cortex*, 10, 359-370.

### MUSCLE ACTIVATION UNDER DIFFERENT LOADING CONDITIONS DURING THE POWER CLEAN EXERCISE

Psycharakis, S., Dryburgh, I.

*Edinburgh Napier University*

**Introduction** The power clean is a component of the clean and jerk Olympic lift and is also commonly utilised as a training exercise in the training programs for several sports and individual athletes. However, no studies have explored the electromyographical (EMG) activation of the major muscles that are used during this exercise. The aim of the present study was to examine muscle activation during different loading conditions of the power clean exercise for the following muscles: gastrocnemius (GS), vastus lateralis (VL), transversus abdominus (TA), multifidus (MU), erector spinae (ES) and trapezius (TR). **Methods** Eight experienced lifters performed five maximal voluntary contraction (MVC) exercises followed by three sets of three power clean repetitions at 70%, 80% and 90% of their 1 repetition maximum, in randomised order. The peak and mean values for each load were calculated and normalised to the highest EMG value recorded during the power clean or the MVC exercise. **Results** There was a significant increase with load for the peak EMG values of the ES ( $p=0.002$ ) and the mean EMG values for the GS ( $p=0.002$ ) and VL ( $p=0.049$ ). There was a trend for increasing EMG with load for the other muscles, but no other comparisons reached significance. Interestingly, peak EMG values were significantly greater during the power clean than the maximal voluntary contraction in the MU and ES muscles. **Discussion** The findings suggest that when athletes attempt to increase lifting loads from 70 to 90%, performance can be improved if activation of the ES, GL and VL is increased. The relative contribution of each muscle group in the force generation required for the lift is, however, not known, and it cannot be suggested that these muscles are prioritised over others in training. Indeed, there was a trend of increase in muscle activation with load for all muscles, which suggests that performance could potentially be improved if activation of all six muscles tested in the present study increases. The peak EMG values recorded during the power clean exceeded in many cases those of the MVC exercise, a phenomenon previously noted by other researchers (e.g. Soderberg and Knutsen, 2000). This finding suggests that if the power clean exercise is used in training programmes it could have positive effects in muscle activation and, therefore, force development of the muscles tested in the present study. The findings also suggest that the power clean could be used as an MVC exercise for the MU and ES in future EMG studies. **References** Soderberg, GL, Knutsen, LM. (2000). *Phys Ther*, 80: 485-498.

### COMPARISON OF RECRUITMENT PATTERNS DURING ON-WATER AND ON-ERGOMETER ROWING.

Fleming, N., Donne, B.

*Trinity College Dublin*

**Introduction** The development of dynamic rowing ergometers which more accurately simulate on-water biomechanics have led to their increased use in training. While electromyographic (EMG) and kinematic analysis of rowing ergometer designs has been performed (Nowicky et al., 2005); a direct comparison to the on-water scenario is necessary. This study assessed recruitment patterns during on-ergometer and on-water rowing to validate task specificity of rowing ergometry. **Methods** Male rowers ( $n=10$ ; age  $21\pm 2$  yr, height  $1.90\pm 0.05$  m, body mass  $83.3\pm 4.8$  kg) performed 3 by 3 min exercise bouts at heart and stroke rates equivalent to 75, 85 and 95%  $VO_{2max}$  on both dynamic and stationary rowing ergometers and on-water. During exercise, surface EMG data were recorded (Mega ME6000) from Rectus Femoris (RF), Vastus Medialis (VM), Biceps Femoris (BF) and Erector Spinae (ES). Video recording at 50 Hz with audio triggers pre- and post-exercise facilitated data synchronisation. EMG data from 10 consecutive stroke cycles in the latter stage of each bout were amplitude processed via root mean squaring and normalised relative to pre-trial maximal sprints. Overall muscle activity within cycle was quantified via integration (iEMG) of rmsEMG data. Mean data for 10% interval of stroke cycle were compared using repeated measures ANOVA, Tukey post-hoc tests quantified significant differences ( $P<0.05$ ). **Results** iEMG activity significantly increased in RF (75 vs. 95%;  $118\pm 17$  vs.  $130\pm 20$   $\mu v.s$ ,  $P<0.01$ ) and VM (75 vs. 95%;  $195\pm 28$  vs.  $249\pm 29$   $\mu v.s$ ,  $P<0.01$ ) as exercise intensity increased. No intensity related differences were observed in BF or ES. Comparing rmsEMG data across rowing conditions revealed significant differences at discrete 10% intervals of stroke cycle in RF and VM. On-water RF activity was significantly greater than dynamic ergometry at the 10 and 20% interval ( $P<0.01$ ). On-water RF activity was also significantly greater than both rowing ergometer conditions at 60 ( $P<0.01$ ) and 70% ( $P<0.001$ ) intervals. During the drive phase (10, 20 and 30%) mean VM activity was significantly greater on-water vs. on-ergometer; these differences were most pronounced at 95%  $VO_{2max}$ . While on-water ES activity at the 20% interval was significantly greater than on-ergometer ( $P<0.05$ ) during exercise at 75%  $VO_{2max}$ , significant differences were not observed at 85 and 95%  $VO_{2max}$ . No significant differences in BF activity were observed across condition at any exercise intensity. **Discussion** Results suggest that significant difference exist comparing recruitment patterns during on-water and on-ergometer rowing. These differences may be due to altered acceleration and deceleration of moving masses on-ergometer which do not perfectly simulate the on-water scenario. **References** Nowicky A, Burdett R, Horne S (2005) *J Sports Sci Med* 4, 18-28.

## SYNERGETIC AND ANTAGONIST MUSCLE STRENGTH AND ACTIVITY RELATIONSHIPS IN WOMEN WITH KNEE OSTEO-ARTHRITIS

Patsika, G., Katis, A., Amiridis, I.G., Kellis, E.

*Neuromechanics Lab, Aristotle University of Thessaloniki*

Synergetic and antagonist muscle strength and activity relationships in women with knee osteoarthritis Patsika G. 1, Katis A. 1, Amiridis I.G. 1 and Kellis E. 1 1. Laboratory of Neuromechanics, Department of Physical Education and Sports Sciences, Aristotle University of Thessaloniki, Greece Abstract Introduction Osteoarthritis (OA) is the most common form of arthritis (Guccione et al., 1994) and the leading cause of chronic functional disability (O'Reilly et al. 1998). People with knee OA display limitations in daily activities (Hortobagyi et al., 2005) and a lower quality of their life (Baker & McAlindon, 2000), due to increased pain (Dekker et al. 1992; O'Reilly et al., 1998) and muscle weakness (O'Reilly et al., 1998). The purpose of this study was to investigate the differences in strength balance and muscle co-activity during an isokinetic test between women with knee OA and typical individuals. Method Twelve females with knee OA (age  $60.33 \pm 6.66$  yr, height  $1.61 \pm 0.05$  m, mass  $\pm 77.08 \pm 9.2$  kg) and eleven controls (age  $56.54 \pm 5.46$  yr, height  $1.64 \pm 0.05$ , mass  $\pm 77.36 \pm 13.34$  kg) volunteered to participate in this study. Subjects performed maximal isokinetic knee extension and flexion strength at  $60^\circ/s$ ,  $120^\circ/s$  and  $150^\circ/s$  was measured. Surface, electromyography (EMG) from the biceps femoris (BF), vastus lateralis (VL) and vastus medialis (VM) was recorded during all tests. Functional and conventional ratios and synergetic (Aagaard et al., 1995; Kellis & Katis, 2007) and co-activation ratios were calculated. Analysis of variance was used for the statistical analysis. Results During isokinetic protocol people with knee OA demonstrated higher moment ratios during isokinetic tests. Moreover, people with knee OA have shown higher VM to VL ratio during extension and knee flexion and lower co-activation ratio during knee flexion. Discussion People with knee OA might demonstrate different synergetic and antagonist muscle strength and activity in order to stabilize the knee joint during maximum contractions. Concentric and eccentric forms of exercise can be used in decreasing muscle weakness in the knee joint region and also can impede the disease progression, in order to perform the knee joint muscles more efficient. Key words: arthritis, quadriceps, hamstrings, co – activation, strength testing, conventional ratio, functional ratio Bibliography Aagaard P, Simonsen EB, Trolle M, Bangsbo J, Klausen K. (1995) *Acta Physiol Scand*, 154(4), 421-7. Baker K, McAlindon T. (2000). *Curr Opin Rheumatol*, 12(5): 456-63. Dekker J, Boot B, van der Woude LH, Bijlsma JW. (1992). *J Behav Med*, 15(2): 189-214. Guccione AA, Felson DT, Anderson JJ, Anthony JM, Zhang Y, Wilson PW, Kelly-Hayes M, Wolf PA, Kreger BE, Kannel WB (1994). *Am J Public Health*, 84(3): 351-8. Hortobagyi T, Westerkamp L, Beam S, Moody J, Garry J, Holbert D, DeVita P. (2005) *Clin Biomech (Bristol, Avon)*, 20(1): 97-104. Kellis E, Katis A. (2007). *Journal of Athletic Training*, 42(4): 477-85. O'Reilly SC, Jones A, Muir KR, Doherty M. (1998). *Ann Rheum Dis*, 57(10): 588-94.

## NORMALIZATION OF MUSCLE HARDNESS FOR LOWER LIMB MUSCLES BY CONSIDERING INDIVIDUAL MUSCLE THICKNESS

Murayama, M.

*Keio University*

NORMALIZATION OF MUSCLE HARDNESS FOR LOWER LIMB MUSCLES BY CONSIDERING INDIVIDUAL MUSCLE THICKNESS Murayama, M.1, Kuwada, K.2, Uchiyama, T.2, Yoneda, T.3 1 Institute of Physical Education, Keio University, 2 Faculty Science & technology, Keio University, 3 School of Health & Sports Science, Juntendo University (Japan) Introduction Changes in muscle hardness are commonly evaluated for medical rehabilitation and conditioning in sports medicine. Horikawa et al. (1993) non-invasively evaluated muscle hardness using a two-layered spring model with a pressure device. Recently, we proposed a modification to this method that considers individual muscle thickness (MT) (Murayama et al. 2008). In brief, we compared the hardness values calculated from 5–30% MT and concluded that muscle hardness should be calculated from a range of approximately 15% MT in the elbow flexor muscle. However, the feasibility of using this normalization for other muscles has not been established. The purpose of the present study was to identify a relevant range of distortion for evaluating muscle hardness in the human quadriceps muscle and triceps surae muscle by considering individual MT. Methods This study included 157 college students who volunteered to participate. The subjects were instructed to assume a standing position, with their back and legs against a wall (for evaluating muscle hardness in the quadriceps muscle) or with their shin leaning against a supporting device such as a shin guard (for evaluating muscle hardness in the triceps surae muscle). We measured the MT and the subcutaneous tissue thickness (ST) by ultrasonography. We used a muscle hardness meter, which was attached to a stage controller system. The muscle hardness meter could be shuffled linearly for approximately 25 mm at 40 mm/s by the stage controller system. Results & Discussion In most of the subjects, muscle hardness values (E) for both muscles were calculated by responded force data against distortion in the range of 5–25% MT. However, in some subjects, the final depth of distortion did not reach 25% MT. Therefore, the calculation of E from long-range MT was not always possible. Further, strong correlations were observed among muscle hardness values in the range of 5–25% E. Furthermore, significant correlations were observed between muscle hardness values and ST. In particular, the correlation coefficient (r) was larger for short-range MT than for long-range MT (i.e., r for 5% E > r for 25% E). Therefore, the calculation of E from short-range MT was strongly influenced by individual ST. From these results, we concluded that muscle hardness calculated from a range of 15% MT is adequate, because measurement in this range had the least number of disadvantages. References. Horikawa et al. (1993) *Med Biol Eng Comput* 31, 623-27. Murayama et al. (2008) 13th Annual congress of the ECSS Book of abstracts, 339

## ELECTRICALLY ASSISTED BICYCLE ALTERS INDEX OF EFFECTIVENESS AND MUSCLES COORDINATION

Androuet, P.

*Oxylane*

ELECTRICALLY ASSISTED BICYCLE ALTERS INDEX OF EFFECTIVENESS AND MUSCLES COORDINATION Androuet, P.1, Morio, C.1, Barla, C.1 1: Oxylane Research (Lille, France) Introduction Electrically assisted bicycle (EAB) is a novel tool for meeting the physical activity guidelines in terms of intensity and is sufficiently high to contribute to the moderate-intensity standard (3–6 MET) of the physical activity for adults (Simons et al., 2009). This was confirmed by Louis et al. (submitted) that the energy expenditure in electrically assisted cycling, in every support conditions, was sufficiently high to contribute to the ACSM standards for moderate-intensity health-enhancing physical activity for adults. Furthermore, this study show that with electrical support for same speed the power output decrease and for high support the gross efficiency (GE) decrease too. The more the electrical support was, the less the organism was efficient to move. The present study aim to explain GE reduction by analysing the Index of Effectiveness (IE) and the muscular coordination in normal condition and at different support level on EAB. Methods 12 subjects participated in this study. A single session of exercise on EAB on a home trainer consisted in 5 sequences of pedalling for the duration of 3 minutes. Two levels of support (S2 and S4) and one level without support (NO) was tested for

a pedalling cadence of 75rpm. Finally, 2 sequences of pedalling were carried out without support at power recorded at S2 and S4 (NOS2 and NOS4, respectively). Data were recorded for the final 30s of each ride. IE was measured by the Powertec pedal force system. Surface EMG of 6 lower limb muscles (VL, RF, BF, TA, GAL, SOL) were recorded. Average activity of each muscle was calculated for 30 cycles of pedalling. Onset and offset of the main EMG burst were calculated in degrees referred to the crank angle (Dorel et al., 2008). ANOVA with repeated measures (2 supports x 2 powers) were performed on every parameter. Results Statistics analyses showed no significant support effect on IE but presented an increased variability on IE and pedalling rate for S4. EMG analyses showed that support have no significant effect on EMG burst. However, EMG burst reduce significantly with power decrease. Interaction between power and support showed that this reduction is limited by support for the VL, RF, BF and GL muscles. Discussion Our hypothesis was that electrical support altered IE and muscles coordination. IE value was not modify modified by the support but the maximal support increased variability between cycle of pedalling. It's supposed that subject can't keep a stabilized pedalling rate while using the maximal electrical support. EMG analyses support this finding with EMG burst reduction. References Louis J, Brisswalter J, Morio C, Barla C, Temprado JJ (submitted) Int J Sport Med. Simons M, Van Es E, Hendriksen I (2009) Med Sci Sports Exerc 41: 2097-2102. Dorel S, Couturier A, Hug F (2008) J Electromyogr Kinesiol 18:857-865.

### WAVELET SCALOGRAM ANALYSIS OF GASTROCNEMIUS SEMG DURING THE COUNTER MOVEMENT JUMP

Baeyens, J.P.1,2, Pintens, S.2, Aerenhouts, D.1, Vissers, D.2,3, Clijisen, R.1,2

1: VUB (Brussels, Belgium), 2: University College Thim van der Laan (Landquart, Switzerland), 3: UA (Antwerp, Belgium)

**Introduction** The wavelet transformation provides combined time appended information concerning the amplitude-frequency domain of sEMG, furthermore its is applicable to a non-stationary sEMG signal. **Methods** Raw sEMG data obtained with a Megawin device on the right gastrocnemius of 40 male sprint athletes (14,7 yrs  $\pm$  1,9) performing a counter movement jump, were pre-amplified, downsampled to 1KHz, band pass filtered to 20-500Hz, normalized to maximal voluntary contraction (MVC) and (complex Morlet) wavelet transformed to a time/frequency/amplitude combined scalogram output. For analysis, the scalogram was divided in different levels of amplitude (0: 0%-10% MVC ; 1: -20% ; 2: -30% ; 3: -40% ; 4: -50% ; 5: -60% ; 6: -70% ; 7: -80% ; 8: -90% ; 9: -100% ; 10: >100%). Within the different amplitude levels, 'areas of activity' were defined by boundary detection on the time and frequency variable. based on a capturing of 90% of the activity along the time axis and 90% along the frequency axis, starting from the frequency or time variable's centroid of activity. The output variables were time onset/offset; frequency lower/higher bound, area of activity, and for the levels 8-10 the frequency centroid. Repeated measurement ANOVA was used in SPSS19 (significance level 5%) for the factor 'amplitude level'. Results Post hoc significancies between the different amplitude levels were: • Increased mean 'frequency lower bound' from level 1 (27.1Hz) to 10 (46.3Hz); decreased mean 'frequency higher bound' from level 1 (340.2Hz) to level 10 (189.1Hz). • Decreased mean 'area of activity' from level 1 (14968.8) to 10 ((level 7: 592.3, level 8: 394.8, level 9: 240.8, level 10: 833.4). • The mean time interval (time offset – time onset) decreased from level 1(2702.3 msec) to 10 (531.5 msec). The 95% confidence interval for the frequency centroid on the levels 8-10 was between 67.4 and 97.1 Hz. **Discussion** Gastrocnemius sEMG activity during the counter motion jump presented with a spread out of activity in time and borderline activity over a broad frequency bandwidth for the low amplitude levels evolving in sEMG activity for the highest amplitude levels concentrated over a small time interval and a small frequency bandwidth. Following the conclusions from Schiaffino et al. (2011), the sEMG activity of the highest amplitude level of gastrocnemius activity within this study suggest dominant contribution of fast twitch muscle fibers. References Schiaffino, S., Reggiani, C., Fiber types in mammalian skeletal muscles, Physiological reviews, 91: 1447-1531, 2011

**14:45 - 15:45**

## Poster presentations

### PP-BN07 Coaching 2

#### RELATION BETWEEN ANTHROPOMETRIC CHARACTERISTICS, HANDGRIP STRENGTH AND BALL-HANDLING PERFORMANCE IN YOUNG BASKETBALL PLAYERS

Apostolidis, N., Zacharakis, E., Kostopoulos, N., Bolatoglou, T.

UNIVERSITY OF ATHENS

**RELATION BETWEEN ANTHROPOMETRIC CHARACTERISTICS, HANDGRIP STRENGTH AND BALL-HANDLING PERFORMANCE IN YOUNG BASKETBALL PLAYERS** Apostolidis, N.1, Zacharakis, E.1, Kostopoulos, N.1, Bolatoglou, T.1 1: Faculty of Physical Education and Sport Science, Dpt of Games and Sports, University of Athens **Introduction:** In basketball game the anthropometric characteristics and especially arms' and hands' length can define handgrip strength. Furthermore, the anthropometric characteristics can define the performance of the young basketball players (Visnapuu & Jurimae, 2007). The aim of the present study was to investigate the relation between arms' and forearms' length and hand surface with the handgrip strength, as well as between handgrip strength and the basketball handling as it is expressed by shooting and dribbling skill (A.A.H.P.E.R., 1984). **Methods:** A sample of 105 young basketball players (aged 13.5 years) volunteered to participate in the following measurements and tests: (a) Anthropometric measurements of body high, length of arms, forearms and fingers, as well as hand surface and (b) handgrip strength, shooting and dribbling skill tests (I). For the statistical analyses were conducted: (a) Pearson correlation for the initial exploration of the relation between all of the measured variables and (b) six separate stepwise regression analyses in order to confirm the predictability of the anthropometric characteristics against handgrip strength, and of the handgrip strength against dribbling and shooting skills. Statistical significance was accepted at  $p < 0.05$  level. **Results:** Strong correlations were revealed among handgrip strength and all of the measured variables. The results of the regression analyses revealed significant predictability of the anthropometric characteristics against handgrip strength and also of the handgrip strength against dribbling and shooting skills. **Discussion:** The results of the study are in accordance with the recent literature, namely, the anthropometric characteristics of body high, arms and forearms length, as well as the hand surface are clear predictors of the handgrip strength. Regarding the second part of the study, handgrip strength is also clear predictor of shooting and mostly dribbling abilities. Conclusively, the longer of the arms and hands, the stronger of the handgrip, and the stronger of the handgrip, the better of the basketball handling. **References:** American Alliance for Health, Physical Education, Recreation and Dance, (1984). Basketball for boys and Girls, Skill Test Manual. Reston, V A.

Visnapuu, M., & Jurimae, T. (2007). Handgrip Strength and Hand Dimensions in Young Handball and Basketball Players. *Journal of Strength and Conditioning Research*, 21(3), 923-929.

### QUANTITATIVE ANALYSIS OF REAL MADRID OFFENSIVE PROCESSES

Barbosa, A.1, Sarmiento, H.2, Anzano, A.1, Campanico, J.2

*Institut Nacional d'Educació Física de Catalunya*1 *University of Trás-os-Montes e Alto Douro, Vila Real, Portugal* 2

**Introduction** The purpose of this study was to characterize the offensive process of the teams of Real Madrid. We analyzed the different styles of play (Counterattack (Ca), Fast Attack (F.A.) and Positional Attack (P.A.)) by accessing the interaction contexts in Real Madrid (R.M.) 2010/2011. **Methods** The sample consisted of 12 football games of domestic competitions that were analyzed by systematic observation. The design used in the present study was descriptive and was based on an observational methodology applied to the acquisition of data (Anguera et al., 2000). The matches were analyzed through systematic observation by using a specific instrument to observe the offensive process (Sarmiento et al. 2010). The study of the data reliability was calculated by the intra and inter observer agreement, and values above 0.90 for all criteria were achieved. Chi-square test to compare the differences between the team concerning the styles of play and descriptive analyses for all variables was done with the statistics software SPSS.19.0. **Results** R.M. plays more through the P.A. (39,2%), followed by the F.A. (34,39%) and the offensive style less performed is the Ca. (29.1%). Regarding to the sector where the possession of the ball is recovered, the lateral corridors of the defensive midfielder zones are more often used to recover the ball, zones 4 and 6 in F.A. and P.A., and in the Ca. are the zones 7 and 9. The recovery of ball possession generally occurs in interaction contexts of relative numeric superiority. In terms of orientation, the zones more often used for the last pass are the two left-hand (P.A., 29%; C.A., 36.4%; and F.A.,40%). The central zone (Z11) characterizes the end of the offensive process (P.A., 45.7%; C.A., 45.4% and F.A., 42.3%). We can analyze that the most frequent behaviors regarding the end of the offensive process were the shot and the recovery of the ball possession by the opponent. Concerning the goals scored, the RM team scored more goals (14) through the F.A. When compared with the goals scored by Ca. (10) or by the P.A. (5). The type of attack that presented more efficiency was F.A. with 9.2%. **Discussion** We believe that there exist an attacking style that seems more efficient but more important than efficiency is identifying a set of principles that predict a style of play. The success of the offensive process is directly related to the players of a team awareness and their ability to adapt behavior according to the opposing team's defensive model. **References** Sarmiento, H., Anguera, T.; Campanico, J.& Leirão, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. *Medicina(Kaunas)*, 46(6), 401-407.

### T-PATTERNS REGARDING GOAL SITUATIONS OR EMINENT SCORING SITUATIONS

Barbosa, A.1, Sarmiento, H.2, Anzano, A.1, Campanico, J.2

*Institut Nacional d'Educació Física de Catalunya*1, *Espanha*; 2 *University of Trás-os-Montes e Alto Douro, Vila Real, Portugal*

**Introduction** This study intends to identify the significant repeated and regular behaviors, emerging from the diversity of game actions. It intends to determine the behavioral variables regarding Goal situations or eminent scoring situations, in two teams that share the same coach and the same technical staff. The selected football teams are Real Madrid (RM 2010/2011) and International Milan (MI 2009/2010). **Methods** To collect data, we used the instrument developed and validated by Sarmiento et al. (2010). This instrument consists in a specific notation analysis to study the offensive process and its variables. Several offensive sequences were coded through the observation of 24 games of Inter Milan and Real Madrid, 12 per each team. In order to verify pattern occurrence, we used the software THÈME 5.0, which is a professional system for detecting and analyzing hidden behavioral patterns. The reliability of the data was calculated by the intra observer agreement, and values above 0.95 were achieved for all the variables. For pattern detection, we only considered the ones that were repeated 3 times, and the significance level was set at 0.005. **Results** We detected 3 complete t-patterns, referring to the whole process, from ball possession recovery until successfully completing the offensive process (OP). The same standard repeated with the finishing zone with scoring being the frontal part of the goalpost. We have identified three patterns that repeated five times each. The data collected complements previous research. The area of ball possession recovery is located in the defensive midfield sector, with prevalence in the side wing. In the analyzed patterns we found the prevalence of zone 4. When recovering the ball there is a relative numerical superiority by intercepting the pass. The second analyzed action takes place in zone 8 which seems to prove the direct style of the offensive game. Patterns end with an eminent scoring situation in the central area of the goalpost (Z11). One of the patterns we analyzed ends in relative numerical inferiority. **Discussion** We believe that although the coach's plan suffers some adjustments, according to the characteristics and type of championship, the central idea that manages an offensive game model has the same principles and sub-principles in spite of the team change, championship and players. **References** Sarmiento, H., Anguera, T.; Campanico, J.& Leirão, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. *Medicina(Kaunas)*, 46(6), 401-407.

### TIME SPENT CYCLING IS THE MOST PREDICTIVE FACTOR IN ORDER TO BE SUCCESSFUL IN A OFF-ROAD TRIATHLON RACE.

Caria, A., Massidda, M.

*University of Cagliari*

**Introduction** Race result prediction is one of the most interesting aspects for sports scientists. Triathlon is a 3-event endurance sport (swimming, cycling and running) that are generally completed in succession and are separated each other by a transition periods of only a few seconds (Suriano et al., 2010). A scarce number of studies have examined the Triathlon in its entirety, particularly as far as the relationships between overall and single event competition times and positioning during an official off-road race. **Purpose** The purpose of this study was to identify the most important event in order to be successful in a off-road Triathlon race. **Methods** Two-hundred-ninety-seven athletes were studied (n=260 males, n=37 females) during a world stage of the 'X TERRA World Championship'. All athletes have completed the World's off-road Triathlon race (1.5 km, 30 km, 10 km). The Swim Time (S), the Bike Time (B), the Run Time (R), the Transition Time between S and T (T1) and Transition Time between the T and R (T2) were recorded for each athlete using the SYNOPSIS GPS system (T4 model). The analysis was computed for each gender separately, considering the final standings as dependent variables and the S, B, R, T1 and the T2 as independent variables. **Results** For males, the 99.4% of the final standings variability was explained by the B ( $R^2_{adj}=.9940$ ,  $F=43098.82$ ,  $df=1$ ,  $p<0.01$ ). The second most important variable (even if with a less significant level with respect to B) was the R ( $R^2_{adj}=.9943$ ,  $F=22777.01$ ,  $df=2$ ,  $p<0.01$ ), followed by the T2 ( $R^2_{adj}=.9945$ ,  $F=15652.47$ ,  $df=3$ ,  $p<0.01$ ) and by the T1 ( $R^2_{adj}=.9946$ ,  $F=11971.65$ ,  $df=4$ ,  $p<0.01$ ). For females, the only significant variable entered in the regression equation in predicting the variability of the final standing was the B ( $R^2_{adj}=.9951$ ,  $F=7259.37$ ,  $df=1$ ,  $p<0.01$ ). **Discussion** Our results suggest that the time spent cycling during off-

road Triathlon competition was the best predictor of the final positioning in both sex. However, the time spent running and the transition times were correlated to the final standing in males but not in females. Finally, swimming time was not significantly related to the final positioning in both gender. This result agrees with those of previous researches on Triple Iron Triathlon (11.6 km swimming, 540 km cycling and 126.6 km running) that showed the low importance of swimming performance in order to be successful during competition (Knechtle and Kohler, 2009). In conclusion, Triathlon is more than the sum of its parts, but it is "one sport, three disciplines and two transitions" (Millet and Vleck, 2000). References Knechtle B, Kohler G. (2009). *Br J Sports Med*, 43(6):437-441. Millet GP, Vleck VE. (2000). *Br J Sports Med*, 34, 384-390. Suriano R, Bishop D. (2010) *J Sci Med Sport*, 13,340-347.

### EFFECTS OF A TRAINING PROGRAM ON MEDICINE BALL THROWING PERFORMANCE IN YOUNG VOLLEYBALL PLAYERS

Battaglia, G.1,2, Bellafiore, M.1,2, Proia, P.1, Palma, A.1,2

*School of Sports Science, University of Palermo*

**Introduction** It is often recommended that off-season training programs aim to develop muscular strength and power in volleyball players (Marques et al., 2008). However, improvements in performance may be possible with a well-designed training regimen. The purpose of this case report is to study the effects of a specific training program to improve explosive power of upper limbs in young female volleyball players. **Methods** In the present study were included twenty one short-limbed girls (Scelic Index  $\geq 54.6$ ) of which 11 age-matched control sedentary subjects [SS] (age: 15.00 $\pm$ 0.52 years, BMI: 21.10 $\pm$ 2.09, SI: 55.45 $\pm$ 1.45) and 10 volleyball players [VP] (age: 14.50 $\pm$ 0.97 years, BMI: 22.17 $\pm$ 1.87, SI: 55.29 $\pm$ 2.12). SS did not perform any physical activity during the 4-week experimental period. Instead, VP completed 3 training sessions per week, which included specific exercises to improve explosive power of upper limbs and technical-tactical exercises. Over the 4-weeks, athletes performed 2-4 sets of 4-12 repetitions for resistance exercises during each training session (~55 minutes). All sessions were supervised by one of the investigators as well as by the team head coach. Muscular strength and power were assessed before and after the 4-week training program by seated backward overhead ball throw (SBOBT) and seated chest pass throw (SCPT) using a 3-kg rubber medicine ball. All tests were performed for three times but only the best performance was considered. **Results** We did not show any significant differences in SS' performances during SBOBT and SCPT after 4-weeks. Instead, we found that this specific training program can improve throwing performance in young female volleyball players. Indeed, we showed that VP increased the distance both in SBOBT ( $P < 0.001$ ) and SCPT ( $P < 0.001$ ) after 4-weeks of a specific training program. **Discussion** The current findings suggest that this specific training program can improve VP' explosive power during the pre-competition season by implementing a well-designed training program. However, in agreement with Ha'kkinen et al. (1993) we suggest that in order to maintain the explosive strength, the magnitude of both strength and explosive training stimuli should be given careful attention during the entire course of the competitive season. **References:** Marques MC, Tillaar R, Vescovi JD, González-Badillo JJ. (2008). *J Strength Cond Res*, 22(4), 1147-55. Ha'kkinen, K. (1993). *J Sports Med Phys Fitness*, 33(3), 223-32.

### THE INFLUENCE OF LIFE COMMITMENTS AND EMOTION REGULATION ON COACHING EFFECTIVENESS

Davis, P., Davis, L., Dinning, S.

*Northumbria University*

**Introduction:** Sport coaches are often volunteers with numerous life commitments (e.g., jobs, family) outside of the domain of sport. The influence of life commitments and associated stress on athletes' performance has been shown to be significant; however, coaching effectiveness has not been examined in relation to coaches' personal responsibilities. Therefore, the aim of this study was to analyse the influence of life commitments, perceived stress and emotion regulation on coaching effectiveness. **Methods:** Thirty level three (UKCC) coaches from the United Kingdom completed questionnaires measuring perceived stress, coaching effectiveness and emotion regulation. Additionally, coaches completed a qualitative writing task exploring their perceptions of the influence of life commitments on their coaching effectiveness. Linguistic analyses were conducted on the writing transcripts to investigate participants' expressions of emotions and indicators of cognitive processes (e.g., insight, causation). **Results:** Coaches reported experiencing a range of life commitments (e.g., education, relationships) and a variety of emotions (e.g., joy, anger, sadness) associated with personal responsibilities outside of the domain of sport. Coaches perceived their life commitments to be both positive (e.g., financially enabling sport participation) and negative (e.g., causing fatigue) influences on their coaching effectiveness. In particular coaches who reported high levels of perceived stress reported that life commitments were more detrimental to their coaching effectiveness. Linguistic analyses revealed that coaches felt that they largely understood the influence of life commitments on their emotions and coaching effectiveness. Coaches' attempts to cope with perceived stress also emerged as a theme in the qualitative analyses. **Discussion:** Coaches' perceived effectiveness can be influenced by the life commitments they experience outside of sport. The regulation of coaches' emotions and the ability to manage perceived stress can reduce the detrimental effects of personal responsibilities on coaching effectiveness. The implications of life commitments on coaching effectiveness have received limited research attention; interventions aimed at developing effective emotion regulation may help coaches cope with perceived stress, enhance coaching effectiveness and prevent burnout.

### ANTHROPOMETRIC PARAMETERS AND FIELD TEST RESULTS OF YOUNG ATHLETES ON A FOLLOW-UP STUDY

Petridis, L.

*University of Debrecen*

**Introduction** The purpose of this study was to examine the effect that, body height and body weight changes can have on physical tests performance in pre-pubertal and pubertal athletes. Improvement of conditioning abilities at that age can vary according to the athletes' age period, their sport and their gender. **Methods** A total of 79 athletes were measured (40 boys and 39 girls) practicing in either basketball or handball. The subjects were divided into two age groups ( $n = 42$  of 11-12 years old and  $n = 37$  of 13-14 years old). Data were obtained in two separate measurements, in spring of 2010 and in autumn of 2011, thus the changes of data were recorded within a 16 month period. Body height (BH), body weight (BW), vertical jump (VJ), 30 m sprint run and 2800 m run were measured at the two time periods. Regression analysis was used to analyze the effect of the body parameters and grouping factor on the physical tests performance. **Results** BH changed 4.6 $\pm$ 2.44%, BW 13.0 $\pm$ 9.95%, 30m 6.12 $\pm$ 11.72%, VJ 16.93 $\pm$ 23.37% and 2800m 5.93 $\pm$ 11.04%. In both age groups (11-12 & 13-14 years) boys basketball players had a faster growth in BH and in BW, however in all three physical tests had lower improvement compared to handball players. Among body parameters BH had a significant effect on the 30m run ( $\beta = 0.39$ ;  $t = 2.78$ ;  $p < 0.05$ ), while the BW, sex, age group and sport didn't show to effect 30m run performance. On vertical jump BH showed significant effect ( $\beta = 0.42$ ;  $t = 3.23$ ;  $p < 0.05$ ), BW had a negative, but not significant effect. Between boys and girls, there was a slight, but not significant

difference, with boys performing higher. 2800m run, didn't seem to be effected by any parameter. Discussion It seems that among the three physical tests, at the pre-pubertal age BH can be important only in 30m run, which has a logical explanation, while there is no difference in the improvement pace between boys and girls, as also between basketball and handball players. In many aspects a similarity between the two sports conditional requirements and between the training patterns can explain the lack of any improvement alterations in this age group.

### **THE IMPORTANCE OF THE OBSERVATION IN FOOTBALL. QUALITATIVE STUDY WITH PORTUGUESE FIRST LEAGUE COACHES**

Sarmiento, H.1,3, Pereira, A.2, Anguera, M.T.3, Campanico, J.1,2, Leitao, J.1,2

1- UTAD, CIDESD (Vila Real, Portugal); 2-IPV (Viseu, Portugal); UB (Barcelona, Spain)

Qualitative analysis is the primary method used to improve human movement. Several professional soccer coaches rely on qualitative analysis for improving the performance of their teams (Knudson & Morrison, 2002). This study aims to understand how do these coaches makes the diagnostic decisions that affect the team's performance. The participants were 8 experienced Portuguese First League coaches (14,9±8,6 years of experience). Semi-structured interviews (Creswell, 2006) were carried out and the data were analyzed through the technique of content analysis (Bardin, 1977). The elaboration of the categories had been defined à posteriori. The software QSR NVivo 9 was used in coding the transcripts of the interviews. The analysis of the data allowed to establish a model of qualitative analysis consisting of four dimensions: preparation; observation; diagnostic/evaluation; intervention. Coaches considered that the most important aspect in the preparation of an observation is the knowledge of the game, through both the identification of critical characteristics as the knowledge of the individual characteristics of players. Regarding the observation task, they consider that the most important aspects to observe in the game are: the 4 moments of the game (offensive and defensive organization, and transition defense/attack and attack/defense); tactical schemes (corners, free kicks, etc.); individual characteristics of players; random aspects of the game. Coaches have the perception that over the years his observation became more effective and they value different aspects in the game. However, perceive that the quality of his observation is influenced by factors such as the expectations, the environment, the referee's errors and by its position in the field. These coaches evaluate the teams in a general way focusing mainly on strengths and weaknesses and they follow a specific logic of prioritization for the evaluation of these aspects. The intervention is done mainly through the adaptation of the training exercises, but also through visual strategies (movies, photos, etc.) and meetings (individual, by sector or in group). They have a great concern with appropriate intervention (body language, appropriate feedback, etc.). To communicate with players during the game, they provide immediate feedback or use target players that serve to convey the message, but consider that the half time is the privileged time to talk with the players. Bardin, L. (1977). *Análise de conteúdo*. Lisboa: Edições 70. Creswell, J. (2006). *Qualitative Inquiry & Research Design: Choosing among five approaches* (2nd. Edition). London: Sage Publications. Knudson, D., Morrison, C. (2002). *Qualitative analysis of human movement*. Champaign, IL: Human Kinetics.

### **ANALYSIS OF THE SAILING BOAT TRACK IN A VIRTUAL SIMULATOR WITH DIFFERENT LEVEL SKILL SAILOR.**

Manzanares Serrano, A., Segado Segado, F., Menayo Antúñez, R.

*Universidad Católica de San Antonio Murcia*

Introduction Physical attitude, speed of the boat and tactical intelligence are the main elements of the competitive movement in dinghy sailing (Spurway, Legg & Hale, 2007). The aim of this research has been analyze and compare the boat track by sailors of different levels and related them with the success they got at the start. Methods The participants of this study have been six Optimist class sailors from Murcia (Spain), between the ages of 12 to 15. The level of the sailors is determined by the position they have in the ranking. Two of them are on the top of the classification, another two are on the middle positions and the last two are on the lower positions of the ranking. The registry of the boat track by the sailors was carried out with the sailing simulator VSail-Trainer®. Research variables were the boat track and the speed of the boat on second 0,0. The boat race consisted of a simulated start, with stable conditions of wind, opponent and sea. The simulated start presented the same conditions that can be found in a real start. Result The results show that expert sailors do a better performance of boat track, due to the fact that they reach the second 0.0 in a closer position to the start line and at a better speed than sailors with less experience. It must be highlighted that the rest of the sailors of the middle positions of the ranking perform a boat track different than the rest, even surpassing the start line before the 0.0. Beginners perform the less stable boat track and are the last ones to surpass the start line. Discussion Expert sailors show the best behaviour, which consists on reaching the 0.0 second as close as possible to the start without surpassing it. This can be due to a major capacity to assimilate environmental changes and adapt to them that expert sailors have in relation to beginners (Rocha, Araujo & Serpa, 1995). The differences shown by those sailors in the middle positions of the ranking in relation to those of the lower positions can be due to the capacity to look for a better strategy, which is developed as one gains experience (Walls, Bertrand, Gale y Saunders, 1998). References Rocha, L., Araújo, D. & Serpa, S. (1995). Psychological characteristics and decision making in top level sailing. Paper presented at the IX European Congress of Sport Psychology: Integrating laboratory and field studies, Brussels. Spurway, N., Legg, S. & Hale, T. (2007). Sailing Physiology. *Journal of Sports Science*, 25(10), 1073-1075. Walls, J., Bertrand, L., Gale, T. & Saunders, N. (1998). Assessment of Upwind Dinghy Sailing Performance using a Virtual Reality Dinghy Sailing Simulator. *Journal of Science and Medicine in Sport*, 1(2) 61-71.

14:45 - 15:45

## Poster presentations

## PP-SH05 Management &amp; Ethics

**GENDER, AGE AND PERCEPTION OF IMPORTANT LEADERSHIP OF MONITORS WORKING IN ADAPTED PHYSICAL ACTIVITY PROGRAMS IN SPAIN**

Campos, A.I., González, M.D.2

*1: Polytechnic University of Madrid (Madrid, Spain), 2: Alcalá University (Madrid, Spain)*

**Introduction** The importance of human resources programs that develop physical activity and sport is essential for safe and effective implementation and to ensure the benefits of physical activity and sport as well as the influence of its leadership (Madella, 2003; Campos, 2010). The objective is study of gender, age and the perceptions of the importance of leadership in the work of the monitors physical activity and sport of adapted physical activity programs in Spain and their analysis by gender and age. **Methods** The quantitative methodology consisted of a cross-sectional survey. Cluster sampling was used. The final sample size was 241 monitors. Data were collected through structured questionnaires with face-to-face interview between January and November 2011. All the statistical analyses were done using the SPSS/Windows 19.0 statistical software. The inferential analysis with Cronbach's was .802. Signification levels were set at  $p < 0.05$ . Results 64,3% of monitors are men and 35,7% women. By age, 31,5% of monitors are under 30 years, 57,2% of monitors are 30 to 50 years and 11,3% monitors are over 50 years. 14,1% of the monitors perceive that leadership is not important, 17,8% important and 68,1% very important. By gender, 13,6% of men believe that leadership is not important, 17,4% important and 69% very important; and 15,1% of women perceive that leadership is not important, 18,6% important and 66,3% very important. By age, 18,4% of monitors under 30 years believe that leadership is not important, 17,1% important and 64,5% very important; 13% of monitors 30 to 50 years perceive that leadership is not important, 18,8% important and 68,2% very important; and 7,4% monitors over 50 years believe that leadership is not important, 11,1% important and 81,5% very important. **Discussion** Most monitors are men and under 35 years. Most monitors programs working in adapted physical activity programs in Spain perceived that the leadership in their very important job, men more than women and as age increases perceived leadership is more important. The human resources are very important in efficient development of physical activity and sport and the influence of its leadership (Camy, Chantelat y Le Roux, 1999; Campos, 2010) **References** Campos A. (2010). Dirección de recursos humanos en las organizaciones de actividad física y del deporte. Síntesis, Madrid. Camy J, Chantelat P, Le Roux N. (1999). Sport et emploi en Europe. Comisión Europea, France. Madella A. (2003). Methods for analysing sports employment in Europe. *Managing Leisure*, 8(2), 56-69 The research reported is a part of the Fundamental Research Project I + D + i DEP2009-12828 which has been funded by the Ministry of Science and Innovation.

**GENERAL CHARACTERISTICS OF PHYSICAL ACTIVITY PROGRAMMES FOR ELDERLY PEOPLE: RESULTS OF A CLUSTER ANALYSIS**

Marques, A.I., Rosa, M.J., Amorim, M., Oliveira-Tavares, A., Santos, R., Mota, J., Carvalho, J.

*CIAFEL*

**Background:** Despite the recommendations for an active lifestyle, most of the elderly European citizens are not physically active. The role of community-based interventions in promoting physical activity (PA) and the positive effects of participation in PA programmes have been closely studied and publicized. It is widely accepted that the benefits of such programmes depend on adherence to exercise regimes, which is influenced by degree of enjoyment and satisfaction. Moreover, one of the most important factors in customer satisfaction is quality of service. Thus, quality is an important issue when designing a PA programme for older people. **Aims:** 1) to distinguish groups of PA programmes according to the implementation of the quality management practices (QMP), and 2) to identify the general characteristics of the cluster with the best results in quality practices, concerning the profile of the programmes' coordinators and the programmes' features. **Methods:** A methodological triangulation was conducted in 26 PA programmes using questionnaire surveys, semi-structured interviews and document analysis. Cluster analysis using Ward's method of agglomeration with squared-Euclidean distance measures was used to identify subgroups of PA programmes based on the results of the QMP associated with the EFQM's criteria. The significant differences in categorical variables and continuous variables among subgroups types were compared with the chi-square test and the Kruskal-Wallis test, respectively. **Results:** We identified four clusters of PA programmes: "Beginners - results neglected", "Committed - process focus", "Committed - society focus", and "Beginners - customer oriented". They differ essentially in degree of implementation of each EFQM's criterion and scope of all criteria. No significant differences were found between clusters for their general characteristics, except for the number of facilities managed by the programme ( $p \leq 0.05$ ). **Conclusions:** Clustering identified four subgroups of PA programmes. The number of facilities is significantly associated with the created clusters. The cluster with the best results in quality practices – the "Committed - process focus" – is the one whose programme coordinators have a bachelor in physical education, whose programmes have run for a longer period of time, which have the largest number of customers and facilities and which are mostly free of charge and led by women. Since the quality of a service increases customer satisfaction, the continuous improvement of the PA programmes should be implemented to increase elderly satisfaction and adherence.

**DESIGNING MODEL OF STAKEHOLDER- ORIENTED WITH EMPHASIZING ORGANIZATIONAL LEGITIMACY IN SPORT ORGANIZATIONS**

Goharrostami, H., Kozechian, H., Amiry, M., Honari, H.

*Tarbiat Modares University*

**Introduction** Organizational legitimacy is obtained through provision of stakeholders' interests. Also, According to Sotiriadou (2008), many stakeholders are actively involved in national sport (Sotiriadou et al., 2008). Hence, this study is intended to identify factors that affect provision of stakeholders' interests in ministry of sport and youth of I.R.IRAN emphasizing organizational legitimacy. **Method** The participants of this study include 366 stakeholders of ministry of sport and youth of I.R.IRAN. For data gathering purposes, literature review, structured interview and questionnaire were used. In the interview session, the conceptual model, the variables and the relationships



among them were discussed with 22 managers and experts, and later on the conceptual model, based on the data from questionnaires, was tested with Amos16. Results Based on the fit indices, the model hypothesized in this study was fit (GFI=.924, AGFI=.900, CFI=.970, NFI=.930, RMSEA=.043). The results of study showed that there was a significance relationship between stakeholders' capability of management and providing of stakeholders' interests ( $p=0.000$ , Regression weight=1.307). Adaptive culture also influenced on providing stakeholders' interests ( $p=0.000$ , Regression weight=-.484). However, there was not a significance relationship between organic structure and provision of stakeholders' interest ( $p=.298$ , Regression weight=.074) Contextual factors (adaptive culture ( $p=0.000$ , Regression weight=.734), organic structure ( $p=.048$ , Regression weight=.157)) influenced on stakeholders' capability of management, moreover, another significance relationship between provision of stakeholders' interest and organizational legitimacy was found ( $p=0.000$ , Regression weight=.846). Discussion and conclusion In fact, national sport organizations such as ministry of sport and youth need to provide stakeholders' interests at national level to survive in its environment and increase organizational legitimacy. The increase of organizational legitimacy results in more political and social support by stakeholders. Consequently, achieving organizational goals is easier (Koen et al., 2007). Hence, all of these issues are dependent on the development of an effective sport system in which stakeholders' needs and demands are satisfied. References Sotiriadou, K. (2009). The Australian sport system and its stakeholders: development of cooperative relationships', *Sport in Society*, 12: 7, 842 - 860. Sotiriadou, K., Shilbury, D., Quick, S., (2008). 'The attraction, retention/ transition, and nurturing process of sport development: Some Australian evidence' *Journal of sport management*, 22 (3), 247-272. Koen, B. V., and Bouckaert, G. (2007). Pressure, Legitimacy and Innovative Behavior by Public Organizations, *governance*, 20(3).

## COOPERATION MODELLING IN THE CONTEXT OF GLOBALIZATION: PARTNERING COMPETENCES PERSPECTIVE

Valantiene, I., Krikstaponytė, I., Tilindienė, I., Staskeviciūtė, I.

*Lithuanian Academy of Physical Education*

Introduction Globalization is altering the world economic landscape in fundamental ways. Besides others, it creates important new opportunities—wider markets for trade, an expanding array of tradable, larger private capital inflows, improved access to technology. Prior researches on partnering and globalization also suggests that as the speed of knowledge generation and innovation has increased dramatically, organizations need to engage in partnering to optimize their innovation efforts and management efficiency and that the degree of organizations innovation success via cooperation is positively correlated with its level of partnering capability and competences needed for it. The following research methods are used in this paper: comparative analysis of scientific literature, systematization and generalization, authors work experience in the fields of partnering/alliances management and competence. The novelty of this paper. The theoretical aspects of the scientific literature on managerial competences as well as their development are widely researched (Boyatzis, 1982; Krogh, Roos, 1996; Wallace, Hunt, 1996; Magarinos, 2002). Prior research suggests that the degree of a organization's success via cooperation is positively correlated with its level of partnering and managerial competences. Based on a grounded theory approach, we have developed a conceptual framework of partnering competences, which also provides some testable ground for further research and managerial practice. Conclusions 1. In order to have successful partnering, organizations will have to enter into partnering more aggressively in the future cause of the reasons to learn; to take advantage of partners' specialization advantages; to leverage resources; to create linkages; to leap over existing constraints; and to 'lock out' the competition. 3. The concept of competence is used for the wide spectrum of skills and abilities which are close with experience: specialization, intelligence, problem solving, talent. The degree of organizations innovation success via cooperation is positively correlated with its level of partnering capability and competences needed for it. 4. Partnering competencies can be grouped into three categories: managerial, generic and technical. 5. The main task of partnering competence development for cooperative success is to grow organization to that level that it could survive the challenges of competition and globalization. References Boyatzis, R. *The competent manager: A Model for Effective Performance*. New York: Wiley and Sons. 1982. Krogh, G., Roos, J. *Managing Knowledge*. University Press. 1996. Magarinos, C. *Strengthening Organizational Core Values and Managerial Capabilities // Human Resource Management Branch*, 2002, p. 9-20. Wallace, J. and Hunt, J. *An analysis of managerial competencies across hierarchical levels and industry sectors: A contemporary Australian perspective // Journal of Australian and New Zealand Academy of Management*, 1996, 2(1), p. 36-47.

## LEGISLATIVE CREEP: UNPACKING LEX OLYMPICA

Osborn, G., James, M.

*University of Westminster; Salford University*

At Atlanta 1996 many commentators argued that the value of the official sponsorship agreements was undermined by rival brands and the look and feel of the Games diluted by unregulated clutter. Following this, and since the Sydney 2000 Games, the International Olympic Committee has required specific legislation, via the Host City Contract, to protect the commercial and intellectual property rights associated with each edition of the Games. In terms of the evolution and scope of the legislation and regulatory measures each host uses, this 'law' tends to be iterative in that it uses the previous legislation as the starting point from which it enacts measures based on the assumed successes and perceived shortcomings of what has gone before. This 'horizontal legislative creep' has seen host governments enact ever more draconian restrictions on the ability of local businesses to trade effectively during the Games period in order to fulfil the requirement of the Host City Contract but without ever pausing to contemplate whether or not such legislation is necessary or appropriate. However, in addition to this there is a related form of creep that needs to be evaluated. Here we see the practices and approaches developed for the Olympic Games adopted and utilised across sporting mega events in a form of 'vertical creep'. This paper analyses these instances of creep, and locates it within the debate around the need for, and scope of, 'Olympic Law', or what, in a nod to the debates on the emergence, existence, scope and desirability of *lex sportiva*, we have contentiously termed 'Lex Olympica'. Mark is a Reader in Law and Head Salford Law School. He has published widely sports law in the UK and is the author of *Sports Law* (Palgrave). Guy is Professor of Law at Westminster University and is one of the UK's leading authorities on law and popular culture. Over the past two years, Mark and Guy have been examining the development and scope of 'Olympic Law' and in particular its impact on advertising and trading around London 2012 venues. Their publications include: 2012 'The Olympic Laws and the tensions and contradictions of promoting and preserving the Olympic Ideal' with G Osborn in V Girginov (Ed), *The 2012 London Olympic and Paralympic Games: Vol. 1 Bidding, Delivering and Engaging with the Olympics*, (Routledge, forthcoming June 2012) ch.6. 2012 'The Olympics, the law and the contradictions of Olympism' with S Greenfield and G Osborn in H Lenskyj and S Wagg (Eds), *Handbook of Olympic Studies*, (Palgrave, forthcoming March 2012) pp304-318. 2011 'London 2012 and the impact of the UK's Olympic and Paralympic legislation: protecting commerce or preserving culture?' with G Osborn, 74(3) *Modern Law Review* 410-429, 0026-7961. 2010 'Consuming the Olympics: the fan, the rights holder and the law' with G Osborn, commissioned piece for the British Library's Olympic Legacy website, 'Sport and Society: The Summer Olympics Through the Lens of Social Science' available at: <http://www.bl.uk/sportandsociety/exploresocsci/parlaw/law/law.html>.

## IS OF HUMAN RESOURCES MANAGEMENT IN THE SPORT OF LOCAL PUBLIC ADMINISTRATIONS

Pérez, E., Martínez, G., Pablos, C., Mestre, J., Campos, A.

*Catholic University of Valencia*

**Introduction** 45% of citizens in 1990 and 63% in 2010 recognizes the local governing bodies as entities of public administration to be contacted for sports, according to the survey of sports habits in Spain (García Ferrando & Llopis, 2010). Our research analyzes the profile of local public administrators who carry out their work in the field of sports and physical activity. **Methods** This research has followed a descriptive quantitative methodology of survey procedures, all of this based on the design and methodological application of the study of Campos (2005). Questions and reflections on the responses could be produced; the selection of places and people that was necessary to obtain information have been previously analyzed and applied. The study population is finite (10,000 workers in the region under study). The size of the sample obtained by applying the formula for finite populations (Campos, 2001) is 588 people. The realization of standardized interview (questionnaire), registration of information and data collection were carried out by author of the research. **Results** The profile of people working in roles of physical activity and sports for local government responds to: A man older than 30 years, born in the same region where he works; bachelor, without a major in physical education or sports, has attended courses in the last 4 years. He has several functions, primarily teaching, along with other tasks not related to sports. He has experience working in other areas of physical activity. He is satisfied with his current tasks, which are performed in different populations. He has participated in Federated competitions. He obtained his job based on his biography and/or curriculum vitae. He has a full-time temporary contract. He has been working in this field for over 4 years and has previous work experience in other fields. He does not consider his job to be temporary Work and is not aware of his employment rights. He wants to have a life-long career in an occupation related to physical activity and sports. He thinks that more staff needs to be employed in the institution where he works. **Discussion** It confirms the lack of human resources and specialized training in physical activity and sports of the local professional public administrators in this region of Spain. **References** García M, Llopis R. (2011). Survey of sports habits in Spain 2010. CSD – CIS, Madrid, Spain. Campos, A, Pablos, C. & Mestre, J.A. (2006). The structure and management of the labour and professional market of physical activity and sport. Wanceulen, Sevilla, Spain. Martínez, G., Campos, A., Pablos, C. & Mestre, J.A. (2008): The human resources of physical activity and sport. Tirant lo Blach, Valencia, Spain.

## CONTROLLING HEART RATE RESPONSE ON BICYCLE ERGOMETER

Lefever, J., Hias, J., Berckmans, D., Aerts, J.M.

*Katholieke Universiteit Leuven*

**Introduction** An optimal training pace is necessary to reach substantial health benefits and will help to avoid under- and overtraining. Knowledge of the actual exercise intensity is essential to optimise the training. Power output can be used as a direct indicator of exercise intensity (Jeukendrup et al., 1998). This technology is still quite expensive, so heart rate is more often used as an indicator for exercise intensity and to prescribe essential training zones. A possible way for effective fitness training is through monitoring and controlling the heart rate of the individual. Heart rate controllers have already been developed for running, using nonlinear modelling techniques (Cheng, 2008). The goal of this study was to explore if model predictive control (MPC) allows controlling heart rate for cycling applications by making use of compact, dynamic, linear data-based model structures. **Methods** Six amateur male road cyclists ( $22 \pm 1$  years;  $75.3 \pm 7.2$  kg;  $182.0 \pm 5.6$  cm) participated in this study. Sixteen datasets were collected to develop a MPC heart rate controller based on single-input, single-output discrete-time transfer function models describing the dynamic responses of heart rate to variations in exercise intensity. These model structures were re-estimated every thirty seconds and allowed updating the MPC algorithm for an optimal heart rate control. The experiments lasted seventeen minutes and the target heart trajectory varied between 115 and 178 bpm. **Results** The RT2 between the wanted and the controlled heart rates was 0.77 (std = 0.055) using the MPC control algorithm. The heart rate varied from the predetermined value by 5 bpm. **Discussion** A MPC control based on compact dynamic model structures was developed to control the cyclist's individual heart rate response during cycling ergometer training. The results indicate that the a simple algorithm gives comparable results as the more complex and nonlinear controlling techniques ( $\pm 5$  bpm). This technique can be used to optimise the cycling training by keeping the heart rate in the optimal training zone. **References** Cheng, T.E. (2008). Nonlinear Modeling and Control of Human Heart Rate Response During Exercise With Various Work Load Intensities. IEEE transactions on biomedical engineering, Vol. 55, 11, 2499-2508. Jeukendrup, A.E. & Van Diemen, A. (1998). Heart Rate Monitoring During Training and Competition in Cyclists. Journal of Sports Sciences, 16, 91-99. Quanten, S., De Valck, E., Mairesse, O., Cluydts, R. & Berckmans, D. (2006). Individual and time-varying model between sleep and thermoregulation. Journal of Sleep Research, 15, 243-244.

## ESTIMATING LACTATE THRESHOLD BASED ON SUBMAXIMAL CYCLING TESTS

Lefever, J., Berckmans, D., Aerts, J.M.

*Katholieke Universiteit Leuven*

**Introduction** During cycling, an optimal training pace is necessary to avoid overtraining. Knowledge of the exercise intensity and the physical condition is essential to optimise the training. The power output can be used as a direct indicator of exercise intensity (Jeukendrup et al., 1998) and the lactate threshold (LT) is a measure of the cyclists condition. However, a strenuous and invasive test protocol is used to calculate the LT. This means that test protocol cannot be performed daily to avoid overtraining. Since the heart rate recuperation speed is a measure of someone's condition, we hypothesised that the heart rate dynamics during a submaximal cycling test could serve as a non-invasive estimation of the LT. So, the objective of this study was to find a significant relationship between the heart rate dynamics during a submaximal cycling test and the LT. **Methods** Nine healthy students ( $21 \pm 1$  years) participated in this study. All the participants performed an incremental step test until exhaustion on a Tunturi T8 ergometer (Tunturi, Turku, Finland) for determination of their LT. On a different day, they performed a submaximal test to determine their heart rate dynamics. The heart rate dynamics were estimated with a multi variable dynamic transfer function approach making use of an instrumental variable parameter estimation method (RIVBJ, Taylor et al., 2007). Exercise intensity was defined as the input and heart rate as the output of the considered system. A linear regression analysis method was used to describe the relationship between the quantified heart rate dynamics and the LT. **Results** The heart rate dynamics were described by the parameters of a second order RIVBJ model structure and yielded model fits between 0.38 and 0.99 with a coefficient of determination (RT2) of  $0.88 \pm 0.10$  ( $n = 9$ ). A significant ( $P < 0.0001$ ) relationship between the heart rate dynamics (quantified based on the denominator parameters of the RIVBJ model structure) and the heart rate at LT ( $r = 0.97$ ) was found. **Discussion** A non-invasive submaximal cycling test was developed, based on the relationship between the heart rate dynamics and the heart rate at LT. This test could be incorporated into the warming up protocol to calculate the daily condition. In a next step, this could allow altering predefined training protocols and training intensities, based on the daily estimated condition instead of using the condition

measured based on an invasive maximal heart rate test. References Jeukendrup, A.E. & Van Diemen, A. (1998). Heart Rate Monitoring During Training and Competition in Cyclists. *Journal of Sports Sciences*, 16, 91-99. Taylor, C. J., Pedregal, D. J., Young, P. C., & Tych, W. (2007). Environmental Time Series Analysis and Forecasting With the Captain Toolbox. *Environmental Modelling & Software*, 22(6), 797-814.

### IS IT CANNABIS REAL PROBLEM IN BASKETBALL?

Andjelkovic, M.1, Dikic, N.1,2, Vukasinovic Vesic, M.1, Vajagic, B.1, Radivojevic, N.1, Antic, T.1, Curcic, D.1, Baralic, I.1, Djordjevic, B.1, Turner, R.2, Heinz, G.2

*Sports Medicine Association of Serbia 1, FIBA Europe 2*

Introduction According to the WADA statistics Cannabinoids are on the second place in 2009 with 7,8% (399/5084) and on the third place with 9,6% (533/5546) in 2010 of all reported positive findings. Percentage of Cannabinoids of total tests performed in 2009 has been 0,14% (399/ 277,928) and 0,2 % (533/258,267) in 2010. There is the opinion that basketball is the sport with the most of the Cannabinoids users. Methods In order to check that, we have performed two studies. First was analysis of the statistics of 34 National Antidoping Agencies (NADO) for 2009 and 2010. In second study, we have performed anonymous testing of the urine of 8 national teams during U20 European Championship Men 2011-Division B. We have done testing on 96 players on social drugs: Cannabis, Cocaine, Opiates with the morphine structure, Amphetamine Methylenedioxymethamphetamine or Ecstasy. Results Basketball doping positive cases have been reported by 12 NADO (35%) in 2009 and 15 NADO (44%) in 2010. Cannabinoids have been reported by 9 (26%) NADO in 2009 and 8 (24%) NADO in 2010. That was 72.22% and 39.29 % of all reported positive findings, which is 0.53% and 0.39% of all test performed in 2009 and 2010, respectively. In second study, one sample has been positive on cannabis of 96 tested samples, which is 1.04%. Discussion Our first research has showed that Cannabinoids are presented in much more then world average (up to 3 times) in basketball and that they are the most frequently used substance among basketball players. Second study has just confirmed that Cannabinoids are present in very high numbers, up to 5 times more than world average. We might conclude that Cannabinoids are real problem in basketball and that basketball governing bodies should implement new educational policy and couple with problems on the way to convince basketball players to change habits and stop consider Cannabinoids as necessary recreational drug.

**14:45 - 15:45**

## Poster presentations

### PP-SH06 Physical Education and Pedagogics 1

#### MICROSOFT KINECT AS MOTION ANALYSIS DEVICE FOR DIDACTIC PURPOSES: PROCESSING KINECT MOTION DATA ACCORDING TO MOTION ANALYSIS PROTOCOLS TO OBTAIN HIGH-ACCURACY PARAMETERS WHEN DEVELOPING EXERGAMES

Di Tore, S., Aiello, P., Corona, F., Baldassarre, G., Gomez, F., Sibilio, M.

*University of Studies of Salerno*

Introduction Microsoft Kinect is an accessory to the Xbox 360 capable of tracking a user's body segment positions and orientations in 3D, in real time. Goal of this research is obtaining an evaluation of Microsoft Kinect's motion data accuracy, in order to use specific range of parameters when projecting and developing Kinect-based exergames and in order to assess whether Kinect is suitable as a motion analysis device in educational context. Exergaming is the use of video games in an exercise activity (Sinclair, Hingston, et al. 2007). "We now need high-quality randomized, controlled trials to evaluate the effectiveness and sustainability of exergaming, as well as its clinical relevance" (Daley, 2009). Methods Methodology involves the comparison of data traced via Kinect with data traced via both optical based system from BTS BioEngineering and inertial-magnetic system from XSenS and processed with same software and same protocol. Motion data obtained with Kinect will be processed against an ad-hoc developed protocol and compared with data obtained with other motion capture technologies, both stereo optical and inertial/magnetic ones, in order measure the gap between technologies and have a secure basis when projecting exergames, and in order to evaluating the feasibility of using Kinect as a motion analysis device in an educational context. Results This work describes the development of a software module to acquire motion data from Kinect, calculate position of additional points required by the protocol and convert them in a format readable by stereophotogrammetry-based BTS bioengineering Smart Analyzer Software. The Kinect SDK takes data coming from the Kinect camera and performs a process called "skeletonization". It detects individual users who are within view of the camera and then tracks the positions of their bodies as a series of joints in space. As far as outputting data to file for later analysis, the Kinect SDK doesn't provide functionality to save this data. The output EMT ASCII format contains only 3D position of points (and not segments). Discussion The expected results are: an estimate of the accuracy and reliability of Kinect to know what degree of accuracy is implementable in the development of exergames and evaluation the opportunity of using Kinect in an integrated system of motion analysis for use in educational context. References Sinclair, J., P. Hingston, et al. (2007). Considerations for the design of exergames, ACM. Daley, A. J. (2009). "Can exergaming contribute to improving physical activity levels and health outcomes in children?" *Pediatrics* 124(2): 763-771.

#### CONVERTING DATA FROM MOTION ANALYSIS SYSTEMS BASED ON INERTIAL AND MAGNETIC SENSORS TO MOTION ANALYSIS SYSTEMS BASED ON STEREPHOTOGRAMMETRY

Di Tore, A., Vastola, R., Prospero, R., Raiola, G., Sibilio, M.

*University of Studies of Salerno*

Introduction Kinematic motion analysis techniques can vary by their input methods; there are two primary input methods: magnetic systems based on inertial and magnetic sensors, and optical systems based on stereophotogrammetry The use of instrumentation based on stereophotogrammetry requires the measurement to be carried out in a laboratory This implies problems relative to dimension of a laboratory and to measuring in artificial environment The Inertial and Magnetic Measurement Systems (IMMSs) allow the user to

execute and acquire the movement in laboratory-free settings (Cutti, Ferrari et al. 2010), but actually there is a lack of protocols to process the data acquired by IMMs. Furthermore, methodological differences make it difficult to compare results obtained with different protocols, and a standardization is difficult to implement. This pilot work is part of a global project that aims at determining the accuracy of a motion inertial measurement system. Methods In order to compare data acquired via IMMs with data acquired via an optical video based system, and to process them according to same protocol, the work describes the development of a software module able to create an interchange data format, converting the joint kinematics data from Xsens IMMs Moven to a format compatible with Smart Analyzer Software. Results The software parses the non-well-formed MVNX, an Xml file format of Xsens, calculate the position of additional points not considered in MVNX file and required by chosen protocol, and convert the data in EMT, a file format used by BTS bioengineering Smart Analyzer Software. The MVNX (Moven Open XML format) files contains 3D position and 3D orientation of each segment (not the sensors) in XML format (Roetenberg, Luinge et al. 2009). The section defines all positions of connecting joints and anatomical landmarks with respect to origin of that segment, and the section contains the actual motion capture data. Each time frame consists of one row, containing 23 segments with 7 channels per segment (4 quaternion, 3 position) = 161 columns of data. The output EMT ASCII format contains only frame-per-frame 3D position of points (and not segments). Conclusions The software is released under GNU/GPL license and a web-based version is available at Unisa Laboratorio H website. References Cutti, A. G., A. Ferrari, et al. (2010). "Outwalk: a protocol for clinical gait analysis based on inertial and magnetic sensors." *Medical and Biological Engineering and Computing* 48(1): 17-25. Roetenberg, D., H. Luinge, et al. (2009). 'Xsens MVN: Full 6DOF human motion tracking using miniature inertial sensors.' Xsens Motion Technologies BV, Tech. Rep.

### MOTION ANALYSIS IN DIDACTIC EXERGAMES DESIGN

Di Tore, S., D'Elia, F., Raiola, G., Palumbo, C., Sibilio, M.

*University of Studies of Salerno*

Introduction Exergaming is the use of video games in an exercise activity (Sinclair, Hingston, et al. 2007). In this work we considered the history of exergaming and the current state of research in this field, pointing out that research has focused on exergames bioenergetic side, while a few papers consider the kinematic side. This is attributable to the fact that, while the history of exergames is relatively old, accessible markerless devices able to detect motion are relatively recent. "We now need high-quality randomized, controlled trials to evaluate the effectiveness and sustainability of exergaming" (Daley, 2009). A device that looks set to change significantly design and fruition of exergames (and videogames) is Microsoft's Kinect. The Microsoft Kinect device detects the gestures of the user and uses them to control a game, but also measures the 3D world, can measure surfaces, track motion and even put a skeleton on real-time analysis. This pilot work is part of a larger project aimed at evaluating the different technologies that can capture the movement in order to determine which are best suited in the design of exergames accessible in educational contexts. This work focuses on Microsoft Kinect Methods The selected method has involved the design and development of a pilot educational exergame, described below, which uses Kinect both as an interface and as players performance analysis device. Results The exergame, for now tested on a small number (< 20 students, 9 years aged) of participants, seems to show that kinect is suitable for capturing the movement of the body in relation to space and time and to recognize and evaluate trajectories, distances, paces, and executive succession timing of motor actions Discussion Exergames capable of recording and evaluating performance in connection with the kinematics seems to have great potential in education and rehabilitation, also considering the possible lack of precision of devices such as Kinect. Performance improvement is a relative concept: for elite athlete could be measured in hundredths of a second, while in didactics or rehabilitation the tolerance threshold is much wider References Sinclair, J., P. Hingston, et al. (2007). Considerations for the design of exergames, ACM. Daley, A. J. (2009). 'Can exergaming contribute to improving physical activity levels and health outcomes in children?' *Pediatrics* 124(2): 763-771.

### SINGLE-GENDER GAMEPLAY IN PHYSICAL EDUCATION: EFFECTS ON PERCEIVED COMPETENCE, MOTIVATION AND PHYSICAL ACTIVITY IN GIRLS

Slingerland, M., Barmiento, H.

*Fontys University of Applied Sciences*

Introduction Creating physical education environments that foster perceived competence, autonomous motivation and high levels of physical activity during coeducational physical education (PE) lessons is a challenge in adolescent girls, especially during games lessons. This study aimed at increasing perceived competence, autonomous motivation and in-class physical activity in adolescent girls by applying a single-gender grouping strategy during gameplay sessions within a coeducational setting. Methods Four-hundred-and-sixty-three students (252 girls: 54%) agreed to participate in the study. During their PE lesson participants played two similar 30-minute gameplay sessions with one week in between sessions. One session consisted of mixed-gender gameplay while the other session was played in single-gender groups (girls versus girls / boys versus boys). Participants played one of three sports: volleyball (n = 55), football (n = 74) or indoor hockey (n = 155). Students wore heart rate monitors for the duration of the gameplay session and filled out a situational motivation scale and perceived competence scale after each session had ended. Three separate repeated measures ANOVA's were employed with perceived competence, motivation and physical activity as the dependent variables, gameplay condition (single-gender grouping versus mixed-gender grouping) as the within-subjects factor and gender and lesson subject as between-subjects factors. Results Valid data was provided by 265 students (142 girls: 54%). Interaction effects (condition x gender) indicated that perceived competence (F (1, 249) = 12.84, p < .001) and percentage of lesson time in MVPA (F (1, 259) = 8.57, p < .01) increased in girls in the single-gender condition. However, a significant interaction effect of condition x gender x sport for perceived competence (F (2, 249) = 3.46, p < .05) showed that increases in competence only occurred in girls in the single-gender condition when football was the lesson subject. Furthermore, the interaction of condition x sport for MVPA indicated that, irrespective of gender, MVPA was highest during football (F (2, 259) = 4.44, p < .05). No changes in motivation were observed. Conclusion Single-gender grouping within a coeducational setting can be an effective strategy for PE teachers who aim at increasing perceived competence and in-class physical activity in female students during PE. However, the effectiveness might vary depending on the subject being taught. Furthermore, since one gameplay session might not be sufficient to bring about changes in motivation, future studies should investigate if a longer period of gameplay in single-gender groups results in increased autonomous motivation in adolescent girls.

## THE RELATIONSHIP BETWEEN ACHIEVEMENT GOALS AND SELF-TALK IN PHYSICAL EDUCATION

Argyropoulou, E., Zourbanos, N., Papaioannou, A.

*University of Thessaly, Trikala*

**Introduction** Self-talk in sport has been claimed to facilitate the learning of new skills and the enhancement of sport performance. Hardy, Oliver, and Tod (2009) proposed a conceptual model for self-talk in sport postulating that one of the personal antecedents that influences individual's self-talk are Achievement Goal Orientations (AGT). AGT is often used by researchers and sport psychologists to investigate and to understand why some individuals seem to be more motivated than others in sport and physical activity (e.g., Roberts, Treasure, & Conroy, 2007). The main objective of the present research was to bridge the gap between positive and negative self-talk and achievement goals by examining students' thoughts in PE during play with high and low sport achievers. **Methods** Participants were 628 students (325 females and 303 males) with a mean age of 14.49 years (SD = .50). **Measures** Self-Talk in PE. An adapted version of the Automatic Self-Talk Questionnaire for Sports - ASTQS (Zourbanos et al., 2009) in PE was administered to assess students' self-talk. Achievement goals in PE. The Task and Ego Orientation in Physical Education Questionnaire (TEOPEQ; Duda & Nicholls, 1992) was administered to assess students' achievement goals. **Results** Dependent t-tests revealed significant differences for the negative self-talk dimensions revealing that students experience higher negative self-talk referring to worry, disengagement, somatic fatigue and irrelevant thoughts when they play against the best student than when they play against the worst student. Non-significant differences were observed for positive self-talk referring to instruction and anxiety control, but significant differences were observed for self-talk referring to psych up and confidence showing that students exhibit more positive self-talk when they play against the best student than when they play against the worst student. **Discussion** The present findings suggest that students' achievement goals may impact students' self-talk. Taking into account the significant role of thoughts on performance, this line of research may contribute to subsequent explorations into the antecedents of students' self-talk. **References** Duda JL, & Nicholls JG. (1992). Dimensions of achievement motivation in schoolwork and sport. *J Educ Psychol*, 84(3), 290-299. Hardy J, Oliver E, & Tod D. (2009). A framework for the study and application of self-talk in sport. In S. D. Mellalieu & S. Hanton (Eds.), *Advances in applied sport psychology: A review* (pp. 37-74). London: Routledge. Roberts GC, Treasure DC, & Conroy DE. (2007). Understanding the dynamics of motivation in sports and physical activity. In G. Tenenbaum, & R. Eklunds, (Eds.), *Handbook of Sport Psychology* (3rd ed. pp. 3-30). New York: John Wiley & Sons. Zourbanos N, Hatzigeorgiadis A, Chroni S, Theodorakis Y, & Papaioannou A. (2009). Automatic Self-Talk Questionnaire for Sports (ASTQS): Development and preliminary validation of a measure identifying the structure of athletes' self-talk. *Sport Psychol*, 23, 233-251.

## THE PHENOMENON OF TEENAGERS' SPORT DROPOUT

Mondoni, M.

*Università Cattolica Sacro Cuore*

**The phenomenon of teenagers' sport dropout** Mondoni M.1, A. Superti, A. Ajani.1, L. Bottini 1Faculty of Science Education: degree in physical educations and sports-Catholic University of Sacred Heart of Milan **Introduction** Teenagers are abandoning sports at an increasingly worrisome rate. The phenomenon of dropout has reached levels whose consequences should not be ignored. Indeed, the consequent sedentary lifestyle and unbalanced nutrition patterns are the cause of hypo kinetic diseases, i.e. obesity, cardiovascular diseases and 2 diabetes. **Objectives** This study aims to shed light on the phenomenon of sports dropout, in all its aspects, causes and potential consequences on the social life and health of the youngsters. By investigating and understanding the reasons that lead teenagers to abandon any sportive activity, we intend to outline possible interventions that could limit and, eventually, reverse this phenomenon. **Methodology** The data was collected in form of anonymous surveys, through the cooperation of P. E. teachers. We surveyed the entire population of 12165 students attending high schools in the province of Cremona (Italy). The questions refer to the sport practiced (i.e. reasons for the choice, beginning age, frequency of training, etc) and the dropout (i.e. causes etc). **Results** As expected soccer is the most practiced sport with 36.10% of the students identifying it as their main sportive activity, followed by volleyball 17.52% and basketball. These are also the sports with the highest dropout rates, but interestingly other sports such as swimming and gymnastics suffer in their survival rate, with relative high dropout and low average practice rate-only few students seem to practice them at an older age. Furthermore, despite the dropout phenomenon, more than one third of the students who are practicing a sport are committed to more than 2 trainings per week (32%). The reasons that drive the choice of a sport are mainly personal and peer-related around 75%, on the other hand, health experts or PE teachers seem to have an insignificant role. Finally, the decision of abandoning the sport is identified by the students in their change of taste and in the decision of investing their time in some other activities. Also in this case, the decision seems to be taken quite autonomously. **Conclusions** The fact that the majority of the teenagers choose the sport at a very young age, before 7 years old, and that this decision-making process is rarely supported by PE experts, may produce an inefficient matching between physical predisposition, skills and sport chosen. It is evident how this could lead to a higher rate of dropout in older ages, especially in those sports where the physical characteristics represent a determinant limitation to a competitive practice. Therefore, the introduction of a figure of sport consultant in elementary school system could help children to combine their personal attitude with their physical potential for a more successful and satisfying sportive experience in older ages.

## THE EFFECT OF AN INTEGRATED SCHOOL CURRICULUM Pedometer INTERVENTION TO ENHANCE PHYSICAL ACTIVITY AND REDUCE WEIGHT STATUS IN CHILDREN

Duncan, M.J., Birch, S.L.

*Coventry University*

**Introduction** Integrating physical activity through the school day using an integrated curriculum model has been suggested as one means to increase total daily PA in an attempt to reverse the decline in PA and halt increases in overweight and obesity seen in young people worldwide (Oliver et al., 2006). Few studies have examined whether this is the case. The aim of this study was to examine the effect of an integrated school curriculum pedometer intervention on physical activity and weight status in children. **Methods** Following ethics approval and informed consent, 59 children (22 boys, 27 girls, aged 10-11) from a primary school in central England completed a 4-week integrated physical activity intervention based on virtually walking from John O'Groats to Lands End. Habitual physical activity (via pedometer) and weight status (Body mass index) were determined pre and 4 weeks post intervention using pedometer. Steps/day were also calculated during the intervention period, plotted on individual maps of the journey the length of the UK and used as an open-loop feedback tool to encourage physical activity. Focus group interviews were utilised to examine the children's experiences of the intervention. **Results** Results indicated that average steps/day were significantly higher (P = .0001) during and post the intervention compared to

baseline and children classified as normal weight were significantly more active than those classified as overweight/obese ( $P = .003$ ). Body mass index was not significantly different across the measurement period ( $P < .05$ ). Qualitative data indicated that the children thought the intervention was interesting and could help in making them, and their wider family group, more active. The children also reported that the use of the step count data in school lessons made them think more and understand more about physical activity because they could engage with the data collected differently than during normal school teaching. Discussion These results support prior claims that using a pedometer led integrated curriculum model can increase children's PA (Oliver et al., 2006) and that pedometers can be effective open loop feedback tools in providing a goal based approach to increasing PA (Lubans et al., 2009). The use of a 4-week integrated curriculum pedometer intervention in school is therefore feasible and results in increases in school day physical activity both in the wider school curriculum and during leisure time. References Lubans DR. et al. (2009). *Prev Med*, 48, 307-315. Oliver M. et al. (2006). *J School Hlth*, 76, 74-79.

### **THE RELATIONSHIP BETWEEN YEAR GROUP, GENDER AND WEIGHT STATUS ON THE MASTERY LEVEL OF FUNDAMENTAL MOVEMENT SKILLS.**

Bryant, E.S., Duncan, M.J.1, Birch, S.L.1, Oxford, S.  
*Coventry University*

Introduction: Fundamental Movement Skills (FMS) are the underpinning skills of sporting and physical activities (Cowely et al., 2010). In schools children are excluded from games due to their lack of skill (Ignico, 1990), thus decreasing participation levels in physical activity. Research has therefore predicted that mastery in these FMS will result in an increase of physical activity levels progressing from childhood to adulthood (Okley et al., 2004). However, there is a lack of research in this area in England and therefore the aim of this study is to identify the effects that age, gender and weight status have on the mastery level of FMS. Method: 292 children in years 2-6 from a school in central England completed the research. Each child performed 8 FMS (run, hop, gallop, jump, balance, kick, throw and catch) 3 times in front of a camera. This was then analysed using Quintic Biomechanics software and the process orient checklist (objective measurement). Height and weight were measured to calculate body mass index (BMI) and used to determine weight status using Cole et al. (2000) criteria. Ethical approval and informed consent were gained prior to research commencing. Results: Using SPSS results from a 2(gender) by 2(weight status) by 5(year group) ways analysis of variance indicated; that weight status of the children significantly affected the mastery level of the jump ( $P < 0.05$ ). Gender significantly affected the mastery level of kick, catch, throw and balance ( $P < 0.05$ ). Boys had a higher mastery of kick, catch and throw, whilst girls had a higher mastery of balance. Each year progressively has a higher percentage mastery of the skills ( $P < 0.05$ ). Discussion: Weight status having a negative effect on the jump is consistent with the findings from Okley et al. (2004). The male gender had a higher mastery level of the object control skills, whereas the female gender had a higher mastery of a static skill. This supports previous research from Hardy et al. 2010. Blatchford et al. (2003) suggests this is because boys are more likely to engage in ball games compared to girls and thus increasing mastery of object control skills. Year group, gender and weight status all had an effect on the mastery of FMS and therefore can influence physical activity levels in life and highlighting the importance of the mastery of FMS. References: Blatchford et al. (2003) *Br J Dev Psych*, 21, 481-505 Cole et al. (2000) *BMJ*, 320,124-1243 Cowely et al. (2010) *BMJ*, 44, 11-12. Ignico, A (1990) *Play Culture*, 3, 302-31. Okley et al. (2004) *Res Ex and Spt*, 75, 238-247.

### **IDENTIFYING THE COMPETENCIES OF THE PHYSICAL EDUCATION PROFESSIONAL TO PERFORM IN PRIMARY CARE: A DELPHI STUDY**

Coutinho, S.S.1, Queiroga, M.R.1, Volski, V.1, Santana, C.S.2, Mishima, S.M.2, Pereira, M.J.B.2  
*1: UNICENTRO (Guarapuava, Brasil), 2: USP (Ribeirão Preto, Brasil). Research Support: CNPq, Brasil.*

Introduction In Brazil, it is observed that numerous programs and initiatives to promote health which are developed in the Unified Health System (SUS) and related to the Primary Health Care (PHC) have included the physical education professional as one of the professions that should make up the interdisciplinary health team (Malta et al., 2009). In this sense, this research aimed to create a list of general and specific skills that can give support to the physical education professional practice in the context of PHC. Methods The research subjects are physical education professionals who work in programs for the promotion of bodily practices/physical activities, linked to the Primary Health Care for of the SUS and also researchers who study physical education and SUS. For data collection and organization, the Delphi technique was used to perform three rounds. Results The answers to the first round of questions generated a list of 135 general skills and 88 specific skills. After the first sending, a content analysis of the listed skills was accomplished, resulting in 21 general skills and 19 specific skills. After the 2nd and 3rd round, skills were analyzed using descriptive statistics, which resulted in the following general skills: bond, communication, creativity and flexibility, humanization, leadership, planning, adaptation and strategic vision, evaluation, prevention, encouraging empowerment, teamwork and respect to differences, knowledge about the Brazilian Unified Health System (SUS), epidemiology and strategies for permanent and continuous learning. And in the following specific skills: individual and group evaluation, broad view of the body, body-oriented practices, knowledge about public health policies and their relationship with physical education, knowledge of diversified body practices beyond the narrow focus on biomechanics and the spend of calories, planning and prescription of physical activities, including special groups, conception of first aid, awareness about the importance of regular physical activity practice, development of programs and projects, and knowledge in anatomy, kinesiology, biomechanics, human physiology and exercise. Discussion The listed skills point to the possibility of having a professional who has a broaden view of health not restricted only to the biological aspects. References Silva, RB, Tanaka, OU (1999). *Rev. Esc. enfermagem USP*, 33 (3), 207-216. Malta DC, Castro AM, Gosch CS, Cruz DKA, Bressan A, Nogueira JD, Morais Neto OL, Temporão, JG (2009). *Epidemiol. Serv. Saude*, 18(1), 79-86. Simões EJ, Hallal P, Pratt M, Ramos L, Munk M, Damascena W. (2009). *Am J Public Health*, 99 (1), 68-75.

14:45 - 15:45

## Poster presentations

### PP-SH07 Sport Psychology

#### A QUALITATIVE INVESTIGATION OF THE TACIT KNOWLEDGE OF JAPANESE OLYMPIC SPRINTER

Kitamura, K.

*Tohoku University*

**Introduction** In learning process of sport movements, full use of body movement is emphasized to transfer coaches' explicit knowledge within the athletes. However, the tacit knowledge approach emphasizes understanding the kinds of knowledge that athletes create their own movement by themselves. But how tacit knowledge affects sport learning other than explicit knowledge has not been sufficiently elucidated (Ikuta & Kitamura, 2011). In the present study, we focused on the application of the action directed learning through sharing the feelings. Action directed learning is defined as the learning process to focus on the tacit knowledge to pursuit the ideal feeling which leads an ideal movement, not to acquire the skills. Using a qualitative analysis of experiences of elite sprinter, we aimed to demonstrate (1) how action directed learning was seen, and (2) what the factors are that promote or inhibit action directed learning. **Methods** One Olympic medalist in short-distance run was selected as participant of this study. In depth, semi-structured, open-ended interviews were used to analyze the action directed learning of the participant. Immediately after the interviews the speech data were transcribed, and the meaning was analyzed using the transcriptions. Data were analyzed based on the qualitative data analysis method of Patton (2002), and hierarchical categories were created through discussions with co-researchers. **Results** As a result of inductive analysis, 94 meaning units were finally identified as subjects of analysis for this study. These units were divided into a total of 3 categories, devotion, commitment, and investigation with 10 subcategories. The following three points were demonstrated from the results of the study. First, the elite sprinter experienced many kinds of body movements which brought him a sensibility. Second, he directed himself to commit to deliberate practice as a way of monitoring his movements. Third, the elite sprinter intentionally reflects his feeling which he got during movement. In addition to reflection in action, other frequent behavior including reflecting the sense of action was reported. **Discussion** Participant monitored his behavior in such a way that he tried to find the proper expressions of tacit knowledge for his learning setting. In short, it was found that action consciousness is frequently influenced by many factors, and strongly shaped by a tacit instructional behavior which leads the participant to create his ideal action. **References** Kumiko Ikuta and Katsuro Kitamura. (2011). *Practical Art Language: Action directed learning through sharing the feelings*, Tokyo Japan, Keio University Press.

#### SINGLE AND COMPOSED CONFIGURATION OF PERCEPTUAL CUES ON THE ANTICIPATION OF TENNIS SERVES

Zawadzki, P., Roca, J.

*Barcelona University*

**Introduction** Players are common required to fit their responses under a variety of strokes of different opponents. On the tennis serve devolution this becomes evident because of anticipation requirement (Farrow and Abernethy, 2002). During association of perceptual cues to response, two functional ways can be establish: constancy between elements or configuration between values of elements (Roca, 2006). The aim of this study was compare the analyses of two single cases approximating the concepts of Model Field Theory to Statistical Correlation Theory to verify the existence of both cases. **Methods** One female and one male tennis professionals were recorded during an official match, kinematics method were used to digitise polar coordinates of four perceptual cues (position, ball toss, knee bend and racket arm). Pearson Correlation (r) and Canonical Correlation Analysis (Rc) were performed between perceptual cues and bounce result. **Results** On the female case a single perceptual cue were founded, significant results shows the height of ball toss correlated to serve depth ( $r=0.887$ ,  $p<0.01$ ). On the male case significant results were found but with no power ( $r<0.5$ ) of prediction on the single cues, however, composed cues presented values of  $Rc=0.9098$  ( $p=0.0104$ ) presenting similar weights for position ( $cv=0.1601$ ) and ball toss ( $cv=-0.1365$ ) however with different directions on the relationship. No results were found about constancy on perceptual cues. **Discussion** Associations between values of elements were found, the power related serve as evidence to support perceptive configuration theory. Nonetheless, results also suggest two ways of configuration, one established by the relationship of just two variables or cues, called here as single configuration and another established by the relationship between one cue with a group or between two groups of cues, called here as composed configuration. Ventura (2004) demonstrated that a reduction of performance is observed when the grade of variability increase; what could propose that during player development a technique disguise occurs and through that more than one cue must be perceived by his opponent. In any case, the Opponent Study in Sport reveals itself as field plenty of opportunities to help players to fit better their responses. **References** Farrow, D., and Abernethy, B. (2002). Can anticipatory skills be learned through implicit video-based perceptual training? *Journal of Sports Sciences*, 20(6), 471-485. Roca, J. (2006). *Psicología: una introducción teórica*. Girona: Documenta Universitaria. Ventura, C. (2004). El factor variabilidad en una tarea perceptivo-motriz. *Apuntes. Educación Física y Deportes*, 77, 30-33.

#### RELATIONSHIP BETWEEN ATTITUDES TOWARDS DOPING AND SELF-ESTEEM IN PARTICIPANTS OF A POPULAR LONG-DISTANCE ROAD CYCLING EVENT

Morente-Sánchez, J.1, Freire, C.1, Ramírez-Lechuga, J.2, Zabala, M.1,3

*1 Faculty of Sport Sciences, University of Granada (Spain); 2 Faculty of Sport, University Pablo Olavide (Seville-Spain); 3 Spanish Cycling Federation, Madrid (Spain)*

**Introduction** In view of the lack of scientific literature investigating the association between attitudes towards doping and other factors, the purpose of this study was to know the relationship between the attitudes towards doping and the self-esteem of participants in a popular long-distance road cycling event. **Methods** The sample was composed by 2022 amateur cyclists ( $40.95\pm 9.42$  years) who participated in a long-distance (205 km) Spanish road cyclist event called "Quebrantahuesos" (UCI Golden Bike). Descriptive design was carried out by means of two validated questionnaires: Performance Enhancement Attitude Scale -PEAS- (Petroczi & Aidman, 2009) and Rosenberg Self-Esteem Scale -PSES- (Fleming & Courtney, 1984; Rosenberg, 1965). The PEAS has 17 questions using a Likert scale from 1 (Strongly Disa-

gree) to 6 (Strongly Agree) for different statements that supported the use of doping in sport. In other hand, Rosenberg's scale - 4-point scale ranging from 1 (strongly disagree) to 4 (strongly agree)- was originally developed as a Guttman scale scored dichotomously (yes/no). The correlation coefficient of Spearman was used to analyze the relationship between Self-Esteem and attitudes towards doping. Results The correlation coefficient of Spearman showed a negative value of  $r = -0.140$ ;  $p < 0.001$ -. Consequently, the higher score in "Performance Enhancement Attitude Scale", the lower score in "Rosenberg Self-Esteem Scale". Discussion According to Van Amsterdam et al. (2010), the typical banned drugs abuser is a male poly-substance user who has a low self-esteem due to a poor body image. In our study, unsurprisingly, a relation between attitudes towards doping and self-esteem existed, but despite of the fact that there were significant differences, the relationship between both factors was very weak. It could be because this type of sample (amateur cyclists) looked for other aims such as performance improvement instead of changing their body image. In this way, we recommend further research in this field because there is a significant dearth in this matter. References 1. Petroczi, A., Aidman, E. (2009). Measuring explicit attitude toward doping: Review of the psychometric properties of the Performance Enhancement Attitude Scale. *Psychology of Sport and Exercise*. 10: 390–396. 2. Fleming, J. S., & Courtney, B. E. (1984). The dimensionality of self-esteem II: Hierarchical facet model for revised measurement scales. *Journal of Personality and Social Psychology*, 46, 404-421. 3. Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press. 4. Van Amsterdam, J., Opperhuizen, A., Fred Hartgens, F. (2010). Adverse health effects of anabolic-androgenic steroids. *Regulatory Toxicology and Pharmacology* 57, 117–123.

### **CHALLENGE OF THE GAME – ATHLETES' SKILLS: THE ROLE OF FLOW THEORY ORTHOGONAL MODEL IN ULTRA MARATHON ATHLETES**

Stavrou, N.A., Bagios, I., Noutsos, K., Psychountaki, M.

*National & Kapodistrian University of Athens*

**Introduction** The concept of flow has been described as an optimal subjective mental state. A central issue of flow theory is that whether or not an athlete is in flow depends on his/her perception of the existing challenges and the nature of his/her skills (Csikszentmihalyi, 1982). When the challenges and skills are perceived as being in balance, in a high level, the athlete experiences flow. When the skills outperform the challenge, there is relaxation, whereas when the skills and challenges are below average, there is apathy, and, finally, when the challenges outweigh the skills, there will be anxiety (Csikszentmihalyi, 1982). The purpose of the study was to examine the role of subjective estimation of challenge of the competition and athlete's skills in the quality of their experience. **Methods** One hundred and fifteen athletes participate in the present study, ranging in age from 26 to 66 years ( $M = 40.31$ ,  $SD = 7.98$ ). Just after the competition, the athletes completed the Flow State Scale – Short Form (FSS-SF; Jackson, Martin, & Eklund, 2008), and five 11point Likert type scales measuring (a) challenge of the game, (b) athlete's skills, (c) stress, (d) activation and (e) subjective estimation of performance. The race length was 44 km, the higher altitude 2800m and the mean duration of the competition was approximately 7 hours. Results The results indicated significantly higher correlations between athletes' skills and FSS-SF subscales compared to the value of the correlations of perceived challenge of the game. The athletes in the flow and relaxation quadrants revealed higher values of flow experience compared to the athletes of the other two states, sustaining significant differences among the four states (Wilks'  $\Lambda = .629$ ,  $F_{3,100} = 1.719$ ,  $p < .05$ ,  $\eta^2_p = .143$ ). Significant correlations revealed among activation and flow experience. Finally, no significant differences revealed in athletes' performance among the four states. **Discussion** Athletes' quality of experience is differentiated among the quadrants of the orthogonal model. Specifically, the results suggest that the perception of skillfulness is essential for the athlete to experience positive mental states, compared to the perception of challenge. The importance of athletes' skills on the quality of their experience is further supported by the significantly higher correlations between the FSS-SF factors and the perceived skills, suggesting a close relationship, compared to the correlations between the FSS factors and perceived challenges. Finally, activation appears as an important factor for flow experience. References Csikszentmihalyi, M. (1982). *Annual review of personality and social psychology* (Vol. 3, pp. 13-36). Beverly Hills, CA: Sage. Jackson S.A., Martin A.J., Eklund, R.C. (2008). *Journal of Sport and Exercise Psychology*, 30, 561-587.

### **COMPETITIVE AGGRESSIVENESS AND ANGER TEMPORAL TREND APPROACHING TO A WATER-POLO MATCH.**

Ferri, I.

*University of Padua*

**Introduction** Wide part of educational value of sport results from healthy, genuine and equilibrate emotional experiences. Emotions can widely influence sport performances: the IZOF model and the directional perception approach show the great subjectivity that characterizes emotions effects and explain how personal perception determines intensity and facilitative or dysfunctional direction of each emotions. Contact sport, more than others, can stimulate and carry aggressive and violent behaviors but very different levels of aggression acceptance exists (Kerr, 2002). The aim of this study was to examine temporal trend of competitive aggressiveness and anger in two different dimensions, intensity and direction, approaching to a match in a water-polo team. **Methods** Participants were a sample of Italian young male athletes ( $N = 15$ , mean age 15.9 years,  $SD \pm 0.7$ ) of a water-polo team, regularly involved in a national championship. They had on average 5.4 years of experience ( $SD \pm 1.3$ ). Written informed consent was signed by all players parents. An adapted version of the CAAS (Competitive Aggressiveness and Anger Scale, Maxwell et al., 2007) was used to define a 'state' assessment (48, 24, 2 hours before and 48 hours after the match). The score of each items ranges from 1 to 5 for intensity and from -4 to 4 for direction dimensions. Results Aggressiveness and Anger mean scores were analyzed. Before the match aggressiveness intensity has been proved significantly lower rather than 48 hours after the match ( $p < .01$ ) and results quite facilitative just before the match ( $t = 4.2$ ,  $p < .01$ ). Anger intensity before the match can be overlapped to the levels reached after the game and after the match anger direction resulted significantly higher compared with the value obtained 48 hours before the match ( $t = -9.2$ ,  $p < .01$ ). **Discussion** Results confirmed that aggressiveness and anger temporal trend changes according to the IZOF model and the directional perception perspective. Further investigations are needed to better understand how manage aggressiveness and anger levels to improve athletes performances. Anticipating athletes intentions and perceptions could represent a great challenge to reduce violent behavior in sportive competitions (Russell, 1993). References Kerr J. (2002). *The Sport Psych*, 16, 68-78. Maxwell JP, Moores E. (2007). *Psychol of Sport and Exe*, 8, 179-193. Russell GW. (1993). *The social psychology of sport*. NY: Springer.



## EXECUTIVE FUNCTIONS IN VOLLEYBALL- AND BADMINTON PLAYERS

Schmitz, G., Effenberg, A.O.

*University of Hannover*

**Introduction** Motor control and cognitive executive control are interrelated, but the underlying mechanisms are largely unknown. 10 weeks of table tennis training can improve executive control in children with developmental coordination disorder (Tsai, 2009). A similar effect was reported for healthy adults after two years of baseball- but not tennis-training, suggesting that cognitive improvements are based on sport-specific demands (Kida et al., 2005). The aim of the present study was to investigate (1.) whether experts from different sports have different executive abilities and (2.) if sport-specific training has acute effects on executive functions. **Methods** 47 athletes participated in the study (aged 24.9 ±5.2 years, 18 female). 19 were volleyball-players (expertise: 14.8 ±2.8 years) and 8 Badminton-Players (expertise: 13.8 ±8.3 years). 20 subjects from various sports (expertise: 8.0 ±5.7 years) served as control-group. Executive functions were assessed with Tower of London (ToL), Stroop-Test (ST), Trail Making Test (TMT), FAIR II Test (FT) and a Maze Test (MT), latter including a reference trail (rMT) as screening tool for visuomotor control. All tests were applied before and in a modified version 50 minutes after sport-specific training or social activity (control-group). Results were submitted to repeated measure ANOVAs and significant effects were decomposed with Fisher's LSD test. For clarity only p-levels are reported here. **Results** (1.) Volleyball-players performed better in rMT than badminton-players and the control-group (both  $p < 0.01$ ). Badminton-players were better than the other groups in MT (both  $p < 0.05$ ) and better than volleyball-players in ToL ( $p < 0.05$ ). Expertise correlated negatively with performance in TMT across all subjects ( $r = -0.44$ ,  $p < 0.01$ ). (2.) All groups significantly enhanced their performance from pre- to post-test in FT ( $p < 0.001$ ), MT ( $p < 0.001$ ), TMT ( $p < 0.05$ ), ST ( $p < 0.001$ ) and ToL ( $p < 0.05$ ) but not in rMT ( $p > 0.05$ ). Rates of enhancement did not differ significantly between groups ( $p > 0.05$ ). **Discussion** (1.) Results confirm that executive and probably sensorimotor abilities differ between experts of various disciplines. Higher performance of badminton-players in MT and ToL might be based on more effective planning and decision-making, since those functions are addresses by both tests. The negative correlation of TMT and expertise might indicate a detrimental effect of long-term sport-specific training on cognitive flexibility. (2.) Enhancements from pre- to post-test can be explained by repeated measures effects. Therefore no acute effect of sport-specific training was found. **References** Kida N, Oda S, Matsumura M (2005). *Cog Brain Res*, 22(2), 257-264. Tsai CL (2009). *Res Develop Disabil*, 30(6), 1268-1280.

## IS PERFECTIONISM ASSOCIATED WITH BURNOUT OF UNIVERSITY BASEBALL ATHLETES? -DEVELOPMENT OF PERFECTIONISM SCALE AND BURNOUT SCALE FOR BASEBALL ATHLETES-

Shimizu, Y., Miyazaki, M.

*International Christian University and J.F. Oberlin University*

**Introduction** Baseball is one of the most popular club sports from elementary to college level in Japan. College baseball athletes' maladjustment to college baseball teams and dropout from athletic clubs has become one of the prevalent problems. The purpose of this study was to develop Perfectionism Scale for Baseball Athletes (PSBA) and Burnout Scale for Baseball Athletes (BSBA) and to examine the relationship between the subscales of PSBA and BSBA. **Methods** The subjects of 203 baseball athletes (mean age=19.43, SD=0.86, mean baseball experience=11.33, SD=2.12) in four official university baseball teams were asked to answer a questionnaire composed of question items on socio-demographic background and 42 baseball athletes' perfectionism evaluation question items and 30 baseball athletes' burnout evaluation question items both of which were developed from our preliminary survey in 2010. Exploratory factor analyses, confirmatory factor analyses and reliability analyses were conducted to develop PSBA and BSBA. Multiple regression analyses were employed to examine the relationship between PSBA and BSBA. **Results** The results of exploratory factor analyses yielded for PSBA a 8-factor model with 39 items ("Social Norm," "Teammates," "Practice," "Performance," "Goal Setting," "Coaching," "Competition," "Managing") and for BSBA a 4-factor model with 30 items ("Emotional Exhaustion," "Maladjustment to Clubs," "Depersonalization," "Lack of Personal Accomplishment"). Confirmatory factor analyses and Reliability analyses confirmed that each scale had acceptable structural validity and satisfactory Cronbach's alpha reliability. The results of multiple regression analyses showed that the sub-scales "Social Norm" and "Performance" of PSBA had significantly positive association with the sub-scales of BSBA and the sub-scales "Competition" and "Coaching" of PSBA had significantly negative association with the sub-scales of BSBA. **Discussion** The findings above support the use of PSBA and BSBA in assessing perfectionism burnout tendency of baseball athletes respectively and suggest that baseball athletes with high perfectionism in competition and coaching have a high risk of burnout. This implies that appropriate psychological intervention from baseball managers and coaches may prevent athletes' burnout. Future research with a larger sample size and longitudinal design will be needed in order to explore effective psychological coaching intervention methods. **References** Midori SAWAGUCHI, Yasuo Shimizu (2011) Development of Perfectionism Scale for University Athletes. *Kyusyu Journal of Sport Psychology*. 23:28-29.

## IMAGERY TYPES OF ATHLETES IN DIFFERENT SPORTS

Kizildag, E., Tiryaki, M.S.

*Mersin Universitesi*

**Introduction:** The main purpose of this study was to compare the imagery use of elite male and female athletes in different sport types. Imagery has been defined as; "creation or re-creation of an experience generated from memorial information, involving quasi-sensorial, quasi-perceptual and quasi-affective characteristics, which is under the volitional control of imager, and it may occur in the absence of the real stimulus antecedents normally associated with the actual experience" (Morris etc. 2005). Hall etc. (1998) developed the Sport Imagery Questionnaire (SIQ) to assess the frequency with which athletes use these imagery functions. These functions are: cognitive specific-CS, cognitive general-CG, motivational specific-MS, motivational general-arousal-MG-A, motivational general-mastery-MG-M. **Methods:** 186 athletes (122 male and 64 female) from 6 various sports (volleyball, basketball, soccer, track and field, tennis, swimming), aged between 15 to 33 years (Mage= 21. 25± 3. 42) participated in the study. We used SIQ (Hall, etc., 1998). SIQ consists of 5 subscales (CS, CG, MS, MG-A, MG-M) and 30 items. In Turkish version of SIQ has supported the Questionnaire's 4 factor structure and 21 items. To determine if there was a difference between male and female athletes we used to data Kruskal Wallis. **Results:** Results of this study there was a significant difference in MS subscale ( $p < .05$ ). To determine the source of the difference we used Mann-Whitney U test. In this test result female volleyball and female basketball players had significantly higher score than tennis players in MS (Uvolleyball-tennis= 34.5,  $p < .05$ ; U basketball-tennis= 19.0,  $p < .05$ ). It was also found that male volleyball players had higher scores than soccer players in CI (Uvolleyball-soccer= 188.0,  $p < .01$ ), male swimmers had significantly scores than male basketball players in MG-A (Uswimming-basketball= 59.5,  $p < .05$ ). **Discussion:** In literature review we were not run across imagery studies that compare gender. Generally in

compare sport types male- female distinction didn't find. Male volleyball players had higher scores than soccer players in CI. The reason of this difference the soccer player more amateur group than volleyball players in our study. Salmon etc. (1994) found elite soccer players used imagery more than novice and found they used motivational dimension more than cognitive. Isaac, Marks (1994) and Gammage etc. (2000) studies showed there were imagery differences existed based on gender and type of activity. References Gammage, KL. Hall CR. Rodger WM. (2000). *Sp Psychologist*, 14,348-359. Hall C. Mack D. Paivio A. Hausenblas H. (1998). *Int J of Sp Psy*, 29, 73- 89. Isaac AR. Marks DF. (1994). *Bri. J Psy*, 85, 479- 500. Morris T. Spittle M. Watt AP. (2005). Imagery in sport. Salmon J. Hall C. Haslam I. (1994) *J of Ap. Sp Psy*, 6, 116- 133.

**14:45 - 15:45**

## Poster presentations

### PP-PM22 Sports Medicine 3

#### PREVENTING INJURIES IN BASKETBALL

Klein, C., Luig, P., Henke, T.

*Ruhr-University Bochum*

**Introduction** Approximately 1.7 million citizens within the EU-27 area play basketball regularly. Recent research shows an injury incidence of 3-6 injuries/1000h. Thus, one has to expect at least 720,000 basketball-related injuries a year causing direct medical costs of 500 million. The purpose of this study, which is part of the EU funded project "Safety in Sports", is to illustrate smart ways how to prevent basketball injuries in a sustainable manner. **Methods** A structured literature search for relevant publications of the period 1990-2009 was performed. The identified sources were furthermore graded by a panel of basketball injury prevention experts (n=20) in terms of their effectivity, applicability and acceptance. This evaluation process led to a number of encouraging recommendations which were adapted to the national demands and have been pilot implemented into two national basketball associations within the FIBA-Europe. **Results** 70 sources dealing with 108 preventive recommendations were identified and divided into four categories – (1) Training/Physical Preparation, (2) Technical/Political Approaches, (3) Equipment/Facilities and (4) Medical/Non-medical Support. The great majority (47 %) is focusing on the first category, which is also judged most valuable by the expert panel. These preventive measures focus on basic physical preparation, structured warm-up routines, basic and advanced technique training and neuromuscular training. Further important preventive measures are given in the category Equipment/Facilities. These recommendations focus on ankle injury prevention via external ankle stabilisation as well as custom-made mouth guards to reduce dental injuries. **Discussion** Basketball associations and clubs should follow a pro-active strategy as to the risk of injury and communicate with members and the general public openly about risks involved and necessary measures to be taken by clubs and individuals. Players should be provided with educational materials presenting basic exercises. It is recommended to have all national associations to include an injury prevention module in their trainer education curriculums and to designate an official staff member as 'safety promotion ambassador' of the federation. Such a pro-active approach will also contribute to the positive image of the game and will help to attract new members.

#### COOLING HYPERTHERMIC INDIVIDUALS WITH ICE SLUSHY VERSUS ICE PACKS

Burdon, C.1, Schmidt, C.1, Johnson, N.1, Chapman, P.2, O'Connor, H.1

*1 USyd (Sydney, Australia), 2: ACU (Sydney, Australia).*

**Introduction:** During endurance exercise in hot environments core body temperature ( $T_{tr}$ ) is elevated, which can lead to heat exhaustion and heat stroke. Cooling hyperthermic individuals as quickly as possible is recommended (1). In field situations, immersion in ice/cold water is often impractical so the application of cold towels and ice packs to the neck, axilla and groin is typically used as an alternative (1). Recently, the use of an ice slushy bolus has been demonstrated as an effective pre-cooling technique (2). The aim of this study was to compare the efficacy of ice packs (IP) against ice slushy consumption (SC) for reduction in  $T_{tr}$  and management of hyperthermia. **Methods:** The study was a randomised cross-over trial. Eight active participants (5M, 3F) heated to a  $T_{tr}$  of  $\sim 39.5^{\circ}\text{C}$  by cycling in a climate chamber ( $40^{\circ}\text{C}$ , 50% relative humidity). Water ( $19^{\circ}\text{C}$ ) was consumed to prevent dehydration with intake matched between trials. Upon reaching  $T_{tr}$   $39.5^{\circ}\text{C}$ , exercise was terminated and participants were removed to a cool room ( $22^{\circ}\text{C}$ ) with a fan ( $2.2\text{ m.s}^{-1}$ ) and reclined supine until  $T_{tr}$  dropped by  $1^{\circ}\text{C}$ . In IP, ice packs (n=4; 300g ice each) were placed bilaterally on the axilla and groin. In SC, participants consumed 400g of ice slushy ( $-1^{\circ}\text{C}$ ) in two 200g boluses. **Results:** Participants cycled for  $42\pm 11$  min to reach  $39.3\pm 0.2^{\circ}\text{C}$  and were cooled to  $38.3\pm 0.2^{\circ}\text{C}$ . No difference in cycling time, peak  $T_{tr}$  and end- $T_{tr}$  was observed between conditions ( $p=0.57$ ,  $p=0.19$  &  $p=0.17$  respectively).  $T_{tr}$  decreased  $1^{\circ}\text{C}$  in  $12\pm 2.8$  min with SC versus  $15\pm 2.1$  min with IP ( $p=0.02$ ). Rate of  $T_{tr}$  change was  $0.09\pm 0.04^{\circ}\text{C.min}^{-1}$  for SC and  $0.06\pm 0.01^{\circ}\text{C.min}^{-1}$  for IP ( $p=0.05$ ). Some participants experienced a transient  $T_{tr}$  increase with IP before cooling. **Discussion:** Cooling after exercise-induced hyperthermia was significantly faster with 400g ice slushy consumption than a traditional method of ice packs placed over the neck, axilla and groin. The superior rate of decrease with SC is considered important as rapid cooling ensures the best outcome following hyperthermia (1). Use of cold air and ice packs is associated with a decrease in skin temperature which would reduce skin blood flow and likely lead to shunting of blood internally, temporarily increasing  $T_{tr}$ . In contrast, we propose that the more effective cooling with ice slushy consumption is a result of concurrent internal and external cooling via heat sink, evaporation and convection. Cooling with SC also restores fluid balance after prolonged exercise in the heat. This method (SC) may be useful as an alternate or complimentary strategy to ice packs when individuals are able to ingest fluid and immersion baths are not available. **References:** 1. Armstrong, L et al., (2007). *Med Sci Sports Exerc*, 39(3):556-572. 2. Lee, J et al., (2008). *Med Sci Sports Exerc*, 40(9):1637-44

### RECURRENT CHILDHOOD WHEEZING AND EXERCISE INDUCED ASTHMA IN LATER LIFE

Rosenhagen, A., Vogt, L., Thiel, C., Bernhoerster, M., Banzer, W.

*Goethe University*

Aim Exercise induced asthma (EIA) common in endurance and other athletes limits physical activity. Although a correlation between recurrent childhood bronchitis and the development of asthma has been reported, its relation to EIA in adult athletes has not been assessed. The study evaluates the EIA risk after recurrent childhood wheezing (RCW) and its aggravating influence on the known risk factors. Methods To evaluate the effect of RCW on EIA, 570 multiple choice questionnaires were evaluated, assessing the history of RCW and the EIA occurrence. The latter was defined either according to physician-derived diagnosis, by typical symptoms or by decrease of the 1-second forced expiratory volume after a 6-minute running test. Contingency tables and a logistic regression model were worked out to describe referring parameters of EIA incidence. Result Almost one quarter of the athletes with RCW were attributed positive for EIA. Contingency calculations revealed a 2.6 times higher chance of symptoms of EIA after RCW. Outdoor sports performed on a professional level further increased this risk. Long lasting sport participation, exercising in cold weather, self-limiting of symptoms within 30 min are revealed as predicting factors for a higher risk of EIA. The Nagelkerke R<sup>2</sup> of .596 for this model explains almost 60% of the variance. Summary These results suggest an effect of recurrent affections of the respiratory tract in childhood to EIA in adults. For safe sports participation, the athlete, as well as involved caregivers (parents, coach) should have an adequate knowledge of EIA and prevention/intervention strategies like warming up or the use of inhalers.

### NO DIFFERENCE IN EFFECTIVENESS BETWEEN FOCUSED SHOCKWAVE THERAPY AND RADIAL SHOCKWAVE THERAPY FOR TREATING PATELLAR TENDINOPATHY. THE TOPSHOCK STUDY: A RANDOMIZED CONTROLLED TRIAL.

Van der Worp, H., Zwerver, J., Hamstra, M., Van den Akker-Scheek, I., Diercks, R.L.

*center for sports medicine*

Introduction Patellar tendinopathy is a chronic knee injury that is often therapy resistant. Conservative and surgical treatment of patellar tendinopathy are not always successful, hence new treatment options are being developed (Gaida & Cook, 2011). One of these treatments is Extracorporeal Shockwave Therapy (ESWT). Two ESWT technologies are available: focused shockwave therapy (FSWT) and radial shockwave therapy (RSWT). These two technologies generate therapeutic waves with different characteristics. The aim of the study was therefore to compare the effectiveness of FSWT and RSWT for treating patellar tendinopathy both in combination with eccentric training. Methods Patients were randomized into two groups (van der Worp et al., 2011). One group received three sessions of FSWT whereas the other group received three sessions of RSWT. Both groups also received an eccentric training program. Follow-up measurements took place 1, 4, 7 and 14 weeks after the final shockwave treatment. The primary outcome measure was the VISA-P questionnaire which measures pain, function and sports participation. Secondary outcome measures were pain during ADL, sports activities and the decline squat. Results 43 subjects (57 tendons) were included in the study. 21 subjects (31 tendons) received FSWT whereas 22 subjects (26 tendons) received RSWT. Both groups improved significantly on the VISA-P score, but there were no differences in improvement between the FSWT group (15.0 points on the VISA-P) and the RSWT group (9.6 points,  $p=.30$ ). This was also the case for the secondary outcome measures. Discussion Despite the technological differences, there were no differences in the effectiveness between FSWT and RSWT. Based on this it is not possible to recommend one treatment over the other on grounds of outcome. Both groups improved significantly although it is questionable whether this difference is clinically relevant. References Gaida JE, Cook J. Treatment Options for Patellar Tendinopathy: Critical Review. *Curr Sport Med Rep* 2011;10(5). van der Worp H, Zwerver J, van den Akker-Scheek I, Diercks RL. The TOPSHOCK study: Effectiveness of Radial Shockwave Therapy compared to Focused Shockwave Therapy for treating patellar tendinopathy. Design of a randomised controlled trial. *BMC Musculoskelet Disord* 2011; Oct 11;12(1):229.

### STRUCTURAL DEFORMATION OF LONGITUDINAL ARCH DURING RUNNING FOR MEDIAL TIBIAL STRESS SYNDROME

Noh, B., Masunari, A., Miyakawa, S.

*University of Tsukuba*

Introduction Medial tibial stress syndrome (MTSS) is one of the most common exercise induced leg injuries. But the literature regarding MTSS which was analyzed dynamically is not seen. In recent years, using fluoroscopy to perform motion analysis as well as to evaluate the biomechanics of the connective tissues during gait and running has received increased attention. Therefore, The aim of this study was to examine sagittal plane motion of the medial longitudinal arch (MLA) and the lateral longitudinal arch (LLA) as well as the kinematics of the arch during running for medial tibial stress syndrome. Methods A total of 10 individuals with 5 MTSS and 5 non-injured controls volunteered. Fluoroscopic imaging was used to investigate the movement of the bones during running of the right foot. The data were analyzed using a template method. Sagittal motion was defined the translational motion of the 1st metatarsal (M1), 5th metatarsal (M5) and d1, d2(d1 and d2 which is distance of the M1 and M5 for the calcaneus.). Results Regarding translational motion, the motion MLA and LLA of the MTSS had significantly larger anterior displacement and inferior displacement of the M1, M5 than non-injured controls ( $p<.05$ ). With regard to the d1 and d2 displacement, MTSS had significantly larger anterior displacement of the d1 and d2 than non-injured controls ( $p<.05$ ). Discussion In both M1, M5 translational motion was displaced anteroinferiorly. The relationship with MTSS between increased tension of the tibialis anterior and tibialis posterior found in the present study (Mannoji T., 2001). And the inferior displacement has a relationship with shock absorption insufficient of contact and to muscle fatigue which is insertion in metatarsals (Japan Sports Assoc., 2007). If the movement of the metatarsals was extreme, Early occurrence of muscle fatigue which has been inserted in the metatarsals and increased tension of that muscle. Oida (2011) reported that foot arch decreased with the output incompleteness of intrinsic muscles of the foot. Because of that d1 and d2 had anterior displacement. This kind of things in traction the periosteum of the tibia related possible MTSS. This study suggested that it is possible risk factor for MTSS not only excessive decrease of MLA but excessive decrease of LLA. References Mannoji T. (2001). Shin-splint, 286-289. Ishiyaku Publishers, Inc. Japan Sports Assoc. (2007). Text for the Athletic Trainer, 122-128. Bunkoudo. Oida T. (2011). Tokai Hokuriku Jpn Phys Ther Assoc., 27, 128.

## EYE INJURIES IN SPORTS – LATEST FIGURES

Jendrusch, G.1, Katlun, T.2, Schnell, D.2, Schulz, D.3, Henke, T.1, Platen, P.1

1: Ruhr-Universität Bochum (Bochum, Germany), 2: Ressort Sports Ophthalmology (BVA) (Germany), 3: ARAG Sports Insurance (Düsseldorf, Germany)

Introduction According to Schnell (2000) about 3 % of all eye injuries happen during sports activities. A good quarter of these eye injuries are so severe that they need ophthalmic treatment. Roughly 10 % of all eye injuries during sports activities lead to blindness. In those circumstances latest figures of eye injuries in sports will be presented. Furthermore, the risk of eye injuries during diverse sports disciplines will be pointed out. Methods 1.830 eye injuries were evaluated on the basis of 180.218 sports injuries (club sports) that have been recorded by the database of sports accidents of the ARAG Sports Insurance and the Ruhr-Universität Bochum between 1988 and 2008. In order to calculate the sports discipline related risk of eye injuries the frequency of eye injuries in one sports discipline has been qualified with regard to the frequency of all sports injuries that have been recorded in this sports discipline. Essential results The average age of the 1.830 eye injured – this equals 1.02 % of all sports injuries – was  $31.6 \pm 16.3$  (age range: 3 - 85 years). 78.2 % of the injured persons were male, whereas 21.8 % were female. On average the men were  $31.8 \pm 16.0$  years old (age range: 3 - 85 years) and the women were  $30.5 \pm 17.2$  years old (age range: 3 - 82 years). In the summarily relatively rare eye injuries in sports, blunt trauma, e.g. contusions, are dominant with over 50 %. These are often injuries caused by balls (e.g. in tennis or squash), rackets (e.g. in squash or ice hockey) or hand and elbow hits during tackles/tacklings (e.g. in handball or soccer). Correspondingly, especially sports disciplines like squash, badminton, tennis, but also water polo, which involves swimming and grasping movements above the surface of the water at eye level, contain a significantly higher risk of eye injuries than other sports disciplines. Conclusion Due to the special risk of eye injuries in squash the use of protective (sports) goggles (polycarbonate lens eye guards) is clearly recommended from an ophthalmological point of view (already for a long time) [Schnell, 2000; Jendrusch et al., 2002]. For one-eyed athletes or sports persons with monocular defective vision protective sports goggles should be obligatory in order to protect the remaining healthy eye. References Jendrusch G, Franke C, Heck H, Völker K (2002). Zur Prävention von Augenverletzungen im Squash – Werden Schutzbrillen akzeptiert? In M Baumgartner (Red.), Mit Sicherheit mehr Sport (S. 141-145). Wien: Kuratorium für Schutz und Sicherheit. Schnell D (2000). Sport und Auge: Augenverletzungen durch Sport und Sport als Therapie bei Augenkrankheiten. Deutsches Ärzteblatt, 97 (41), A 2712-2716.

## COLD WATER IMMERSION RECOVERY PROTOCOLS: DO THEY CAUSE CARDIAC ARRHYTHMIAS AND REPRESENT A CARDIOVASCULAR RISK?

George, K.P., Dolman, G.M., Gregson, W., Somauroo, J., Jones, H.

Liverpool John Moores University

Background: In contemporary sporting environments athletes have adopted whole limb cold water immersion (CWI) as a strategy to aid recovery. Little attention has been paid to the cardiovascular risk associated with CWI despite evidence from "work-physiology" studies of substantial numbers of cardiac arrhythmias being induced with water immersion. The aim of this initial study was to evaluate the effect of CWI (8 and 22oC) at rest on heart rate (HR), blood pressure (BP) and cardiac electrical activity (ECG). Methods: Ten healthy male subjects (mean age  $25 \pm 5$ ; height  $1.79 \pm 0.04$  m; body mass  $79.5 \pm 4.6$  kg) completed two experimental trials consisting of; 30 min supine rest, 10 min CWI and 10 min supine recovery in a stable laboratory environment (22oC, 50% RH). CWI was to the level of the iliac crest and was performed, in a random order, at water temperatures of 8oC and 22oC. HR, BP and both prolonged single lead rhythm and 12 lead ECG data were collected continuously via finger photo-plethysmography, PowerLab and SpaceLabs ECG machines. ECG data were read by a consultant cardiologist. HR and BP were averaged over 1 min intervals across the last 10 min of supine rest, CWI and recovery. Results: HR and mean arterial pressure (MAP) did not significantly changes across the 22oC CWI trial. In the 8oC trial HR increased marginally but MAP was significantly increased during immersion (Rest:  $79 \pm 7$  mmHg; Immersion:  $98 \pm 12$  mmHg,  $P < 0.05$ ) and then returned to baseline during recovery. Sinus arrhythmia and sinus bradycardia were common. There were 2 cases of a low atrial rhythm (1 throughout all phases and another developing in recovery); 1 case with a premature ventricular complex and 2 cases with atrial ectopic beats during baseline or recovery. There was no ST depression but new T-wave inversion in inferior leads occurred in 2 cases during immersion which normalised in recovery. There were no significant time-by-trial interactions for P wave duration and axis, PR duration, QRS duration and axis, QT, QTc, T wave axis and  $sV1+rV5$  voltage. Conclusion: Ten minutes of CWI (at 8oC) resulted in a minor but statistically significant pressor response. Few cardiac arrhythmias were detected and these were not consistently mediated by temperature, trial phase and presented no immediate clinical concern. T wave changes were seen in one athlete, but as to whether this represents a benign phenomenon or an increase in cardiovascular risk is undetermined.

## INCIDENCE OF SPORT INJURIES IN JAPANESE BLIND FOOTBALL PLAYERS: A 1-YEAR PROSPECTIVE STUDY

Kinoshita, H.

Tsukuba University of Technology

INCIDENCE OF SPORT INJURIES IN JAPANESE BLIND FOOTBALL PLAYERS: A 1-YEAR PROSPECTIVE STUDY Hiroaki Kinoshita, Kazushige Ishizuka, Yasuko Kohda, Yoshiki Fukunaga Tsukuba University of Technology (Tsukuba, Japan) Introduction: Blind football is an adaptation of football 5-a-side (futsal), one of Paralympic games, played with modified FIFA (Fédération Internationale de Football Association) rules, for athletes with visual impairments including blindness. Players are assigned to one of sport classes based on their level of visual impairment. Class B1 players are totally or almost totally blind, and Class B2 /3 are partially sighted. For Class B1 games, teams are consisting of 4 field players with visual impairments, using eye shades to ensure fairness, and one goalkeeper may be sighted. The ball is equipped with a noise-making device inside to allow players to locate it by sound. During the game, players have to say clearly and audibly the word "voy" or "go", or any other similar word, when approaching the opponent with a ball to avoid collision between players. As little research has been performed on the athletes with disabilities relative to sports injuries, especially in blind football players, the objective of this study is to find the features of sports injuries in blind football. Methods: In this 1-year prospective study, 11 male Japanese national team blind football players (all Class B1, mean (SD) age  $31.5$  (6.5) years) were interviewed and recorded the incidence of injuries, from July of 2010 to June of 2011. This study documented injury type and location caused by football, according to the FIFA standardized injury report form. An injury is defined as an absence from training or game for at least a week followed by diagnosis of anatomic tissue damage and medical treatment. Results: During the investigation period, there were five total injuries among four players. The body parts injured were head / neck (40%) and lower extremity (60%). The injuries were diagnosed as fracture (20%), sprain (60%) and laceration / abrasion (20%). Discussion: According to many studies of sport injuries in football, major locations of injuries are lower extremities, espe-

cially in thigh, ankle, knee and lower leg. In this study, head / neck injuries were relatively high rate compared to many studies of football-related sports injuries. Head / neck injuries were predominantly caused by collisions between players. As players are completely blinded during the game, they have to say clearly and audibly the words like "voy" approaching the opponent with a ball. Collisions often happen when they could not say the words properly by mistake. Overall, it is indicated that incidence of sport injuries in Japanese blind football was low and there was no catastrophic injury such as fatal or causing permanent severe functional disability. References: Ferrara MS, Peterson CL (2000). *Sports Med*, 30, 137-143. Dvorak J, Junge A (2010). *Br J Sports Med*, 44, 1089-92.

### THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND BONE HEALTH OF PREMENOPAUSAL WOMEN USING DEPOT-MEDROXYPROGESTERONE ACETATE

Babatunde, O.

*Staffordshire University*

The relationship between physical activity and bone health of premenopausal women using Depot-medroxyprogesterone acetate (DMPA) Babatunde, O.O.1., Forsyth, J.J.1 1: Staffordshire University (UK) Introduction Progesterone-only contraception, such as Depot-Medroxyprogesterone Acetate (DMPA), has been associated with decrease in bone health. Physical activity, particularly of a high-impact nature, is known to be beneficial for enhancing bone health and has been advocated for women in the hope of offsetting this contraceptive hormone-related loss in bone mineral density (WHO,2007;Committee on Safety of Medicine,2004); however, little is known about whether exercise is actually helpful for DMPA users. The aim of this study was to examine the relationship between physical activity and bone health of premenopausal DMPA users. Methods Bone health of 45 DMPA users (23 ±3.7yrs) was assessed using calcaneal broadband ultrasound attenuation (BUA). Recent bone-loading exercise (specific to the hip and spine) was assessed using a bone loading history questionnaire. Results The duration of DMPA use ranged from 6 to 132 months. There was a significant but negative correlation between BUA (mean of 62.8 ±10.8 dB/MHz) and recent hip ( $r = -0.499$ ,  $p=0.001$ ), and spine exercise ( $r = -0.642$ ;  $0.001$ ). In a regression analysis, 63% ( $p=0.001$ ) of the variation in BUA was explained by recent hip and spine exercise ( $BUA = 66.3 + 1.82$  (recent hip exercise) –  $2.398$  (recent spine exercise)). Discussion The findings of this study corroborate those of previous research, suggesting that in a hypo-oestrogenic state, as induced by DMPA, a relative increase in mechanical strain could impair bone health (Ehrlich,2002). A cycle of prolonged DMPA use and concurrent engagement in high-impact physical activity may result in a compromise of bone's structural integrity and consequently bone strength. It is suggested that the lack of oestrogen may counteract the effects of physical activity by inhibiting bone formation in response to mechanical bone loading. References 1. World Health Organisation (2007). Technical consultation on the effects of hormonal contraception on bone health. Department of Reproductive Health and research, World Health Organization, Geneva Switzerland, WHO/RHR/0.7.08 2. Committee on Safety of Medicine (2004). Updated advice about Depo-Provera contraceptive. Retrieved February 14, 2012 from <http://www.mhra.gov.uk/home/groups/pl-p/documents/websiteresources/con019479.pdf> 3. Ehrlich PJ, Noble BS, Jessop HL, Stevens HY, Mosley JR, Lanyon LE (2002). The effect of in vivo mechanical loading on oestrogen receptor alpha expression in rat ulnar osteocytes. *J Bone Miner Res*. 2002 Sep; 17(9):1646-55.

### TRAINING CHARACTERISTICS IN DIFFERENT SPORT CATEGORIES AND THEIR RELATIONSHIP WITH NON-CONTACT INJURIES

Malisoux, L.1, Frisch, A.1, Urhausen, A.1,2, Seil, R.1,2, Theisen, D.1

1: *Sports Medicine Research Laboratory, CRP-Santé, Luxembourg*; 2: *Centre de l'Appareil Locomoteur, de Médecine du Sport et de Prévention du Centre Hospitalier de Luxembourg, Luxembourg*

Introduction Training characteristics in high-level sports require careful modulation to optimize performance. However, inappropriate training load could be a risk factor for sport injuries, especially non-contact injuries (NCI). The aim of this study was to compare training characteristics in different sport categories and to investigate their relationship with NCI. Methods Young (12-19 years) high-level athletes ( $n=154$ ) from a regional sport school were followed during the school season 2010-2011 (41 weeks) regarding training characteristics and sport injuries. The 15 represented sport disciplines were classified into 3 categories: racket, team, and individual sports. Practice volume and intensity were used to determine weekly volume, load, monotony and strain for each athlete (Foster et al. 2001). Sport injuries were considered in case of time-loss >3 days and subdivided into contact injuries and NCI. The effect of age, gender, sport category, and injury status (no injury, contact injury or NCI) on training characteristics was tested using analyses of covariance. A repeated measures analysis of covariance was used to study changes of training characteristics prior to NCI, taking into account significant factors from the previous analyses. Results NCI represented 66 % of the 126 injuries recorded and concerned 65 athletes. Across sport categories, differences were found for mean weekly volume ( $p<0.001$ ), load ( $p<0.001$ ), monotony ( $p<0.05$ ) and strain ( $p<0.001$ ), while age was related to weekly load ( $p<0.05$ ) and strain ( $p<0.05$ ). However, no relationship was found between training characteristics and injury status. Controlling for sport category and age, we found no significant difference between mean training characteristics 7 days prior to NCI and those 2-5 weeks prior to NCI. Discussion The method used here to characterize training behavior was sensitive to discriminate between different sport categories and highlight age-related differences. Injury status seems to be unrelated to average training characteristics. Furthermore, NCI do not seem to be coupled to short-term modulation of training behavior. The relationship between training behavior and injury, especially NCI, should be further studied. References Foster, C., J. A. Florhaug, J. Franklin, et al. (2001). 'A new approach to monitoring exercise training.' *J Strength Cond Res* 15(1): 109-15.

### UPPER LIMB INJURIES DURING THE MEN'S FIELD HOCKEY JUNIOR WORLD CUP 2009

Mukherjee, S.

*National Institute of Education, Nanyang Technological University, Singapore*

UPPER LIMB INJURIES DURING THE MEN'S FIELD HOCKEY JUNIOR WORLD CUP 2009 Mukherjee S Nanyang Technological University, Singapore Introduction Field hockey players are at risk of upper limb injuries and the use of protective gear is uncommon in the sport. Despite the suggestive evidence, there are no reports on hand and upper limb injuries in elite youth hockey players during major international tournaments. The objective of this study was to provide a descriptive epidemiological account of upper limb injuries in elite youth male field hockey players during the Men's Junior World Cup 2009. Methods A total of 324 players were observed during 58 matches in the tournament. The injury reporting system was based on that used in team sports during international tournaments. All injury documentation was done by direct on-location observation by a trained sports medicine physician followed by confirmation from the team doctors or physiotherapists. Results A total of 28 hand and upper limb injuries were documented in the 58 matches observed. The overall

injury frequency rate was 19 per 1000 match hours and 22 per 1000 player matches. Most injuries (50%) were due to the ball striking the body part with hand being the commonest site (61%) and contusion being the commonest type (82%) of injury. The left hand and wrist was more commonly injured than the right side. The incidence of injuries was higher in the second-half (64%) than the first half. Fifty-four of the 324 athletes observed wore gloves on either left or both hands. Nineteen of the 20 hand/wrist injuries were in athletes not wearing gloves. Discussion Male elite youth hockey players are at a high risk of upper limb especially hand and wrist injuries during major international tournaments. The injuries can lead to both short and long-term player time loss in the tournament matches. With the hand being the most commonly injured part of the upper limb, use of protective gloves can provide significant protection against hand and wrist injuries in the sport and the players should be educated on the evidence of injury risks and consequences and encouraged to adopt safe practices in the field hockey. References Bowers AL, Baldwin KD, Sennett BJ. (2008). *Med Sci Sports Exerc*, 40, 2022-2026. Junge A, Langevoort G, Pipe A, Peytavin A, Wong F, Mountjoy M, Beltrami G, Terell R, Holzgraefe M, Charles R, Dvorak J. (2004). *Am J Sports Med*, 34, 565-576. Rishiraj N, Taunton JE, Niven B. (2009). *J Sports Med Phys Fitness*, 49, 71-77. Steffen K, Engebresten L. (2010). *Br J Sports Med*, 44, 485-489.

### **APPROPRIATE SODIUM SUPPLEMENTATION INCREASES SERUM SODIUM LEVELS IN ELITE ATHLETES WHICH ARE MAINTAINED DURING EXTREME EXERCISE – IMPLICATIONS FOR EXERCISE ASSOCIATED HYPONATRAEMIA.**

WEATHERALL, L., JUTLEY, R.S., BLOW, A., NANJIAH, P., VOYSEY, V.

#### *PRECISION HYDRATION*

Appropriate Sodium Supplementation Increases Serum Sodium Levels in Elite Athletes Which Are Maintained During Extreme Exercise – Implications for Exercise Associated Hyponatraemia. Weatherall et al. Introduction Exercise Associated Hyponatraemia (EAH) results from overhydration with low-sodium drinks or water in the face of high sweat losses. EAH causes problems ranging from poor coordination, confusion and muscle weakness to seizures and death. There is little evidence linking sweat sodium losses to EAH. As net sodium losses can vary 13-fold amongst athletes training in the same session, it is important to collate such evidence(1). This study evaluates whether sodium supplementation based on individual sweat sodium levels can protect against EAH during extreme exercise compared to water alone. Methods Randomised crossover study comparing H2ProHydrate (500, 1000 or 1500 mg/l sodium) to Evian water (5mg/L sodium) in 7 elite male athletes. Pre-trial all underwent the Precision Hydration pilocarpine-induced sweat sodium analysis. Randomisation was to water or H2Pro allowing ad libitum drinking for 72 hrs pre-trial while maintaining standard diet. Cross-over was undertaken 2 weeks later. Athletes were subjected to extreme exercise consisting of maintaining 70% VO<sub>2</sub> max in a climate chamber at 28C, 55% humidity for 60 min followed by a 15-min blinded performance time trial(TT). Ad libitum drinking was allowed throughout. End-points were baseline serum sodium sampling (pre-trial), post-chamber exposure and post-TT exposure and drink volumes. Results Mean sweat sodium concentration was 1043mg/L (range 430-1640). One athlete failed to complete the trial on water due to nausea and dizziness and was therefore excluded. Mean serum sodium levels were higher in all athletes on H2Pro pre-trial, following the 60-min chamber exposure and following the TT. Baseline mean(mmol/L):H2Pro 141.2;water 138.5 Post-chamber mean(mmol/L):H2Pro 141.7;water 138.2 Post-TT mean(mmol/L):H2Pro 141.5;water 138.7 Analysis showed that 'high sodium sweaters' (>1380 mg/L or 60 mmol/L,n=3) increased their serum sodium by the highest margin(138 mmol/L on water vs.142 mmol/L on H2Pro). The remaining group show a modest rise(139 mmol/L on water vs.141 mmol/L). Ave. volume of drink consumed: 1758 ml ( H2Pro), 1505 ml (water) Conclusion Appropriate sodium pre-loading allows higher serum sodium levels which are maintained during extreme exercise. The greatest increases are seen in high sodium excretors who would typically have the highest sodium losses during exercise. Increased voluntary drinking of H2Pro indicates greater palatability which may help prevent hyponatraemia. The lower water intake compared to H2Pro could explain why serum sodium levels while on water did not decrease to dangerous levels. These findings have implications on understanding the onset of EAH. References 1. Godek et al. Sweat rates...and sodium losses in 3 groups of professional football players.*J Athl Train*.2010;45:364-71

**14:45 - 15:45**

## Poster presentations

### **PP-PM23 Training & Testing 4**

#### **RESISTANCE PRIOR TO AEROBIC TRAINING INTRA-SESSION SEQUENCE OPTIMIZES STRENGTH AND HYPERTROPHY GAINS IN WATER-BASED EXERCISES**

Cadore, E., Pinto, S.S., Alberton, C.L., Zaffari, P., Bagatini, N.C., Radaelli, R., Pinto, R.S., Kanitz, A.C., Bottaro, M., Colado, J.C.S., Krueel, L.F.

*Federal University of Rio Grande do Sul*

Introduction To the best of our knowledge, there is no study regarding the effect of exercise order manipulation during concurrent training in the water-based exercises on the neuromuscular and cardiorespiratory adaptations in young women. Therefore, the aim of the study was to compare the effects of different intra-session exercise orders in the neuromuscular and cardiorespiratory adaptations induced by concurrent water-based exercise training in young women. Methods Twenty-six healthy young women (25.12±2.94years) were randomly placed into two concurrent training groups: resistance training prior to (RA, n=13) or after (AR, n=13) aerobic training. Subjects trained resistance and aerobic training in water environment 2 times per week performing both exercise types in the same training session. The peak oxygen uptake (VO<sub>2</sub>peak), oxygen uptake corresponding to the first and second ventilatory thresholds (VO<sub>2</sub>VT1 and VO<sub>2</sub>VT2) was evaluated during a maximal incremental test on a treadmill before and after the training. Moreover, maximal dynamic strength (one repetition maximum test) of the knee extensors and elbow flexors were evaluated and the quadriceps femoris muscle thickness was determined by ultrasonography. Results There were significant modifications after training in the VO<sub>2</sub>peak (p<0.001), VO<sub>2</sub>VT1 (p=0.001) and VO<sub>2</sub>VT2 (p=0.002) in both groups. Between the groups RA and AR there was no significant difference in the relative gains for all cardiorespiratory variables (VO<sub>2</sub>peak: p=0.219; VO<sub>2</sub>VT1: p=0.321; VO<sub>2</sub>VT2: p=0.939). For maximal dynamic strength (1RM) of the knee extensors (p<0.001) and elbow flexors (p<0.001) there were significant increments after training in both groups. Between the groups RA and AR there was no significant difference in the relative gain for the 1RM of the elbow flexors (p=0.946). However, the RA group present-

ed greater relative gain compared to AR for the 1RM of the knee extensors ( $27.72 \pm 16.81$  vs  $43.58 \pm 14.00\%$ , respectively,  $p=0.015$ ). The quadriceps femoris muscle thickness ( $p<0.001$ ) presented modifications after training in both groups. The RA group presented greater relative gain compared to AR for the quadriceps femoris muscle thickness ( $5.76 \pm 1.88$  vs  $10.24 \pm 3.11\%$ , respectively,  $p<0.001$ ). Discussion The intra-session sequence in water-based exercises influence the strength and hypertrophy gains to concurrent training, as observed greater relative changes on strength of knee flexors and quadriceps femoris muscle thickness was found when the resistance training was performed prior to aerobic training. In summary, to optimize the strength and hypertrophic gains in the young women, the concurrent training prescription in water-based exercises should include an intra-session order of resistance training prior to aerobic training.

### **INFLUENCE OF COMPRESSION STOCKINGS ON CALF MUSCLE-PUMP CAPACITY**

Meyer, H., Meurer, R., Bulling, B., Lötzerich, H.

*German Sports University Cologne*

Influence of compression stockings on calf muscle-pump capacity Meyer, H. 1, Meurer, R. 1, Bulling, B. 2, Lötzerich, H. 1 1: German Sports University Cologne, Institute of Outdoor Sports and Environmental Science 2. Practice for Vascular Diseases, Cologne Introduction: It is well known that compression garments (CG) improve venous pooling or blood flow parameters such as deep venous velocity (Lawrence 1980). However, whether or not there is an enhancement of venous return parameters during physical exercise, is still unclear. The aim of our study is to quantify the influence of CG on calf muscle-pump capacity during physical exertion. Methods: 43 subjects, 21 male (age:  $22.8 \pm 5.5$  years; height:  $185.2 \pm 5.7$  cm; weight:  $77.8 \pm 12.2$ kg) and 22 female subjects (age:  $21.3 \pm 2.6$  years; height:  $169.6 \pm 5.2$  cm; weight:  $58.4 \pm 5.9$ kg) completed 2 randomized testing sessions. In the course of one session, the subjects wore compression socks (?Running Compression Socks?, CEP, Bayreuth (Germany), 24-18mmHg ), during the second, they did not. At each session, every subject had to execute three times twelve tiptoestandings to the pulse of a metronome. The muscle pump capacity was measured by 2-channel-venous-occlusion-plethysmography (Compactus 712, Gutmann MD GmbH, Geretsried, Germany) Results: The calf muscle-pump capacity increased significantly ( $p<0.05$ ) whilst executing the tiptoestandings. The mean improvement ranges from  $1.15 \pm 0.66$ ml/100ml without to  $1.56 \pm 0.59$ ml/100ml with compression stockings. Through compression stockings, all subjects could enhance the capacity under compression conditions, females from  $1.04 \pm 0.64$ ml/100ml to  $1.36 \pm 0.61$ ml/100ml, males from  $1.26 \pm 0.69$ ml/100ml to  $1.76 \pm 0.49$ ml/100ml. Discussion: The present study shows a significant performance enhancement for the function of calf muscle-pump achieved by wearing CG. Previous studies have shown inconsistent results; whilst some promise performance improvement by using CG in sports (Kemmler 2009, Chatard 2004), others do not agree on those findings (Scanlan 2008, Sperlich 2010). For the positive results of wearing CG, the present study may be a statement of grounds. References: Sperlich B, Haegele M, Achtzehn S et al. Different types of compression clothing do not increase sub-maximal and maximal endurance performance in well-trained athletes. *J Sports Sci* 2010 Apr; 28:609-614 Lawrence, D., Kakkar, V. Graduated, static, external compression of the lower limb: A physiological assessment. *Br.J. Surg.* 67:119-121. 1980. Kemmler W, von Stengel S, Kockritz C et al. Effect of compression stockings on running performance in men runners. *J. Strength Cond Res* 2009; 23; 101-105 Chatard JC, Atlaoui D, Farjanel J et al. Elastic stockings, performance and leg pain recovery in 63-year-old sportsmen. *Eur J Appl Physiol* 2004; 93: 347-352 Scanlan, A., Dascombe, B., Reaburn, P., Osborne, M., The Effects of Wearing Lower-Body Compression Garments During Endurance Cycling; *Int J Sports Physiol Perform*, 2008, 3, 424-438

### **INFLUENCE OF A NINE WEEK BALANCE TRAINING PROGRAM ON ONE LEG STAND PERFORMANCE**

Roos, L., Maeder, U., Wyss, T.

*Swiss Federal Institute of Sports Magglingen*

Introduction Balance is crucial in everyday activities such as walking or climbing stairs. In military basic training balance is even more important since recruits have to perform a large number of physical activities on uneven surfaces often while carrying heavy loads. Research suggests that a specific training can improve balance performance [1]. Therefore, the objective of this study was to investigate the improvement of the balance ability over a 9 week training program. Methods In this study 406 male recruits of the infantry training camp in Aarau, Switzerland volunteered during their basic training. Thereof, 243 recruits were chosen to participate in a 9 week balance training program. A 30 minutes program was included into the army sports training of 180 minutes per week. The 163 recruits of the control group participated in the normal army sports training comprised of endurance runs, strength and coordination training and sports. To test the recruits' balance abilities a one leg stand [2] was performed in week 1 and week 11 of basic training. Results Control and intervention group showed a significant increase of the one leg stand duration over the 11 weeks of basic training,  $9.06 \pm 13.46$  s and  $12.71 \pm 15.40$  s respectively. However, the difference in performance enhancement between the groups was significant ( $p=0.014$ ). There was no significant difference in total duration of sport ( $140.21 \pm 76.96$  vs.  $145.24 \pm 27.80$  minutes per week), amount of trainings per week ( $1.73 \pm 0.63$  vs.  $1.86 \pm 0.35$ ) or self reported intensity ( $2.26 \pm 0.23$  vs.  $2.35 \pm 0.39$  on a scale of 1 to 3) between control and intervention group. Discussion Both groups increased the total duration of one leg stand suggesting that the activities executed during daily military training already increase the recruits' balance abilities to a certain degree. The most common military actions such as lifting, carrying loads while marching, climbing, crawling, jumping, digging [3] require good balance and core strength to succeed. However, the intervention group had a significantly higher performance increase. A balance training as deployed here, therefore, could be useful for injury prevention during military basic training [1]. References 1. McGuine, T.A. and J.S. Keene, The effect of a balance training program on the risk of ankle sprains in high school athletes. *Am J Sports Med*, 2006. 34(7): p. 1103-11. 2. Wyss, T., et al., Assembling and Verification of a Fitness Test Battery for the Recruitment of the Swiss Army and Nation-wide Use. *Swiss J Sports Med Sports Traumatol*, 2007. 55(4): p. 126-131. 3. Jones, B.H. and J.J. Knapik, Physical training and exercise-related injuries. Surveillance, research and injury prevention in military populations. *Sports Med*, 1999. 27(2): p. 111-25.

### **ADAPTATION TO ENDURANCE TRAINING IN TEAM SPORTS – THE INFLUENCE OF TRAINING STATUS**

Franke, J.1,2, Hinrichs, T.2, Platen, P.2

*1Saarland University, 2Ruhr-University Bochum*

Introduction: It is known that training status and training intensity significantly influence endurance enhancement in endurance sport athletes. The aim of this study was to investigate the influence of pre-training level of performance on endurance enhancement in team sport athletes when using sport specific training versus classical endurance training modes. Methods: 93 elite players (62 male, 31 female) from 4 team sports were investigated. They completed a VO<sub>2</sub>max-Test on a treadmill and a field test for calculating running velocity at 4 mmol/l lactate (v4). Each team was randomly divided into two training groups according to the individual endurance capacities.

Group one performed a high intensity interval run training (HIT, 4x4 min at 95% of their maximal heart rate (HRmax)) using sport specific running tracks, while group two performed an extensive run training (ET, 45min at 75% of v4). Both groups followed this regime 3x per week for 4 weeks in addition to the equal team training. To examine the influence of training status on endurance enhancement a median (md) split was applied for baseline parameters considering endurance performance. Men (m) and women (w) were analysed separately. Results: Training methods had no sig. effect on performance enhancement for any of the measured parameters. v4 increased sig. from pre to post training in m and w. VO2max did not change sig. while max. running velocity during the VO2max test increased. ANOVA for pre to post differences in v4 of the two md split groups showed a sig. influence of training status on performance enhancement in men (md: 3.8 m/s, mean value below md: 3.6±0.3 m/s, difference pre to post testing (pre/post): 0.2±0.2 m/s; mean value above md: 4.1±0.1 m/s, difference pre/post: 0.1±0.2 m/s) while in women the influence of training status on performance enhancement was not sig. (md: 3.1 m/s, mean value below md: 2.9±0.2 m/s, difference pre/post: 0.3±0.1 m/s; mean value above md: 3.4±0.2 m/s, difference pre/post: 0.2±0.2 m/s; p=0.63). Changes in VO2max were independent of training status in m and w. Considering training method, HIT was analysed to be more effective for improving v4 in men with a lower training status than ET while there was no influence of training method in women (p=0.70). Discussion and Conclusion: In this group of elite team sport athletes we could show an influence of training status on performance enhancement in m while this was not visible for w. It can not be ruled out that the difference in gender is masked by the generally lower performance level in women. Maybe their level of performance was not high enough to induce and analyze different ways of endurance improvements.

## ACOUSTIC FEEDBACK IN HIGH PERFORMANCE ROWING TRAINING

Schaffert, N.1, Mattes, K.1, Effenberg, A.O.2

1 University of Hamburg, 2 Leibniz University Hannover

Introduction Using sonification as acoustic feedback (AF) has effects on perception accuracy and regulation of movement patterns (Effenberg, 2005). Thus, it has become increasingly interesting in motor control and learning. To examine effects of AF on the mean boat velocity (vB), it was provided in technique training of elite rowers during the direct preparation phase for the World Championships. The investigation aimed at optimizing the boat run in on-water training. Methods The German National Rowing Team (N=47) (juniors and seniors) was examined with the AF-system Sofirow in 12 boats (small and big boats). The boat acceleration (aB) was measured as effect variable with a MEMS-acceleration sensor (up to 125Hz, 1% measuring accuracy, ±2g measuring range). The aB-time trace was sonified (Parameter Mapping) and transmitted to athletes and coaches time synchronously during on-water training. Statistical analysis considered a minimum of 3 training sessions per boat in which AF was presented in blocks (with and without AF alternately). Standardized questionnaires examined AF's functionality and the athletes' perception of it. Results The analysis of variance showed a significant increase of the mean vB with AF compared to the reference section without AF for all boats (F2=15.85; p=0.00; η2p=0.45) and a significant interaction between the boats (F3=16.88; p=0.00; η2p=0.73). Intra-cyclical structure of the aB-time trace changed qualitatively. Replying to the questionnaires, AF was perceived as functional and supportive for the movement execution by providing a guiding function. Discussion The results show the immediacy of AF to affect the mean vB in on-water rowing training of elite athletes as well as the potential to display characteristic phases of the rowing cycle (rc) by affecting its time-structure. AF drew athletes' attention to the time-dynamic structure of rc which enables them to regulate its critical phases more precisely and supported the feeling for the movement execution. Moreover, synchronization and coordination among the athletes was improved. AF offers new possibilities to assist the technique training of elite rowers by providing feedback information via the sense of hearing and thus, to facilitate the development for a feeling of the rhythm in racing boats. AF has been integrated into the technique training of elite athletes in preparation for the Olympic Games. References Effenberg, A.O. (2005). Movement sonification: Effects on perception and action. *IEEE Multimedia* 12(2), 53–59.

## GRIP STRENGTH: ARE DINAMOMETERS EQUIVALENT? JAMAR VS E-LINK

Tomás, M.T., Fernandes, M.B.

Lisbon Higher School of Health Technologies

Introduction Levels of risk for future disability can be assessed with grip strength. This assessment is of fundamental importance for establishing prevention strategies. It also allows verifying relationships with functional capacity of individuals. Most studies on grip strength use the JAMAR Hydraulic dynamometer that provides the value of isometric force obtained during the performance of grip movement and is considered the "gold standard" for measurement of grip strength (Mathiowetz, 2002). However, there are different dynamometers available commercially, such as portable computerized dynamometer E-Link (Biometrics), which provides the value of maximum force (peak force) in addition to other variables as the rate of fatigue for hand strength, among others. Of our knowledge, there are no studies that allow us to accept or not and compare values obtained with both devices and perhaps use them interchangeably. The aim of this study was to evaluate the absolute agreement between the measurements of grip strength (peak force or maximum force in kg) obtained from two different devices (portable dynamometers): a computerized (E-Link, Biometrics) and one hydraulic (JAMAR). Methods 41 subjects (15M, 26F, 20 ± 2 years, 23.8 ± 4.5 kg/m2) were assessed at the same time of day on two consecutive days. Test position chosen was the one recommended by the American Association of Occupational Therapists. We considered the best result from three attempts for the dominant hand. Statistical analysis included correlation (Spearman coefficient) between values obtained on both equipments; Bland-Altman analysis to assess agreement between the two measurements and intraclass correlation coefficient (ICC) to assess the absolute agreement. Results Values for grip strength were 41.0±9.9 kg on JAMAR and 40.6±10.5 kg on E-Link showing that differences between both dynamometers ranging from -9.1kg to 4.1kg (0.4±2.9, mean±sd). E-Link slightly underestimate grip strength, without statistical significance. The correlation coefficient between the two measurements was strong (rs =0.962, p <0.001) and Bland & Altman analysis of the values obtained were all, except one, within the range of mean±2SD. ICC was excellent (0.961; p<0.001). Discussion Data indicate that the two measurements were equivalent, revealing that the tested dynamometers can be comparable in different studies with young adults or in different clinical settings. It seems these two dynamometers can be used interchangeably however one must not forget that the same dynamometer should be used in consecutive measurements in the same study and in clinical settings or validity could be compromised. References Mathiowetz, V. (2002). Comparison of Rolyan and Jamar Dynamometers for measuring grip strength. *Occupational Therapy International*, 9(3), pp. 201-209.



### THE ACUTE EFFECTS OF STRENGTH TRAINING ON RUNNING PERFORMANCE OVER TWO CONSECUTIVE DAYS

Doma, K., Deakin, G.B.

*James Cook University*

**THE ACUTE EFFECTS OF STRENGTH TRAINING ON RUNNING PERFORMANCE OVER TWO CONSECUTIVE DAYS** Doma, K.1, Deakin, G.B.1 1: JCU (Cairns, Australia) Introduction Strength training (ST) has been shown to impair running economy with an 8-hour recovery period (Palmer et al., 2001). Accordingly, ST may interfere with endurance adaptations by causing acute detrimental effects on endurance training stimuli. However, to determine whether there are cumulative effects of strength training on endurance training stimulus, it is essential to examine the acute effect of strength training on endurance performance over consecutive days. Subsequently, the purpose of this study was to examine the acute effects of strength training on running performance over two consecutive days. Methods Six male and four female moderately trained runners undertook two running performance tests (RP1 and RP2) 10- and 24 hours following a strength training session, respectively. A baseline running performance test (Base RP) was conducted at least two days before the ST session. Maximal voluntary contractions of the knee extensors were collected prior to and following the ST session and RP1 and RP2. The running performance test was a three stage discontinuous test with the first two stages set at 70- and 90% of ventilatory threshold (VT), respectively, for 10 minutes. The last stage was set at 110% of VT in order to record time-to-exhaustion (TTE). There were two minutes rest between each stage with oxygen cost (CR) and blood lactate (BL) collected during and after the running performance test, respectively. The exercises during the ST session were performed in the order of incline leg press, leg extension and leg curls. All ST exercises were performed at six repetitions maximum with six sets for the incline leg press and four sets for the leg extension and leg curls, respectively, with three minutes rest between each set and exercise. A one way repeated measures analysis of variance was used to determine differences in performance variables. Results The TTE was significantly less during RP 1 and RP2 compared to Base RP ( $P < 0.05$ ). In addition, MVC following the ST session and prior to and following RP 1 and RP2 were significantly less than the MVC prior to the ST session ( $P < 0.05$ ). There were no significant differences in CR and BL between Base RP, RP 1 and RP2. Discussion The attenuation in running performance at maximum effort (i.e. TTE) over 2 consecutive days indicates that cumulative effects of fatigue may be induced as a result of performing one ST session. Such findings may be due to impaired muscular contractility as the knee extensor muscles did not recovery to baseline (i.e. MVC prior to the ST session). The comparable CR between Base RP, RP 1 and 2 shows that strength training does not cause cumulative effects on running performance at sub-maximal levels. Subsequently, caution should be taken when generating training programs that consists of strength and endurance training sessions. References Palmer CD, Sleivert GG. (2001). *J Sci Med Sport*, 4, 447-459.

### SEEKING EQUIVALENCE OF THE ACUTE RESPONSES TO CONTINUOUS AND INTERVAL AEROBIC EXERCISE

Hughes, M.G., Birdsey, L.

*Cardiff Metropolitan University*

**Introduction** A diverse range of training protocols has previously been used to address the issue of how interval training adaptations differ to those obtained from continuous exercise. However, a weakness of these studies is that training duration, mean relative exercise intensity or both of these factors are not fixed at the same values during training. For this reason, it is difficult to be conclusive about the relative merits of these training types. In the present study we sought to identify which variation of a standard interval training protocol would elicit equivalent acute responses to a bout of continuous exercise using sessions of the same training duration. **Methods** Nine healthy, active participants (mean  $\text{VO}_2\text{peak}$  44.5ml/kg/min) performed a maximal test, followed by four 42-min cycle ergometry bouts of either continuous (70 % $\text{VO}_2\text{peak}$ ), or interval exercise. The three interval exercise sessions were variations of the methods used by Helgerud et al. (2007) and comprised six repetitions of 4min all at 85 % $\text{VO}_2\text{peak}$ , interspersed by 3 min of relative recovery at either low, medium or high intensities (45, 60 and 75% of  $\text{VO}_2\text{peak}$ ; i.e., LOW, MEDIUM, HIGH, respectively). Heart rate (HR), Oxygen consumption ( $\text{VO}_2$ ) and blood lactate concentration (BLa) were assessed through the four bouts. **Results** The relative exercise intensities were different between sessions. Specifically, mean BLa was higher in all interval sessions and % $\text{VO}_2\text{peak}$  was lower in the continuous and LOW conditions than in the MEDIUM and HIGH conditions ( $74 \pm 3$  and  $70 \pm 4$  % $\text{VO}_2\text{peak}$  vs.  $77 \pm 4$  and  $83 \pm 4$  % $\text{VO}_2\text{peak}$ , respectively). It was calculated that an interval-recovery intensity of 52 % $\text{VO}_2\text{peak}$  for both the mean  $\text{VO}_2$  and HR data would elicit the same mean response as continuous work at 70 % $\text{VO}_2\text{peak}$ . However, inspection of individual data showed a high variability of results, such that a recovery intensity of between 42 and 66 % $\text{VO}_2\text{peak}$  would elicit the same  $\text{VO}_2$  as the continuous bout in different individuals. The equivalent range for matching the HR responses was between 35 to 61 % $\text{VO}_2\text{peak}$ . **Discussion** For the group mean data, adopting the interval training procedures used in the present study with a recovery intensity of around 52 % $\text{VO}_2\text{peak}$  should elicit equivalent mean  $\text{VO}_2$  and HR responses to continuous exercise at 70 % $\text{VO}_2\text{peak}$ . These findings may be useful for future studies where the physiological benefits of continuous vs. interval exercise are to be compared using matched duration and relative intensity. However, the extent of variation observed in the present study suggests that the individual responses to the contrasting exercise types should be considered if the acute physiological stresses in training are to be controlled for. Reference Helgerud J, Hoydal K, Wang E, Karlsen T, Berg P, Bjerkaas M et al. *Med Sci Sports Exerc*, 39(4) 665-671.

### CHANGE IN UNDERGRADUATES' SELF-ASSESSED KNOWLEDGE AFTER LACTATE INQUIRY-BASED LEARNING EXPERIENCE

Gabel, K.A.

*Montana State University Billings*

**CHANGE IN UNDERGRADUATES' SELF-ASSESSED KNOWLEDGE AFTER LACTATE INQUIRY-BASED LEARNING EXPERIENCE** Gabel, K.A., Montana State University Billings, USA **Introduction** In the influential BIO 2010 report (NRC-NAS, 2003), recommendations highlighted the need for science students to be taught to think independently, answer realistic scientific questions and work cooperatively in groups. Therefore, the aim of this project was to evaluate changes in self-assessed knowledge within an inquiry-based learning experience designed for teams of Health and Human Performance (HHP) undergraduate students. **Methods** Students ( $n = 30$ ) enrolled in a junior-senior level Exercise Physiology course worked in teams to pilot-test relationships among blood lactate and glucose levels, heart rate, and ratings of perceived exertion during an incremental submaximal cycling exercise. Questionnaires were given to students before and after the experience to evaluate changes in lactate knowledge, previous research experience, major in school, and level of interest in HHP research. Students self-assessed knowledge on a 6 point scale from 1 representing No knowledge to 6 being Very high knowledge. Statistical analyses were completed using SPSS (Version 18), i.e. descriptive and nonparametric tests (Wilcoxon). **Results** Changes occurred in all self-assessed knowledge areas: concept of lactate (Pre Mdn=3.5, Post Mdn=5.0,  $z = -4.4$ ,  $r = -.56$ ), lactate metabolism (Pre Mdn=3.0, Post

Mdn=5.5,  $z=-4.7$ ,  $r=-.61$ ), lactate research (Pre Mdn= 3.0, Post Mdn=5.0,  $z=-4.7$ ,  $r=-.60$ ), hematological research methods (Pre Mdn=3.0, Post Mdn=5.0,  $z=-4.5$ ,  $r=-.57$ ), and research methods related to exercise (Pre Mdn=3.0, Post Mdn=5.0,  $z=-4.3$ ,  $r=-.56$ ),  $p<.05$ . Overall, self-assessed ratings of knowledge changed from Low (rating of 3.0) to High (rating of 5.0). Interest in HHP research remained at the Moderate level (Pre Mdn=4.0, Post Mdn=4.0,  $z=.151$ ,  $r=.02$ ). Discussion Exercise physiology undergraduate students are known to have misconceptions about lactate (Morton, et al, 2008). In the present study, lactate knowledge increased two levels (from low to high) after the inquiry-based learning experience. This type of teaching model can enable exercise physiology instructors to stimulate undergraduate students' cognitive development of exercise physiology concepts (Kolkhorst, et al. 2001). Integration of research into teaching may also enable instructors to try new research ideas (Robertson, 2007). This project provides groundwork for a series of lactate-glucose research questions to be answered by future exercise physiology students. References Kolkhorst F, Mason C, DiPasquale D, Patterson P, Buono M. (2001). *Adv Physiol Educ*, 25, 45-50. Morton J, Doran D, MacLaren D. (2008). *Adv Physiol Educ*, 32,142-146. National Research Council-National Academy of Science (2003). *BIO2010: Transforming Undergraduate Education for Future Research Biologists*, Washington, DC, p 75. Robertson J. (2007). *Stud High Educ*, 32, 541-556.

**14:45 - 15:45**

## Poster presentations

### PP-PM24 Training & Testing 5

#### STUDY OF REPRODUCIBILITY AND VALIDITY OF THE METHOD TO MEASURE BRIDGING FORCE BY USING A SCALE

Madokoro, K., Takei, K., Murata, S., Ihara, T., Kai, Y.

*Technical School of Medical and Welfare Ryokuseikan*

Study of reproducibility and validity of the method to measure bridging force by using a scale Madokoro,K.1,Takei,K.1,Murata,S.2,Ihara,T.3,Kai,Y.1 1: Technical School of Medical and Welfare Ryokuseikan(Saga,Japan),2:Faculty of Rehabilitation Science,Nishikyusyu University,3:Department of Rehabilitation,Hiramathu Hospital Introduction It is important to evaluate physical functions of elderly people from the viewpoint of fall prevention as well as to prevent them from being bedridden. Clinical usefulness of 30-sec chair-stand test (CS-30), etc. has been reported in the past as a simple method to measure the lower extremity muscle strength of elderly people. However, it is often difficult to use these tests on frail elderly people, considering physical burdens. In this study, therefore, we designed a quantitative evaluation of lower extremity functions of elderly people who have difficulty in standing by measuring their strength to push the floor with the bottom of their feet at the time of making the bridging motion (bridging force) and investigated the reproducibility and validity. Subjects and method The subjects were 19 community-dwelling frail elderly females (average age:  $84.7 \pm 6.4$  years old; average weight:  $49.9 \pm 7.5$ kg). In addition to bridging force, functional reach test (FRT), CS-30 and timed up and go test (TUG) were also conducted for measurement. To measure bridging force, the bridging motion was taken in the supine position, a scale set up on the bottom of the feet was pushed to the floor with maximum effort, and the bending position of the hip joint and the intermediate position of the ankle joint were maintained during measurement. Measurements were taken twice, and the average was adopted as the representative value. For statistical processing, the intraclass correlation coefficient (ICC) was obtained for reproducibility and Pearson's coefficient was obtained for validity for review purposes. The level of significance less than 5% was determined as significantly different. Results ICC in the measurement of bridging force was 0.964 (95% CI: 0.925-0.983). Significant correlation with bridging force was observed in FRT ( $r=0.486$ ,  $p<0.05$ ) only. No significant correlation was observed between other measurement values and bridging force. Discussion Based on the results of the study, extremely high reproducibility (ICC=0.964) was recognized in the measurement of bridging force. The possibility to safely and simply predict physical functions of elderly people with difficulty in standing or walking was also indicated as we recognized a significant correlation with FRT which is considered as the index of physical functions.

#### EFFECTS OF INTRA-SESSION EXERCISE ORDER IN THE NEUROMUSCULAR ADAPTATIONS TO CONCURRENT TRAINING IN THE ELDERLY

Cadore, E.L., Izquierdo, M., Pinto, S.S., Conceicao, M., Alberton, C.L., Pinto, R.S., Baroni, B., Vaz, M.A., Lanferdini, F., Radaelli, R., González-Izal, M., Bottaro, M., Trindade, G., Krueel, L.F.

*Federal University of Rio Grande do Sul*

Background A limited number of studies have explored the neuromuscular adaptations related to concurrent strength and cardiovascular intervention in elderly populations and there are no data regarding the effect of exercise order manipulation during concurrent training on the neuromuscular adaptations in elderly subjects. Objective The aim of this study was investigate the effects of different intra-session exercise orders in the neuromuscular adaptations induced by concurrent training in elderly. Methods Twenty-six healthy elderly men ( $64.7 \pm 4.1$  years), were placed into two concurrent training groups: strength prior to (SE,  $n=13$ ) or after (ES,  $n=13$ ) endurance training. Subjects trained strength and endurance training during 12 weeks, three times per week performing both exercise types in the same training session. Upper and lower body one maximum repetition test (1RM) were evaluated as strength parameters. Upper and lower body muscle thickness (MT) were determined by ultrasonography. Lower-body maximal surface electromyographic activity of vastus lateralis and rectus femoris muscles [maximal electromyographic (EMG) amplitude] were determined during a maximal voluntary contraction. Results Both SE and ES groups increased the upper and lower-body 1RM, but the lower-body 1RM increases observed in the SE was significant higher than ES ( $35.1 \pm 12.8$  vs.  $21.9 \pm 10.6\%$ , respectively,  $P<0.01$ ). Both SE and ES showed MT increases in all muscles evaluated, with no differences between groups. In addition, there were significant increases in the maximal EMG in the muscles evaluated in both SE and ES. Discussion The intra-session exercise sequence had an influence on strength adaptations, as observed in the greater strength increases when strength training was performed prior to endurance training. Nevertheless, in the elderly, it is important to point out that the intra-session concurrent exercise sequence had no influence on muscle hypertrophy. From a practical point of view, to optimize the strength gains in the elderly, the concurrent training prescription should include an intra-session exercise order of strength training prior to endurance training.

## EFFECTS OF COMBINED STRENGTH AND POWER TRAINING ON LOWER EXTREMITY MUSCLE FUNCTION IN YOUNGER AND OLDER MIDDLE-AGED MALES

Nakatani, T., Terada, K., Nadamoto, M., Murakami, K., Shiraishi, A.

*Dept. Health and Human Performance*

**Introduction** Regular exercise has many positive health benefits and can prevent age-related loss of skeletal muscle mass and muscular function. Muscle strength decreases with advancing age and there is a steep decline after the age of 50 years (Murray et al., 1980; Hakkinen and Hakkinen, 1991). Few studies have examined the effects of combined strength and power training on middle-aged adults. The purpose of the study was to compare lower extremity muscle function adaptations in younger and older middle-aged males in response to a 12-week combined strength and power training program. **Methods** Twenty-six healthy males (aged 40–68 yrs) were divided into a younger middle-aged (YM) group ( $41 \pm 1.5$  yrs,  $n = 8$ ) and an older middle-aged (OM) group ( $54.7 \pm 6.9$  yrs,  $n = 18$ ). Training was performed once every 2 weeks at each subject's work place and 2-3 times/week at home for 12 weeks. The program included lower limb resistance training as well as plyometric, agility, and muscular endurance exercises. The training intensity was individualized and based on active muscle rating of perceived exertion during multiple sets. The outcome measures, determined pre- and post-training, were vertical jump (VJ) height, rebound jump (RJ) index (jumping height/contact time), anaerobic power during maximum bicycle pedalling (AP), 30-second chair-stand (CS-30), and 2-minute step. **Results** After 12 weeks of training, the RJ Index was significantly different between the YM and OM groups. The RJ index decreased by 14.2% in the YM group but increased by 14.3% ( $P < 0.05$ ) in the OM group. VJ height and power increased significantly by 18.5% and 7.2% ( $P < 0.05$ ) in YM and 20.2% and 9.1% ( $P < 0.05$ ) in OM. The CS-30 increased by 21.5% ( $P < 0.05$ ) in YM and 11.7% ( $P < 0.05$ ) in OM. There were no differences in the mean and maximum AP outputs and the 2-minute step for either group. **Discussion** The main finding of this study was that a 12-week combined strength and power training program was effective in improving the rebound jump performance of OM males. The results suggest that combined strength and power training may have limited effects on lower extremity muscle function in older middle-aged men. **References** Hakkinen K and Hakkinen A (1991). Muscle cross-sectional area, force production and relaxation characteristics in women at different ages. *Eur J Appl Physiol*, 62, 410-414. Murray M. et al. (1980). Strength of isometric and isokinetic contractions: knee muscles of men aged 20-86. *Phys Ther*, 60, 412-419.

## COMPARISON OF VENTILATORY AND METABOLIC RESPONSES FIXED BY THE TOLERANCE TIME IN FOUR INTENSITIES ON RESISTANCE EXERCISE BETWEEN YOUNG AND ELDERLY.

Arakelian, V.M.1, Sousa, N.M.F.1, Ferraresi, C.2, Rodrigues, M.F.C.2, Togashi, G.B.1, Gatto, C.D.V.G.1, Perez, S.E.A.2, Baldisera, V.1,2, Borghi-Silva, A.1,2

*1Universidade de São Paulo, – Interunidades em Bioengenharia (EESC/IQSC/FMRP), Brazil, 2Federal University of São Carlos, Brazil.*

**Introduction:** The resistance training has been strongly encouraged, providing favorable effects (Taylor, Dodd et al. 2005); however, little is known about adjustments in the in this type of exercise in different intensities (Kraemer et al. 2002), as well as, the safety for aging people (Visser et al. 2005). So, the aims of the study were to evaluate and compare the ventilatory and metabolic changes during resistance exercise in Leg Press 45°(LP) at different intensities between young and elderly. **Methods:** Two groups were evaluated: 1)- 15 young subjects, (age:  $23 \pm 2.5$  years) and 2)- 13 elderly subjects (age:  $69 \pm 4$  years). All volunteers performed one test for determining the maximum load (1RM) in exercise of LP, and four tests at different intensities of 1RM - 30%, 60%, 75% and 90%. For all intensities the subjects performed flexion and knee extension for 3 seconds on each repetition of movement. The exercise was continued until the time limit of tolerance (Tlim). During the exercises, ventilation (VE), oxygen consumption (VO2) and blood samples for blood lactate determination [La] were collected. Two-way ANOVA were used to test the interaction effect for: VE, VO2 and [La], with Tukey post hoc test, for all comparisons between the groups in each intensity ( $p < 0.05$ ). **Results:** Comparing VE and VO2, we observed significant differences between the rest and exercise in both groups ( $p < 0.0001$ ) for all intensities. Values of VE (group 1:  $45.3 \pm 1.3$  l/min at 30%;  $40.9 \pm 2.7$  l/min at 60%;  $38.7 \pm 5$  l/min at 75% and  $24.9 \pm 3.6$  l/min at 90% - group 2:  $35.7 \pm 1.2$  l/min at 30%;  $31.8 \pm 1.8$  l/min at 60%;  $26.2 \pm 4.2$  l/min at 75% and  $21.9 \pm 2.1$  l/min at 90%) were significant higher for the younger group in all intensities ( $p < 0.05$ ), the values of VO2 were significant higher for de group 1 at 30% (group 1:  $1.7 \pm 0.05$  l/min and group 2:  $1.30 \pm 0.06$  l/min) and 60% (group 1:  $1.51 \pm 0.11$  l/min and group 2:  $1.05 \pm 0.10$ ) ( $p < 0.05$ ). The [La] was a significant increase in post-exercise comparing pre exercise ( $p < 0.0001$ ). Comparing each intensity between young and older subjects, significant differences were found, with a greater accumulation of lactate in the young group for all intensities ( $p < 0.05$ ). **Discussion:** Significant differences were reported with respect to the ventilatory and metabolic parameters in the intensity of exercise performed, and that aging was shown to be crucial for a reduction in the relative values of aerobic capacity and pulmonary function (Fleg & Lakatta, 1988; Fleg et al. 1995; Evans et al. 1992). These results can provide objective evidence of ventilatory and metabolic responses to programs aimed at implementing strength training or muscle endurance-based understanding of such physiological adjustments to resistance exercise. **References:** Taylor, et al. (2005) *Phys Ther* 85(11): 1208-1223. Kraemer, et al. (2002) *Med Sci Sports Exerc* 34(2): 364-380. Fleg, et al. (1988) *J Appl Physiol* 65(3): 1147-1151. Fleg, et al. (1995) *J Appl Physiol* 78(3): 890-900. Visser, et al. (2005) *J Ger. A Biol Sci Med Sci* 60(3): 324-33. Evans, et al. (1992) *Can J Aging* 11: 412-25.

## RELATIVE AGE EFFECT IN OLYMPIC SPORTS – A COMPARISON OF BEIJING 2008 AND SINGAPORE 2010

Hoffmann, A., Wulff, J., Büsch, D., Sandner, H.

*Institute for Applied Training Science*

**Introduction** The Relative Age Effect (RAE) refers to a biased distribution of birth-dates within an age-grouped cohort. During the last three decades, RAE has been widely studied in sport science. Results vary depending on sports, age-group, sex, and level of performance (Delorme, Boiché & Raspaud, 2010; Williams, 2010). Most of the studies were conducted in game sports and specific samples (e. g. professional leagues). To draw consequences for strategies of talent identification and talent development, a closely examination of RAE among participants of most important international competitions is needed. This study investigates the existence of RAE in Olympic Games 2008 (OG) and Youth Olympic Games 2010 (YOG). **Method** Birth-dates of 4983 participants of the OG in Beijing (2782 male) and 3508 participants of the YOG in Singapore (1826 male) were classified in quartiles. Chi-square analyses, differentiated by sex, sports and success, were used to determine if the frequency distributions were statistically different from expected equal distribution. **Results** For the sample of YOG, an RAE emerged both for male and female, whereas in OG, only for male an over-representation of relative younger athletes could be shown. RAE exists in YOG for male in more sports and with larger effect sizes than for female. In OG, in contrast to male, for none of the female subsamples an asymmetry in birth-date distributions could be demonstrated. Only for male and in sports determined dominantly by speed and endurance, RAE could be proven both in YOG and OG. There was no difference in distribution of

birth-dates for successful and less successful athletes. When RAE occurs, effect sizes are small to medium ( $0,14 < w < 0,34$ ). Discussion Results and possible implications are discussed against the background of the state of the art. Present data corroborate former studies suggesting a nuanced consideration of RAE. Until now, most studies confine on the examination of the prevalence of RAE. To enlighten the causes of RAE and the relevance in long term athlete development, longitudinal tracking of asymmetries in birth-date distributions within an age-grouped cohort is needed. Furthermore, there is a demand of incorporating biological age. References Delorme, N., Boiché, J., & Raspaud, M. (2010). Relative Age Effect in Elite Sports: Methodological Bias or Real Discrimination? *European Journal of Sport Science*, 10(2), 91-96. Williams, J. (2010). Relative age effect in youth soccer: analysis of the FIFA U17 World Cup competition. *Scandinavian Journal of Medicine & Science in Sports*, 20, 502-508.

### **VOLUNTARY MUSCLE FORCE INCREASED AFTER A 12-WEEK STRENGTH TRAINING WITH PULSED MAGNETIC FIELDS IN HEALTHY OLDER PEOPLE**

Creuznacher, U., Schulz, A., Köhling, R., Zschorlich, V.

*University of Rostock*

**Introduction** Keeping an active and independent life is a common interest of older people. Many health care programs aimed at saving and restoring physiological fitness, i.e. muscular strength. Compared to electrical stimulation pulsed magnetic fields elicit muscle contractions more painlessly, even at higher frequencies and intensities. Therefore peripheral applied magnetic stimulation could play a prospective role in strength training programs, especially in case of preventing age-related muscle atrophy. **Methods** Seven healthy subjects ( $72,6 \pm 5,8$  yrs;  $164,4 \pm 6,2$  cm;  $72,3 \pm 11,9$  kg) took part in a 12 week strength training program of the quadriceps femoris muscle. The unilateral stimulation training of the non-dominant leg was performed on two days per week. Each training session consisted of three sets of 30 magnetically induced muscle contractions (frequency: 50 Hz; duration: 500 ms, pulse width: 280  $\mu$ s, inter-pulse interval: 3 s) and a resting phase of three minutes between each set. The stimulation intensity was set to 50 % of the torque during maximal voluntary contraction. The elliptic magnetic coil RT 120-II (MagVenture, Denmark) was placed directly over the thigh. **Results** The maximal isometric voluntary torque (PTmax) was used for the determination of the training effect. In addition, the contralateral leg served as control. A two-sided paired t-test revealed a significant increase of PTmax of the trained leg from  $130,2 \pm 31,2$  Nm to  $166,8 \pm 39,9$  Nm ( $28,4 \pm 11,1$  %;  $p \leq .0006$ ). The contralateral leg showed a small increase which was not significant (pre:  $145,4 \pm 27,9$  Nm; post:  $149,9 \pm 27,3$  Nm;  $p \leq .1329$ ). **Discussion** The results suggest that peripheral applied pulsed magnetic fields are capable to mediate an enhancement of maximal voluntary torque in the elderly. Despite the fact that only a few studies focussed on strength training with electrical currents, no other studies examined the effect of pulsed magnetic fields on muscle strength in older people. Caggiano et al. (1994) observed a small increase of PTmax ( $8,5 \pm 10,3$  %) of the knee extensors in  $72 \pm 4$  years old males after a 4 week electrical stimulation training (EST) at a low intensity level of 36 % of individuals' maximal voluntary torque. In a recent study, Maggioni et al. (2010) examined a more obvious improve in maximal voluntary quadriceps strength of  $25,8 \pm 11,3$  % during a 6 week EST of hospitalized females of  $84,1 \pm 3,4$  years. References Caggiano, E., Emrey, T., Shirley, S., Craik, R.L. (1994). *J Orthop Sports Phys Ther*, 20, 1, 22-28. Maggioni, M.A., Cè, E., Rampichini, S., Ferrario, M., Giordano, G., Veicsteinas, A., Merati, G., (2012) *Arch Gerontol Geriatr*, 50, 3, e19-e25.

### **EVALUATION OF THE REPEATABILITY AND VALIDITY OF MEASURING THE ABDUCTION-IN-FLEXION MUSCLE STRENGTH OF THE HIP JOINT IN ELDERLY FEMALE COMMUNITY RESIDENTS**

NORIHISA, M., SHIN, M., KOJI, N., KAZUMI, F.

*Takeo Nursing and Rehabilitation School*

**Objective:** The extension muscle strength of the knee joint as measured by Hand-Held Dynamometer (HHD) is often used as a value representing the lower extremity muscle strength. However, the measurement of the extension muscle strength of the knee is difficult when subjects have knee-joint diseases, or the posture in a sitting position is unstable. With this background, we invented a method to measure the abduction-in-flexion muscle strength of the hip joint to straightforwardly evaluate the lower extremity muscle strength, and examined its repeatability and validity. **Methods:** The subjects consisted of 33 elderly female community residents. The abduction-in-flexion muscle strength of the hip joint was measured in a supine position, with the hip and knee joints bent to 45- and 90-degree positions, respectively, and with the plantae being placed on the examination table. Two sensor pads of the HHD were placed outside the knees, fixed with belts, and the maximum isometric muscle strength was measured while abduction in flexion was performed. The extension muscle strength of the knee joint, one-leg standing time, and TUG were also measured. Each measurement was conducted twice, and the better value was regarded as representative. The repeatability of the abduction-in-flexion muscle strength of the hip joint was evaluated based on the ICC of each measurement. As for the validity of the abduction-in-flexion muscle strength of the hip joint, we performed correlation analysis between the measurements to evaluate the criterion-related validity. **Results:** As a result of evaluating the repeatability of the abduction-in-flexion muscle strength of the hip joint, the ICC was 0.851. The abduction-in-flexion muscle strength of the hip joint showed a significant correlation with the extension muscle strength of the knee joint ( $r=0.513$ ), one-leg standing time ( $r=0.399$ ), and TUG ( $r=-0.384$ ). **Conclusion:** The method to evaluate the abduction-in-flexion muscle strength of the hip joint showed marked repeatability, and validity. However, the subjects in this study consisted of healthy elderly citizens who were living independently in the community. It is now necessary to conduct an investigation involving elderly citizens dependent on care and those with physical disabilities, and determine whether or not the abduction-in-flexion muscle strength of the hip joint is an appropriate index of the lower extremity muscle strength.

### **A STRENGTH, MOVEMENT CONTROL AND BALANCE TRAINING PROGRAM TO PREVENT FALLING FOR OLD ADULTS AGES '61-65' YEARS**

Elnemr, A.1, Elkhateb, N.2, Elnemr, O.3

*Faculty of physical education / Helwan University 1: FPEM (Giza, Egypt), 2: FPEG (Giza, Egypt), 3: HU (Cairo, Egypt)*

**Introduction** Millions of older adults experience an injury due to falling, falls can result in hip fractures, head injuries or even death. Researchers have identified that among the most effective fall prevention programs is a specific physical activity which can target reduce fall risk by increasing balance, gait and total body strength. **Methods** Ten older men ages 61- 65 years participated in the study. Tests for determination lower and upper body 1 RM strength (leg press, chest press, abdominals and seated row) and balance (Tester stands with tandem and single leg stance with eyes open for 10 seconds then closed for 10 seconds in each position on the Posturomed with one brake released) were undertaken before and after 12 weeks of training. Participants learn eight body-movement exercises (with and

without Posturomed) during 1-hour classes and participated in a high-intensity strength training program (three sets of ten repetitions at 80% of 1 RM, 3d / wk for 12 wk). Results Strength variables increased with percentages between 42% - 47% and balance variables increased with percentages between 56% - 74%. Discussion Both strength variables and balance variables increased as a result of the training program, the results of the present study seem to correspond to what happens in experimental situations in the older adults submersed (Frontera et al., 1988 and Fuzhong et al., 2005). High-intensity strength training (80% of 1 RM for 12 weeks is safe for this population and produced significant increases in strength. The increase in strength was associated with an increase in balance. Using the Posturomed (a neuro-orthopaedic therapeutic device) is safe and enjoyable for this population and produced significant increases in balance. References Frontera, M.A. et al.; Meredith, C.N.; O'Reilly, K.P.; Knuttgen, H.G.; and Evans, W.J. 1988. Strength conditioning in older men: Skeletal muscle hypertrophy and improved function. *Journal of Applied physiology* 64:1038-44. CDC. Fatalities and injuries from falls among older adults---United States, 1993--2003 and 2001--2005. *MMWR* 2006;55:1222--4. Fuzhong L, Harmer P, Fisher KJ, McAuley E, Chaumeton N, Eckstrom E. Tai Chi and fall reductions in older adults: a randomized controlled trial. *J Gerontol* 2005; 60A:187--94.

### COMPARISON OF HOME AND LAB TESTING IN OLDER PEOPLE WITH AND WITHOUT KNEE OSTEOARTHRITIS.

van Leeuwen, D.M.1,2, de Ruiter, C.J.1, Lips, P.T.A.3, Deeg, D.J.H.3, de Haan, A.1,2

*Research Institute MOVE, VU University Amsterdam*

Comparison of home and lab testing in older people with and without knee osteoarthritis. D.M. van Leeuwen 1,2, C.J. de Ruiter 1, P.T.A. Lips 3, D.J.H. Deeg 3, A. de Haan 1,2 1 Research Institute MOVE, VU University Amsterdam, The Netherlands 2 Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University, Manchester, UK 3 EMGO+ Institute, VU University medical center, Amsterdam, The Netherlands INTRODUCTION: Knee osteoarthritis (OA) is characterized by pain, loss of strength and limitations with activities such as walking and stair climbing. A battery of tests, such as the short physical performance battery, could assess function over a wide area, and is easy to administer in a home setting with limited space and time with elderly participants. However, more elaborate lab tests may be more sensitive to detect impairments. The aim of the present study is to investigate differences between lab tests and a performance battery that can be applied in a home setting, between subjects with and without knee OA, and how various performance tests are related. METHODS: From 64 participants (33 men, 31 women), aged  $70 \pm 5$  years, with or without radiographic knee OA (Kellgren and Lawrence grade 2-4 vs. 0-1) physical functioning was assessed with a 6-minute walk test (6MWT), a stair climb test (SCT) and measurement of maximal isometric knee extensor strength. These tests were compared with a battery of 3 tests consisting of a repeated chair stand test, a short (6m) walk test, and a balance test, which were summed to an overall performance score (range 0-12). Health-related quality of life was assessed with the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). RESULTS: Overall physical performance was significantly lower in participants with OA (10 [8-11] vs. 8 [7-10],  $P < 0.05$ ), predominantly caused by a slower short walk test ( $5.4 \pm 0.9$  s vs.  $5.1 \pm 0.8$  s,  $P < 0.05$ ). In contrast to our expectations, no differences between participants with and without OA were observed in maximal strength, chair stand, 6MWT, SCT and WOMAC score. This may be explained by our finding that participants with OA had relatively high performance levels and very low impairments as shown by their values for 6MWT ( $546 \pm 82$  m), maximal strength ( $\sim 150$  Nm) and WOMAC (99 [93-100]). All lab tests (SCT, 6MWT and maximal strength) were significantly related to overall performance ( $|\rho|$  between 0.43 and 0.39,  $N=64$ ). The relationships between 6MWT, SCT, maximal strength and the short walk test were strong ( $\rho$  respectively -0.69, 0.76 and -0.52,  $P < 0.001$ ), but the relationships with balance and chair stand were low ( $|\rho|$  between 0.07 and 0.36). CONCLUSION: A short physical performance battery applicable in a home setting had reasonable relationships with physical performance tests in a lab setting. This suggests that home tests are a good alternative if time and space are limited, especially for less fit elderly having trouble to visit a lab.

### STRUCTURE AND FORCE GENERATION CAPACITY ON KNEE EXTENSION AND FLEXION MUSCLES IN AMATEUR JUNIOR WRESTLERS.

Hiratsuka, K.1, Ihara, Y.1, Teshima, T.1, Tanaka, S.1, Kumagawa, D.2, Tsunoda, N.1

*1:Kokushikan University, Japan. 2:Japan institute of Sports Science, Japan.*

Introduction Structural and functional characteristics of the skeletal muscle are directly affect to the athletic performance in amateur wrestlers. It is cleared that the characteristics of muscle structure and force generation capacity due to body size are important to planning for the training program. Therefore, the purpose of this study was to investigate characteristics of the muscle structure and function with body weight class in Japanese amateur junior wrestlers. Methods The subjects were 29 Japanese amateur junior wrestlers aged from 16 to 17 years old. These subjects were classified light body weight (<64kg: LG), middle body weight (65-75kg: MG) and heavy body weight (76kg<: HG). The whole and lower limb muscle volumes were measured by the body impedance analysis methods. Moreover, the relative value of lower limb muscle volume to the whole muscle volume was calculated in all the subjects. Isokinetic peak torques on knee extension and flexion as a muscle functional parameters were measured using isokinetic dynamometer (Biodex System 3). And also, isokinetic knee extension and flexion torques measurement with 30 repetitive maximal contractions as a muscle endurance index was measured in all the subjects. Results Significant differences of whole and lower limb muscle volume were obtained among the three groups. In HG, relative lower limb muscle volume to the whole muscle volume was significantly higher than that of LG and MG. The knee extension and flexion peak torques to the body weight in MG were showed highest value compared to the other groups. Significant difference of decrease ratio on knee extension with 30 repetitive maximal contractions was not observed among the three groups. However, significant group difference was observed in knee flexion contractions. Discussion The relative lower limb muscle volume to the whole muscle volume in HG showed higher than that of MG and LG. Muscle force generation capacities related to the peak torque of knee flexion in MG was significantly decreased compared to the other groups. From the results in this study, it seems that the states of the muscle size and function in amateur junior wrestlers are important factor for the planning of the fitness training program. References Cisar, C. J. et al. (1987). *J. Appl. Sports Sci.*, 1, 66-70. Knehisa, H. et al. (1999). *Eur. J. Appl. Physiol.*, 79, 5, 414-420. Kanehisa, H. et al. (1997). *J. Sports Med.*, 19, 265-271.

14:45 - 15:45

## Poster presentations

## PP-PM25 Health &amp; Fitness: Elderly

**EFFECTS OF LOW-INTENSITY AEROBIC DANCE ON PHYSICAL FITNESS AND BODY COMPOSITION IN HEALTHY OLDER ADULTS**

Shimura, Y.1, Tanaka, K.2

*1: Osaka International University (Osaka, Japan), 2: University of Tsukuba (Ibaraki, Japan)*

Introduction: Older adults generally have reduced muscle mass, less muscle strength, less endurance, balance, and aerobic power than young adults. Numerous studies have found that exercise including resistance training, aerobic exercise and balance training might offer many significant physical benefits for older adults. Aerobic dance could be also an effective exercise to improve their aerobic power, lower muscle strength and endurance, flexibility, balance, and agility (Keogh et al., 2009). However there are few reports about the physical and mental benefits associated with aerobic dance for older adults. The purpose of this study was to investigate the intervention effects of low-intensity aerobic dance on physical fitness and body composition in healthy older adults. Methods: Participants were seventeen healthy older adults aged 62-81 years. Ten participants (Aerobic dance group: age  $72.2 \pm 5.1$  years) performed low-intensity aerobic dance program for 90 min, 1 day a week, for 16 weeks. Seven participants (Walking group: age  $67.1 \pm 3.4$  years) completed a walking program for 90 min, 1 day a week, for 16 weeks. Additionally, we advised them to perform their respective training programs in their daily life. Physical fitness (hand-grip strength, 10-m walking, timed up & go, 8-foot up & go, functional reach, single limb stance with eyes open, single limb stance with eyes closed, sit & reach, 30-sec chair stand, 30-sec arm curl, and stand-up from lying position) and muscle mass in forearms, upper arms, lower legs, thighs and trunk were measured 2 times (first day session, 4 months after the initial session) of all participants. Results: The baseline characteristics of the aerobic dance group were very similar to those of the walking group. Regarding physical fitness, the aerobic dance group had significant improvement in the 8-foot up & go (Pre:  $23.7 \pm 4.3$  sec, Post:  $19.7 \pm 2.5$  sec,  $P < 0.05$ ), timed up & go (Pre:  $6.1 \pm 1.4$  sec, Post:  $5.1 \pm 0.6$  sec,  $P < 0.05$ ), and 30-sec chair stand (Pre:  $21.3 \pm 6.1$  times, Post:  $26.8 \pm 7.1$  times,  $P < 0.05$ ). In contrast, the walking group had significant improvement only in the 8-foot up & go (Pre:  $23.4 \pm 2.9$  sec, Post:  $21.3 \pm 3.1$  sec,  $P < 0.05$ ). There were no significant changes in the muscle mass of all regions in both groups. Discussion: This study suggests that low-intensity aerobic dance has some beneficial effects to improve the mobility including lower muscle strength and endurance, agility and dynamic balance in healthy older adults. References: Keogh JW, Kilding A, Pidgeon P, Ashley L, Gillis D. (2009) *J Aging Phys Act.* 17(4), 479-500.

**ASSOCIATION BETWEEN MENTAL HEALTH AND PHYSICAL FITNESS IN JAPANESE MIDDLE-AGE AND OLDER ADULTS**

Takahashi, S., Suzuki, K., Masuko, T.

*Tohoku Gakuin University*

PURPOSE Physical activity programme improves mental health and physical fitness. Higher physical fitness level has been shown to be associated with higher levels of mental health in the older populations. We investigated the association between mental health and physical fitness in Japanese middle-age and elderly individuals using longitudinal data. METHODS Thirty-five women ( $58.5 \pm 8.1$  years) and ten men ( $64.9 \pm 5.7$  years) participated in a 12-week physical activity programme. The programme consisted of 12 training sessions; contents of the session were 20-min of warm-up, 20-min of walking, 40-min of resistance training with an elastic band and a balance ball, and 10-min cool-down. The frequency of training was once a week. Before and after the programme, mental health and physical fitness of the participants were measured. The mental health was measured using WHOQOL-BREF that is constructed by 4 domains (Physical, Psychological, Social, and Environmental QOL). Physical fitness was measured by grip strength, sit-ups, sit-and-reach, single-leg balance with eyes open, 10-m hurdle walk, and 6-min walk. The effect of the programme on mental health and physical fitness was tested by paired *t* test. Then, we analyzed the association between the change of mental health and the change of physical fitness using multi level modeling. RESULTS The results of paired *t* tests showed that 4 domains of mental health significantly improved after the programme ( $t(44) > 2.2$ ,  $p < 0.031$ ). All of physical fitness components also were significantly higher levels than the levels before training except sit-and-reach ( $t(44) = 1.9$ ,  $p = 0.061$ ). The multi level modeling revealed that there was no significant association between the changes of mental health domains and the changes of physical fitness components. CONCLUSIONS Physical activity programme can improve mental health and physical fitness level in middle and older Japanese adults, while the improvements of mental health and physical fitness are independent.

**THE MULTIDIMENSIONAL STRUCTURE OF THE GRONINGEN FRAILTY INDICATOR**

Bielderman, A.1, van der Schans, C.P.1, de Greef, M.H.G.1, Boersma, N.2, Krijnen, W.P.3, Steverink, N.4

*1: Hanze University of Applied Sciences Groningen, 2: University Medical Center Groningen, 3: Hanze University of Applied Sciences Groningen, 4: University Medical Center Groningen*

Introduction The Groningen Frailty Indicator (GFI) is a widely used self-report screening instrument to identify frail older adults. Frailty is suggested to be a dynamic and multidimensional construct. However, factor structure of the Groningen Frailty Indicator has not been examined yet. Aim of the study is to evaluate the factor structure and validity of the 15-item Groningen Frailty Indicator questionnaire. Methods Older adults aged 65 years and over ( $n=1401$ ) completed the GFI. A subsample of 120 older adults completed additional questionnaires (De Jong Gierveld Loneliness scale, Hospital Anxiety Depression Scale (HADS), RAND-36 physical functioning). Factor structure, internal consistency, construct validity and criterion-related validity of the scale were evaluated. Exploratory and confirmatory factor analyses were used to evaluate factor structure of the GFI. Results Factor structure of the GFI provided support for a three dimensional structure of the scale. The subscales Mobility, General health and Psychosocial functioning showed moderate to good internal consistency (respectively Cronbach's alpha's:  $\alpha=0.81$ , [95% CI=0.79-0.82];  $\alpha=0.60$ , [95% CI=0.56-0.63];  $\alpha=0.80$ , [95% CI=0.78-0.81]). Analyses of construct validity showed significantly higher GFI subscale scores in older age groups, female respondents and institutionalized living respondents than in respondents in younger age groups, male respondents and independently living respondents. Scores on the GFI

subscales correlated significantly with related scales: Mobility GFI with RAND36 physical functioning ( $r=0.61$ ); General health GFI with Rating of health ( $r=0.54$ ); Psychosocial functioning GFI with De Jong Gierveld scale ( $r=0.71$ ); Psychosocial functioning GFI with HADS ( $r=0.66$ ). Conclusion Present findings support a three dimensional factor structure of the Groningen Frailty Indicator. Three valid and reliable frailty subscales were established to identify frail older adults in different domains of functioning.

### ADHERENCE AND EFFECTS OF COGNITIVE-DEMAND PHYSICAL EXERCISE IN THE ELDERLY: A LONG-TERM OBSERVATIONAL STUDY

Shigematsu, R.1, Okura, T.2, Nakagaichi, M.3, Nakata, Y.4,5

1 Mie University, 2,4,5 University of Tsukuba, 3 Nagasaki University

**Introduction.** Exercises that encourage elderly persons to be physically active have been extensively developed. However, few have proved to exhibit method-effectiveness and use-effectiveness in a long-term setting. We recently developed square-stepping exercise (SSE), which demands cognitive and physical activity (Shigematsu et al., 2006 & 2008). SSE is similar to walking and can be easily performed indoors. Walking involves only forward-stepping movements, whereas SSE involves step movements in multiple directions. SSE is performed on a thin mat (100 × 250 cm) that is partitioned into 40 squares (each side = 25 cm). During the exercise, participants step on the mat and follow an instructor's demonstration. The process requires cognitive capacities: there are 200 stepping patterns, which the participants need to identify, based on the instructor's demonstrations, memorize, and mimic. Here, we assessed the effects of SSE in compliance and functional fitness among elderly persons in a long-term, observational setting. **Methods.** Sixty-three persons (SSE group,  $n = 32$ ; walking group,  $n = 31$ ) had participated in a 3-month intervention study. At the end of the intervention period, they were encouraged to continue the assigned exercise autonomously. We measured the adherence to the assigned exercise for a total of 4 years, and functional fitness after 1 and 4 years. The physical performance tests for functional fitness were adopted from our previous study and included the use of the following items: chair stands, stepping with both feet, grip strength, functional reach, walking around 2 cones, forward tandem walking, backward tandem walking, simple reaction time, and choice reaction time. Functional fitness at each point was compared with that at the 3-month intervention entry in terms of method-effectiveness (per-protocol based [PPB]) and use-effectiveness (intention-to-treat [ITT]). **Results.** At each time-point, 22 (69%) and 20 (63%) of the SSE group had continued the assigned exercise. These values were comparable to those of the walking group (65% and 65%). No adverse effects of SSE were reported. From the PPB and ITT analyses, we found that SSE was as effective—or more effective—than walking with regard to functional fitness. **Conclusions.** SSE is a good exercise choice that is highly recommended for the elderly on a long-term basis. **References.** Shigematsu R, Okura T. (2006) *Aging Clin Exp Res*, 18, 242-8. Shigematsu R, Okura T, Nakagaichi M, Tanaka K, Sakai T, Kitazumi S, Rantanen T. (2008) *J Gerontol A Biol Sci Med Sci*, 63, 76-82.

### EFFECTIVENESS OF TWO LOWER LIMBS EXERCISES ON IMPROVEMENTS OF LOCOMOTIVE SYNDROME FOR OLDER ADULTS

OHKI, K., KIMURA, Y., YAMAZAKI, S., HISATOMI, M., NAKAGAWA, N.

Showa Women's University

**PURPOSE** Some impediment to locomotive organs is due to enfeebled bone, joints and muscles with ageing, which led moving capacity such as walking down. Active older adults have good status of locomotive organs than inactive ones of the same age. In this study, we focus on older adults who cannot stand up off the 50 cm high chair, and examine improvements on locomotive syndrome by two exercises during the short-term intervention. **METHODS** Subjects: Thirty-seven urban men ( $n=22$ ) and women ( $n=15$ ) volunteered to participate in the study (age=69 yr, body mass index=27 kg/m). **Experimental design:** Participants completed two exercises, one-leg standing exercise with eyes open one minute for each leg three times a day, squat exercise with fifteen repetitions once a day, every day for 12-wk. **Measurements:** Before and after the training, following items were measured. 1) locomotion check (a questionnaire for seven items) , 2) one-leg standing time with eyes open, 3) 10m walk time, 4) standing upright time off the chair for ten reps consecutively, 5) emotionally, geriatric depression scale (GDS). **RESULTS** After the training, all subjects cleared the locomotion check. One-leg standing time with eyes open increased significantly ( $60.7\pm 42.0$  sec  $\rightarrow$   $72.8\pm 45.2$  sec,  $p<0.05$ ). In 10m walk test, walking time reduced significantly ( $5.44\pm 0.63$  sec  $\rightarrow$   $4.76\pm 0.65$  sec,  $p<0.05$ ) and walking speed increased significantly ( $110.2\pm 16.1$  m/min  $\rightarrow$   $126.0\pm 20.3$  m/min,  $p<0.05$ ). Standing upright time off the chair reduced significantly ( $7.64\pm 0.87$  sec  $\rightarrow$   $5.57\pm 0.98$  sec,  $p<0.05$ ). GDS had a tendency to reduce (3.8 pts  $\rightarrow$  2.7 pts), but the change was not significant. **CONCLUSIONS** This shows that one-leg standing exercise and squat exercise reinforce balance abilities and muscle strengths, and contribute to improvements of locomotive syndrome. This study was supported by a grant from the Ministry of Education, Culture, Sports, Science and Technology of Japan (#22500702).

### RISK OF FUNCTIONAL MOBILITY LOSS IN ELDERLY

MATA, E., Vila-Maldonado, S., Moreno-Vecino, B., González-Morales, M., de la Llave, M.J., Aznar, S., Ara, I.

UNIVERSIDAD DE CASTILLA-LA MANCHA

**Introduction** Functional mobility (FM) is one of the most important factors for independent life in older life. Loss of FM can result in difficulties while performing everyday tasks and activities. Moreover, it is considered as a sign of the frailty syndrome (Searle et al., 2008). Accordingly, the aim of this study was to assess the prevalence of loss of FM and also to assess its association with health related quality of life and anthropometric variables in non-institutionalized people over 65 years old from Castilla-La Mancha region (Spain). **Methods** A cross-sectional study was carried out in a sample of 514 participants (82 males; 432 women) with ages ranging between 65 and 90 years old. The risk of functional independence loss was evaluated by using the "Senior Fitness Test" criterion performance scores (Rikli & Jones, 2001); self-reported health status was measured using EuroQol questionnaire (EQ-5D) (Brooks, 1996) and anthropometric measurements were obtained using standardized techniques and equipment (Gomez-Cabello et al., 2011). **Results** In total, 5.2% of the participants presented risk for functional dependence. There were no differences in the prevalence of risk by sex and the frequency of risk increased by age (65-74 years old: 2.9%; >74 years old: 10.6%;  $p=0.002$ ). Compared with their healthy counterparts, those at risk of losing their functionality, showed worse health status (EQ-D5 index: at risk  $0.57\pm 0.29$ ; pre-risk  $0.81\pm 0.22$ ; healthy  $0.88\pm 0.14$ ,  $p=0.001$ ) and health-related quality of life (EQ-D5 VAS: at risk  $6.66\pm 1.77$ ; pre-risk  $7.63\pm 1.98$ ; healthy  $8\pm 1.78$ ,  $p=.002$ ), worst scores in all five dimensions (mobility, self-care, usual activities, pain-discomfort, and anxiety-depression) of the EQ-5D (all  $p<0.001$ ), higher values in all anthropometric measures (body fat percentage, body mass index, waist circumference) (all  $p<0.001$ ) and higher prevalence of overweight-obesity and central obesity (all  $p<0.001$ ). **Discussion** Low functionality levels (i.e. reduced physical fitness levels) are associated with a reduced quality

of life as well as with overweight-obesity and central obesity. All of these factors can be facilitators for developing frailty syndrome in the elderly population, which is considered as a risk factor of mortality, disability and hospitalization (Fried et al., 2001). References Brooks R. (1996). Health Policy 37(1), 53-72. Fried LP, et al. (2001). J Gerontol A Biol Sci Med Sci. 56(3), M146-56. Gomez-Caballo A, et al (2011) Obesity Reviews, 12(8), 583-592. Rikli RE., Jones, CJ, (2001). Human Kinetics. Champaign IL. Searle SD, et al. (2008). BMC Geriatr. 8, 24.

### COMPLEX SYSTEM FOR THE MONITORING OF THE PREVENTIVE MEDICAL EFFICACY OF REGULAR EXERCISE IN MENO-PAUSE

Orbán, K.1, Kovács, T.1, Vári, B.1, Szilágyi, N.1, Kiss, B.1, Keresztes, N.1, Szablics, P.1, Molnár, A.1, Balogh, L.1, László, F.1,2, Varga, C.2

*University of Szeged*

**Introduction** Menopause changes the physique, the body shape, reduces the body's basic metabolic level appearing on the excess kilograms. In this age many women begin to improper body weight reduction cures, resulting in loss of bone mass which is further enhanced by oestrogen deficiency resulting in osteoporosis. The combination of obesity and oestrogen deficiency also significantly increases the risk of cardiovascular diseases, and the inactive way of life just enhances these problems (Vuksanović et al., 2008). **Methods** Women over the age of 50 were involved to the test (n=96; mean age: 57.64 years; age range: 50-76 years; BMI: 28.41±0.51) who did aerobic physical activity three times a week (mean HR: 115.74±2.91 bpm). Psychosomatic health status was analysed (survey method) in the beginning and at the end of the program. The intensity of training was followed by Polar system (pulse, calorie consumption). The changes in fitness status (step test), resting blood pressure and heart rate, just as body composition (InBody230) were measured every month. These results were completed with lab tests (glucose, LDL-, HDL-cholesterol, triglyceride, HbA1c) and plasma leptin and insulin; levels (ELISA). **Results** By the effect of regular physical activity, the fitness status of the tested women improved significantly, and their blood pressure, resting HR and exercise pulse decreased. The weight loss of participants was 1.79±0.41 kg in average after the four months program. They lost 2.39±0.40 kg fat mass, while their fat-free mass increased by 0.58±0.16 kg. Their mineral mass content increased by 30±0.01 g. The decrease of abdominal obesity degree was less pronounced than the obesity degree related to the whole body, which can be explained by the different impact of sexual steroids expressed in femoral-gluteal and abdominal areas (Kirchengast, 1998). Improvement can be detected also by analysing the hormone and bloodchemical laboratory results: the glucose level decreased, as well as the level of cholesterol and triglyceride. **Conclusion** Our results suggest that this combination of multidisciplinary methods is suitable for the investigation of the mechanism of the beneficial actions of physical exercise. **References** Kirchengast S. (1998). Interactions between somatometric parameters and endogenous hormone levels as well as hormonal induced events in females. *Anthrop.Anz.*, 56 (3), 251-265 Vuksanović M, Đurica S, Žerajić B. (2008). Diabetes mellitus: A risk factor for the development of osteoporosis. *Vojnosanitetski pregljed*, 65 (9), 692-698 Support: TÁMOP 4.2.2-08/1-2008-0006; TÁMOP 4.2.1./B-09-1/KNOV-210-0005

### ACTN3 R577X POLYMORPHISM INFLUENCES THE TENDENCY FOR PHYSICAL ACTIVITIES IN ELDERLY JAPANESE WOMEN

Dai, U.1, Naoki, K.2, Inkwon, H.2

*1: Bunkyo University (Kanagawa, Japan), 2: Nippon Sport Science University (Tokyo, Japan)*

**Introduction** Several gene polymorphisms have recently been reported as determinants of (1) daily physical activities, (2) execution of exercises, or (3) continuance of physical training in individuals from the general population. Therefore, the aim of this study was to investigate whether the ACTN3 R577X polymorphism influences the fitness status and tendency for physical activities and exercise in elderly Japanese women. **Methods** The study included 101 female subjects (age, 65–90 years). All the subjects underwent battery tests for their fitness status. These tests evaluated the body composition, isometric strength during handgrip, back extension, plantar flexion and knee extension, stable standing time on a single leg, and walking speed on a 10-m obstacle course. They also filled a questionnaire on daily physical activities, exercise execution, and active daily living (ADL). Genotyping was performed for the ACTN3 (rs1815739) polymorphism by using TaqMan-based real-time polymerase chain reaction. **Results** The ACTN3 polymorphism of the subjects was in Hardy-Weinberg equilibrium. Significant differences were observed between the subjects with an active life (who answered "Yes" for the question "Do you regularly perform any exercises or physical training?") and contrastive subjects (who answered "No" for the same question) ( $\chi^2 = 7.88$ ,  $p = 0.019$ ) with respect to the presence of ACTN3. The results for back extension strength per BW ( $p < 0.01$ ), stable standing time on a single leg ( $p < 0.05$ ), walking speed on a 10-m obstacle course ( $p < 0.05$ ), and ADL score ( $p < 0.05$ ) were significantly better in the R allele-dominant model (RR and RX) group members who had an active life than in the XX group members who did not perform exercises regularly. **Discussion** The results suggest that the ACTN3 RR and R alleles also influence the fitness status and tendency for performing physical activities in elderly Japanese women, as roughly similar as angiotensin-converting enzyme genotype (Thompson et al., 2006) and aromatase gene polymorphism (Salmen, et al., 2003). **References** Salmen T, et al.: Relation of aromatase gene polymorphism and hormone replacement therapy to serum estradiol levels, bone mineral density, and fracture risk in early postmenopausal women. *Ann Med*, 35: 282-288, 2003. Thompson PD, et al.: Angiotensin-converting enzyme genotype and adherence to aerobic exercise training. *Prev Cardiol*, 9: 21-24, 2006.

### THE INFLUENCE OF TRAINING STATUS ON THE RELATIONSHIP BETWEEN URIC ACID LEVELS AND RISK FACTOR OF CARDIOVASCULAR DISEASE IN ELDERLY

Zago, A.S., Jacomini, A.M., Yoshimura, F.E., Trapé, A.A.

*Univ Estadual Paulista*

**Introduction** Physical exercise is strongly recommended to decrease risk factor of cardiovascular disease (RFCD). Uric acid (UA) is the final enzymatic and product of purine degradation and it has been associated with high BP due to the stimulus for the superoxide production and inhibition of vasodilatation. Therefore, the aim of this study was to investigate the relationship between RFCD and UA and whether this relationship may be mediated by the training status (TS). **Methods** All participants (n=126) performed the indirect maximal oxygen uptake ( $\text{Vo}_{2\text{max}}$ ) by 1 mile walk and AAHPERD Functional Fitness Battery Test (coordination, flexibility, muscular strength, agility and cardiovascular endurance tests) to assess TS. The general functional fitness index (GFFI) was calculated using the sum of the percentile score of each test as described by Zago et al (2003). For the assessment of RFCD, it was evaluated the resting systolic and diastolic blood pressure (SBP and DBP), total-cholesterol (CHOL), LDL-cholesterol (LDL-c), HDL-cholesterol (HDL-c), triglycerides (TG), glucose (GL), nitrite



(NOx), T-BARS and uric acid (UA) by blood sample collection (12h overnight fast). Data were analyzed by Pearson correlation coefficient and ANOVA one-way. The GFFI was considered as independent variable (G1 – regular GFFI; G2 – good GFFI; and G3 – very good GFFI). Results The main correlations were found between GFFI and CHOL ( $r=-0.4 / p<0.01$ ), TG ( $r=-0.5 / p<0.01$ ), UA ( $r=-0.3 / p<0.01$ ), NOx ( $r=-0.4 / p<0.01$ ), SBP ( $r=-0.4 / p<0.01$ ) and DBP ( $r=-0.4 / p<0.01$ ), and between UA and CHOL ( $r=-0.3 / p<0.01$ ), TG ( $r=-0.5 / p<0.01$ ), HDL-c ( $r=-0.4 / p<0.01$ ), SBP ( $r=-0.3 / p<0.01$ ) and DBP ( $r=-0.3 / p<0.01$ ). ANOVA revealed differences among groups, especially between G1 and G3 in Vo2max (22.1(8) and 36.9(5) ml/kg/min), CHOL (203.4(37) and 168.9(31) mg/dL), TG (157.7(59) and 94.2(39) mg/dL), UA (4.7(1.5) and 3.7(1.0) mg/dL), NOx (110.9(28) and 140.3(29)  $\mu$ M), SBP (129(14) and 114(12) mmHg) and DBP (83(14) and 74(8) mmHg). Discussion This finding strengthens the hypothesis that low values of UA are related with low BP and low RFCD. Moreover, the relationship among RFCD, BP and UA may be mediated by training status since the major variables evaluated in this study had better results in the group classified as very good GFFI (G3). References Zago AS, Gobbi S. Valores Normativos da aptidão funcional de mulheres de 60 a 70 anos. Rev Bras Cie Movim. 2003;11(2):77-86. Gonzalez D. et al.. Effects of aerobic exercise on uric acid, total antioxidant activity, oxidative stress, and nitric oxide in human saliva. Res Sports Med. 2008;16(2):128-37. Acknowledgements: CNPq (557967/2099-0) and FAPESP (09/54586-0)

## 14:45 - 15:45

### Poster presentations

#### PP-PM26 Physiology 7

#### CONTINUOUS MONITORING OF THERMOREGULATORY RESPONSES AND HYPOTHALAMIC NEUROTRANSMITTERS DURING INCREMENTAL TREADMILL RUNNING IN RATS

Hasegawa, H.1, Takatsu, S.1, Ishiwata, T.2, Tanaka, H.3, Sarre, S.4, Meeusen, R.4

1: Hiroshima Univ (Hiroshima, Japan), 2: Rikkyo Univ (Saitama, Japan), 3: Yokohama Nat Univ (Kanagawa, Japan), 4: Vrije Universiteit Brussel (Brussels, Belgium)

**Introduction** We have reported on the importance of catecholamines on thermoregulation and exercise-induced fatigue both in human and animal studies (Roelands et al., 2008; Hasegawa et al., 2008). To investigate the relationship between body temperature regulation and hypothalamic catecholamines in the preoptic area and anterior hypothalamus (PO/AH) during incremental treadmill running in the rat using biotelemetry and brain microdialysis methods. **Methods** Ten male Wistar rats were used. A telemetry device was implanted into the peritoneal cavity and an intracerebral guide was implanted in the left PO/AH. After 2 h of baseline collections on the treadmill, the animals were exercised for one hour in a normal environment (23°C). Treadmill speed was increased every 20 min (10, 20, 26 m/min). During the experiment, body core temperature (Tcore), tail skin temperature (Ttail), (an index of heat loss), and oxygen consumption (VO2), (an index of heat production), were simultaneously measured. Brain microdialysis samples were collected every 10 min, and these samples were analyzed by HPLC for noradrenaline (NA), dopamine (DA) and serotonin (5HT). **Results** Tcore and VO2 significantly increased during treadmill and were exercise intensity dependent. After an initial drop Ttail increased significantly during exercise. Both NA and DA levels in the PO/AH increased significantly during exercise. There was no effect on serotonin release. Tcore, VO2 and Ttail were positively correlated with the levels of NA and DA. **Discussion** We employed in vivo brain microdialysis, biotelemetry, and metabolic measurements to perform continuous monitoring of brain neurotransmitters, core body temperature, and thermoregulatory responses, during incremental running in a rat model. Our data suggest that thermoregulatory responses are dependent on the intensity of the exercise and that these responses are associated with changes in NA and DA release, but not in 5-HT release in the PO/AH. These new findings also suggest that the running animal model may be useful for examining the neurotransmitter-governed mechanisms of thermoregulation and central fatigue during exercise (Nybo, 2008). **References** Hasegawa H, Piacentini MF, Sarre S, Michotte Y, Ishiwata T, Meeusen R (2008). J Physiol, 586, 141-149. Roelands B, Hasegawa H, Watson P, Buysse L, De Schutter G, Piacentini MF, Meeusen R (2008). Med Sci Sports Exerc, 40, 879-885. Nybo L. (2008). J Appl Physiol, 104: 871-878.

#### EFFECT OF INGESTING SMALL AMOUNTS OF A CARBOHYDRATE ELECTROLYTE SOLUTION ON COGNITIVE PERFORMANCE IN THE HEAT

Fan, P.W.1, Yeo, Y.Y.W.2, Nolte, H.W.3, Lee, J.K.W.1,2

1. DSO National Laboratories, Republic of Singapore; 2. National University of Singapore, Republic of Singapore; 3. ERGOmics TECHNOlogies, Pretoria, South Africa

**Introduction** Carbohydrate electrolyte (CE) solutions have been extensively investigated and proven to enhance endurance performance (Coombes and Hamilton, 2000). In contrast, findings on the effect of carbohydrates on cognitive performance are divergent (Gibson, 2007). The primary aim of the study was to investigate the effect of ingesting small amounts of a commercially available CE solution on cognitive performance following exercise in the heat. The secondary aim was to determine if changes in body mass can be used as an accurate surrogate for changes in total body water. **Methods** Twelve healthy males aged 24 $\pm$ 2 (mean $\pm$ SD) years, with peak oxygen uptake of 59 $\pm$ 5 ml/min/kg participated in the study. Prior to the experimental trials, all participants underwent three practice sessions on the cognitive test battery - symbol digit matching, search and memory, digit span, choice reaction time and psychomotor vigilance tests; and a full familiarisation trial. They completed two experimental trials ingesting either the CE (sucrose: 48 g/L, glucose: 20 g/L, sodium: 18 $\pm$ 3 mmol/L, potassium: 3.3 $\pm$ 0.1 mmol/L) or placebo (P) drink (1 ml/kg body mass) before exercise, at 15 min intervals during the run and in between each cognitive test after exercise. Participants ran on a level treadmill at 70 $\pm$ 5% of their peak oxygen uptake for 75 min in the heat (dry bulb temperature: 30.2 $\pm$ 0.3°C, relative humidity: 70 $\pm$ 3%). Cognitive performance was assessed before and after the exercise. Body mass, body core temperature, mean skin temperature, heart rate, ratings of perceived exertion and blood glucose were measured. Total body water was measured by diluted isotope method. **Results** Body core temperature was elevated at the end of the trials (P: 39.5 $\pm$ 0.4°C, CE: 39.6 $\pm$ 0.5°C, P=0.41). Mean skin temperature (P: 35.3 $\pm$ 0.5°C, CE: 35.3 $\pm$ 0.5°C, P=0.53), heart rate (P: 171 $\pm$ 10 beats/min, CE: 171 $\pm$ 10 beats/min, P=0.97) and ratings of perceived exertion (P: 17 $\pm$ 2, CE: 16 $\pm$ 2, P=0.18) were similar between the trials. At the end of the run, blood glucose concentration was higher in the CE trial (Pre: 4.6 $\pm$ 0.2 mmol/L, Post: 6.4 $\pm$ 1.1 mmol/L) than in the P trial (Pre: 4.7 $\pm$ 0.2 mmol/L, Post: 6.0 $\pm$ 1.4 mmol/L, P<0.05). Maximum digit span was improved by 1 $\pm$ 2 units in the P trial (P<0.05) and degraded by 1 $\pm$ 1 unit in the CE trial (P<0.05). Ingestion of CE solution had no effects on other cognitive tests (P>0.05). No relationship (R<sup>2</sup>=0.11,

$P=0.15$ ) was found between change in body mass ( $-1.3\pm 0.4$  kg) and total body water ( $-1.9\pm 1.6$  kg). Conclusion These results suggest that the ingestion of small amounts of a CE solution can degrade short term memory after exercise in the heat. Acute changes in body mass do not accurately predict changes in total body water. References Coombes J.S. and Hamilton K.L. (2000). The effectiveness of commercially available sports drinks. *Sports Medicine*. 29: 181-209. Gibson E. (2007). Carbohydrates and mental function: feeding or impeding the brain? *British Nutrition Foundation Nutrition Bulletin*. 32 (S1): 71-83.

### EFFECT OF PHYSICAL FITNESS ON THE CEREBRAL BLOOD FLOW IN ELDERLY WOMEN

Hirasawa, A., Sato, K., Ooue, A., Sadamoto, T.

*Japan Women's College of Physical Education*

**Introduction** The decline in the resting cerebral blood flow (CBF) occurs with ageing (Scheel et al. 2000), and the reduced CBF generally increases risk factors for cerebrovascular disease e.g., stroke and Alzheimer's disease in elderly people. Previous study suggested that fitter persons with higher maximal oxygen uptake have a higher the resting CBF in elderly man (Ainslie et al. 2008). However it has not yet been examined if other physical fitness components such as muscular strength and endurance, body flexibility and balance could also affect the resting CBF. We, therefore, studied the relationship between CBF indices and fitness score obtained in various components and compared the CBF indices between high fitness score group (FIT) and low fitness score group (UNFIT) in elderly women over 65 years old. **Methods** The subjects comprised 120 healthy elderly women between 65 and 89 years old. The resting blood flow in common carotid artery (CCA) was measured as CBF index in subjects in supine position by ultrasonography. Mean arterial blood pressure (MAP) was also measured with Finometer. As CBF index, the cerebrovascular resistance (CVR) was calculated from the ratio of MAP to CCA blood flow. Each score in 6 fitness tests (handgrip strength, trunk flexibility, 10-m walking and getting over obstacles, one-leg balance with eyes opened, 30-s upper body-raising, and walking distance for 6 min) were obtained and then added as total fitness score in individual subject. From the value of total fitness score, the subjects were divided into FIT ( $>$  the median in all subjects;  $n = 60$ ) and UNFIT ( $<$  the median in all subjects;  $n = 60$ ). **Results** The CCA blood flow and CVR were positively correlated to the total fitness score (CCA blood flow:  $r = 0.21$ ,  $p < 0.05$ ,  $n = 120$ ; CVR:  $r = -0.21$ ,  $p < 0.05$ ,  $n = 120$ ). The CCA blood flow was also significantly correlated to the score in trunk flexibility and 30-s upper body-raising (trunk flexibility:  $r = 0.21$ ,  $p < 0.05$ ,  $n = 120$ ; 30-s upper body-raising:  $r = 0.19$ ,  $p < 0.05$ ,  $n = 120$ ). The FIT showed a significantly higher CCA blood flow and a significantly lower CVR compared to UNFIT group (CCA blood flow:  $440 \pm 108$  vs.  $388 \pm 95$  ml/min,  $p < 0.01$ ; CVR:  $0.23 \pm 0.07$  vs.  $0.26 \pm 0.07$  mmHg/ml  $\cdot$  min $^{-1}$ ,  $p < 0.05$ ). **Discussion** This study found that CCA blood flow and CVR in elderly women showed a positive correlation to the total fitness score and the score in the trunk flexibility and 30-s upper body-raising. These findings suggest that not only cardiorespiratory fitness component but also other components such as body flexibility and muscular endurance affect the resting CBF and play an important role in preventing the age-related decline the resting CBF.

### ROLE OF FUNCTIONAL ASYMMETRY OF BRAIN HEMISPHERES IN SPORTS

Porozovs, J., Praulite, G., Spunde, A., Perepjolkina, V., Voita, D.

*Riga Teacher Training and Educational Management Academy*

**Introduction** Differences of behaviour between left-handers and right-handers are determined by functional asymmetry of brain hemispheres. Physiological processes in right and left human brain hemispheres realise in different ways. Asymmetry of brain hemispheres of left-handers is less explicit than right-handers. In some branches of sports (box, tennis, fencing) left-handers have advantages in comparison with right-handers. The statistical data show that 30 – 40 % of cases boxers left-handers win in significant competitions (Brooks et al., 2004). **Methods** Psycho-physiological parameters (velocity of movement, the level of nervous system strength and reactions in conflict situations) as well as exactness of basketball throws in the basket were observed for basketball players: right-handers and left-handers. Tapping test was used in order to observe the strength of nervous processes. Behaviour test of K. Tomass was used to determine typical reactions of basketball players in conflict situations: competition, cooperation, compromise, evasiveness and adaptation. The exactness of basketball throws in the basket was checked up for every observed person throwing with the right hand and with the left hand in 3 series dynamics (10 throws in every of series) and also after load (30 throws). **Results** The velocity of movement touches to surface during 40 seconds for basketball players – right-handers with leading right hand was higher than for basketball players – left-handers with leading left hand. Basketball players right-handers as well as left-handers had middle nervous system strength. Competition reaction for basketball players – right-handers was more typical in comparison with left-handers ( $p < 0,05$ ). Cooperation was a little more typical for left-handers in comparison with right-handers ( $0,05 < p < 0,1$ ). The exactness of basketball throws in the basket of left-handers with "leading" (left) hand (4,78 from 10 throws) was higher than right-handers with "leading" (right) hand (3,89 from 10 throws) ( $p < 0,05$ ). The exactness of basketball throws in the basket of left-handers with "passive" (right) hand was higher than right-handers with "passive" (left) hand before load and after load ( $p < 0,05$ ). **Discussion** The possibility of basketball players left-handers to do more exact basketball throws in the basket, probably, is connected with domination of right hemisphere which has significant role in providing of spatial orientation. For left-handers it is more accustomed to act with right hand than for right-handers to act with left hand. It is connected with that fact that many of tools and instruments are adapted for the work with right hand. It is recommendable for basketball players left-handers fully to put into use their advantages in the actions with "passive" hand. References 1. Brooks, R., Bussiere, L.F., Jennions, M.D., Hunt J. Sinister strategies succeed at the cricket World Cup. In: *Proc Biol Sci.*, Number 2, 2004, p.64–66.

### RELATIONSHIP BETWEEN SEROTONIN LEVELS IN THE VENTRAL TEGMENTAL AREA AND THERMOREGULATION IN FREELY MOVING RATS

Ishiwata, T., Takatsu, S., Hasegawa, H.

*Rikkyo University*

**RELATIONSHIP BETWEEN SEROTONIN LEVELS IN THE VENTRAL TEGMENTAL AREA AND THERMOREGULATION IN FREELY MOVING RATS** Takayuki Ishiwata<sup>1</sup>, Satomi Takatsu<sup>2</sup>, Hiroshi Hasegawa<sup>2</sup> 1:Dept. Sport & Wellness, Rikkyo Univ., Saitama, Japan 2:Grad. Sch. Integ. Arts & Sci., Hiroshima Univ., Hiroshima, Japan **Introduction** The relationship between exercise performance and thermoregulation is well documented. Several brain neurotransmitter systems, including the serotonergic system, are activated during exercise. Brain serotonin (5-HT) is an important monoaminergic neurotransmitter. The serotonergic system is involved in the regulation of physiological functions and behaviour, including thermoregulation. The 2 main sources of 5-HT innervation to the forebrain are the dorsal raphe nucleus (DRN) and median raphe nucleus (MRN). We have already reported that perfusion of tetrodotoxin into the DRN or MRN decreases body temperature (T<sub>b</sub>) (Ishiwata et al., 2001) by increasing heat loss, without changing heat production, in freely moving rats (Ishiwata et al., 2008). These results

suggested that heat loss is the primary effect of 5-HT projection from the DRN or MRN on thermoregulation. The ventral tegmental area (VTA) is an important area that regulates the heat loss response (Kanosue et al., 1998). The present study was designed to determine the relationship between 5-HT levels in the VTA and thermoregulation in freely moving rats by using microdialysis/biotelemetry techniques. Methods A telemetry device and a microdialysis probe were surgically implanted. We measured extracellular 5-HT levels in the VTA during cold and heat exposure (5 or 23°C) combined with on-line HPLC system. Furthermore, we perfused citalopram (5-HT reuptake inhibitors) into the VTA. We continuously measured  $T_b$  and heart rate (HR), indexes of heat production, by the telemetry technique. The tail temperature ( $T_{tail}$ ), an index of heat loss from the dorsal surface of the skin, was continuously measured at approximately 10 cm from the base of the tail using a mini temperature data logger. Results & Discussion During heat exposure,  $T_b$  increased by approximately 1.5°C, with an increase in  $T_{tail}$  and a decrease in HR, suggesting the activation of the heat loss response. 5-HT levels in the VTA increased after 1 hour of heat exposure. During cold exposure,  $T_b$  increased by approximately 0.8°C, with an increase in HR and a decrease in  $T_{tail}$ , suggesting the activation of the heat production response. 5-HT levels in the VTA did not change during cold exposure. Perfusion of citalopram increased 5-HT levels in the VTA, with a decrease in  $T_b$  by approximately 0.5°C and an increase in  $T_{tail}$ , but without a change in HR. Therefore, we concluded that the VTA plays an important role in the regulation of the heat loss response and 5-HT in the VTA is a key neurotransmitter. References Ishiwata T., et al., (2001) *Neurosci. Lett.* 306(1-2):126-128. Ishiwata T., et al., (2008) *JPS* 58 Suppl.: S101. Kanose K., et al., (1998) *Prog Brain Res.* 115:49-62.

### SHORTENING OF LONG-LATENCY SOMATOSENSORY EVOKED POTENTIALS IN BASEBALL PLAYERS

Yamashiro, K., Sato, D., Onishi, H., Maruyama, A.

*Niigata University of health and welfare*

Koya Yamashiro 1,2, Daisuke Sato1,2, Hideaki Onishi1,3, Atsuo Maruyama1,2 1Institute for Human Movement and Medical Sciences, Niigata 950-3198, Japan 2Department of Health and Sports, Niigata University of Health and Welfare, Niigata 950-3198, Japan; 3Department of Physical Therapy, Niigata University of Health and Welfare, Niigata 950-3198, Japan Introduction We investigated the neuro-plastic changes in baseball player using long-latency somatosensory evoked potentials (SEPs). In general, long-term training of athletes and musicians is known to induce neuro-plastic changes. The aim of this study is to clarify whether the long-term training affect the long-latency SEPs relating to information processing of stimulation in baseball players. Methods SEPs were recorded from two groups (baseball group and sports group) in fifteen subjects at Fz, Cz, Pz, C3, C4 stimulating index finger of right hand. The intensity of the stimulus was three times the sensory threshold, and was never reported as painful. The inter-trial interval was randomized between 5-8 s. In baseball group, seven subjects have played baseball over 7 years. While, other subjects have played various sports such as swimming, track and field and soccer. Long-latency SEPs were measured under passive (control) condition and reaction time condition (movement condition). In the passive condition, subjects relaxed and had no task. In the reaction time condition, they were instructed to prepare to push the button, and to push it as fast as they could when the stimulus was presented. Results P100 and N140 were elicited by two groups and conditions. The latency of P100 and N140 in baseball group was significantly shorter than in sports group. In addition, reaction time in baseball group was significantly shorter than in sports group. Moreover, the latency of P100 and reaction time were significantly positive correlation. Discussions Sensation of hands is more important for baseball player than for runner, swimmer and soccer player. Baseball players need sensation of hands in various situations such as throwing, batting and catching. Therefore, long-term training may induce neuro-plastic changes in hand area, and this phenomenon may play an important role to quick responses to required movements.

### CHANGES IN ASPECTS OF COGNITIVE FUNCTION IN RESPONSE TO PASSIVE AND ACTIVE MANIPULATION OF CORE AND SKIN TEMPERATURE

Watson, P., Bandelow, S., Maughan, R.J.

*Loughborough University*

Introduction Cognitive function has been reported to decline following strenuous exercise in the heat (Gopinathan et al. 1988; Cian et al. 2001). Dehydration does not explain this response, since task performance is restored following a period of rest (Cian et al. 2001), but hyperthermia, may contribute to the observed reduction in cognitive function. The aim of the present study was to determine the effect of passive and active means of raising core temperature on aspects of cognitive function. Methods Eight active males ( $22 \pm 2$  y,  $81.4 \pm 5.5$  kg,  $1.82 \pm 0.05$  m,  $4.7 \pm 0.4$  L/min) completed a preliminary trial, a familiarisation trial and 3 experimental trials (cool immersion/cool exercise (C/C), cool immersion/warm exercise (C/W) and warm immersion/warm exercise (W/W)). Volunteers were seated in a water bath maintained at a temperature of either 37.0°C or 39.5°C for 30 minutes before entering a cool (10°C, 60% rh) or warm (35°C, 60% rh) room to undertake cycle exercise at a workload corresponding to 60%  $\dot{V}O_{2peak}$  until volitional exhaustion. Cognitive function was assessed before and immediately after water immersion and after exhaustion, using a battery of computer-based tests. Core (rectal) and weighted mean skin temperature were recorded. Results Immersion in warm water increased core temperature from  $37.0 \pm 0.30$ °C to  $38.3 \pm 0.20$ °C ( $P < 0.001$ ), with no change after the cool immersion ( $P = 0.445$ ). Exercise time was  $83.5 \pm 9.0$  min in the C/C trial, with significantly shorter times when exercise was undertaken in the heat (C/W  $43.3 \pm 8.4$  min; W/W  $33.1 \pm 9.4$  min;  $P < 0.001$ ). At the end of exercise core temperature was  $38.4 \pm 0.30$ °C,  $38.8 \pm 0.50$ °C and  $39.2 \pm 0.40$ °C in the C/C, C/W and W/W trials respectively ( $P = 0.037$ ). Warm water immersion resulted in slower reaction times on the interference level of the Stroop test and on the high memory load condition of the Sternberg working memory test (both  $P < 0.05$ ), but not at the baseline level of each test ( $P > 0.05$ ). No such effect was apparent following exercise ( $P > 0.05$ ). Adding core and/or skin temperatures into the analysis did not explain this slowing better than the warm immersion condition itself. Discussion These data suggest that warm immersion can specifically impair response times in complex tasks involving executive function and working memory. This effect was not solely caused by core or skin temperature changes, but appears to involve additional factors present during passive, but not active, heating, possibly related to changes in brain blood flow resulting from warm water immersion. References Cian C, Barraud PA, Melin B, Raphael C. (2001). *Int J Psychophysiol*, 42, 243-51. Gopinathan PM, Pichan G, Sharma VM. (1988). *Arch Environ Health*, 43, 15-7.

**DOES TDCS OVER THE PRIMARY MOTOR CORTEX HAVE AN EFFECT ON THE CONSOLIDATION OF MOTOR MEMORIES?**

Rroji, O., Pauwels, L., Bekkers, E., Wenderoth, N.

*KU Leuven*

Introduction: Transcranial direct current stimulation (tDCS)(1) is a non-invasive, painless cortical stimulation technique(2) that is well tolerated by healthy subjects and patients. Recent studies have demonstrated that non-invasive brain stimulation enhances memory formation and cortical plasticity for a variety of tasks including visuo-motor coordination(3), implicit motor learning and probabilistic classification learning in healthy volunteers. Here we tested whether tDCS affects also use-dependent plasticity, i.e. increase in neural and behavioral efficiency as a consequence of repeated practice. Methods: 14 healthy young volunteers (age 18 to 30, 6 females, 4 left handed) were involved. The subjects had to practice to flex their non-dominant thumb as fast as possible for 10 blocks, consisting of 20 movements each (1 mov every 3s). Between blocks there were 1min break to prevent fatigue, in total 20min. In half of the subjects, real tDCS was applied during the first training session with the anode mounted over the contralateral primary motor cortex(M1) and the cathode placed on the contralateral shoulder. Results: First analyses indicate that real tDCS enhanced retention performance 1 day and particularly 1 week after training, as indicated by a significant training x stimulation interaction ( $F(16,160)=4.09$ ,  $p<0.0001$ ) which was revealed by an analysis of variance for repeated measurements. In an ongoing experiment we are testing whether placement of tDCS electrodes and the amount of training will show a different result compared to the previous experiment. Discussion: Our data show for the first time that tDCS has a positive effect on use-dependent plasticity. Importantly, tDCS did not affect training performance per se but rather memory consolidation. Its beneficial effect seems to be enhanced when the motor memory is repeatedly reactivated even if reactivation occurs one day after the tDCS intervention. Our results might have important implications for increasing the efficiency of motor practice in healthy subjects and rehabilitation settings. References: 1.Paulus W. Transcranial direct current stimulation (tDCS). *Suppl Clin Neurophysiol* 56:249–54., 2003. 2.Nitsche M. A., Paulus W. Excitability changes induced in the human motor cortex by weak transcranial direct current stimulation. *J Physiol* 27:633–9.2000. 3.Reis J. et al. Noninvasive cortical stimulation enhances motor skill acquisition over multiple days through an effect on consolidation. *PNAS* 106:1590-1595.2009.

**EFFECT OF HEMODYNAMIC CHANGES CAUSED BY VALSALVA MANEUVER ON BRAIN NEAR-INFRARED SPECTROSCOPY MEASUREMENTS**

Tsubaki, A.1,2, Furusawa, A.A.2, Kojima, S.1,3, Onishi, H.1,2

*Niigata University of Health and Welfare*

Introduction Near-infrared spectroscopy (NIRS) is widely used to measure human brain activation on the basis of cerebral hemodynamic response. The advantage of NIRS over other methods is that it provides direct, real-time measurement of oxygenation in cortical tissue. However, a limitation of NIRS is that hemodynamic changes influence the measured signals. The purpose of this study was to clarify the relationship between NIRS signals and blood pressure during the Valsalva maneuver. Methods Four healthy volunteers participated in this study. All participants provided written informed consent after experimental procedures had been explained. The study was approved by the Ethics Committee of Niigata University of Health and Welfare (17157-100203). Subjects performed a 20-s Valsalva maneuver to change blood pressure. NIRS (OMM-3000, Shimadzu) optodes were set in a holder at a distance of 30 mm and stabilized by a crepe bandage around the head. Changes in oxyhemoglobin (O<sub>2</sub>Hb) concentration were calculated by using the modified Beer-Lambert law. Thirty-four channels with an inter-optode distance of 30 mm were used for deep-penetration measurements (deepO<sub>2</sub>Hb), and nine channels with an inter-optode distance of 15 mm were used for shallow-penetration measurements (shallowO<sub>2</sub>Hb). The difference value (diffO<sub>2</sub>Hb) of deepO<sub>2</sub>Hb and shallowO<sub>2</sub>Hb was calculated. Beat-to-beat mean arterial pressure (MAP) was recorded by volume clamping the finger pulse with a Finometer (Finapres Medical Systems BV) on the left side. A height reference sensor was used to remove confounds related to arm position. Skin blood flow changes were measured at the forehead by a laser Doppler blood flow meter (Omegaflow FLO-CI, OmegaWave, Inc). The relationships between deepO<sub>2</sub>Hb, shallowO<sub>2</sub>Hb, diffO<sub>2</sub>Hb, and MAP were assessed using Pearson's correlation coefficient with significance set at  $P<0.05$ . Results Pearson's correlation coefficient between deepO<sub>2</sub>Hb and MAP, shallowO<sub>2</sub>Hb and MAP, and diffO<sub>2</sub>Hb and MAP was 0.64–0.88 ( $P<0.01$ ), 0.64–0.89 ( $P<0.01$ ), and 0.45–0.67 ( $P<0.01$ ), respectively. Discussion Regional and systemic changes in the cardiovascular state strongly influence NIRS signals. Our observations, which revealed a significant relationship between O<sub>2</sub>Hb and MAP, demonstrate that not only are blood pressure changes influenced by deep and shallow-penetration NIRS signals, but also that diffO<sub>2</sub>Hb is suitable for measuring brain activation.

**SPONTANEOUS WHEEL RUNNING ALTERS BRAIN ACTIVITY RELATED TO MENTAL CONDITION IN OBESE ZUCKER RATS**

Yanagita, S., Kanemaru, J., Ochiai, H., Umezawa, M., Takeda, K.

*Tokyo University of Science*

Introduction Throughout the world, obesity has become an increasing health concern due to its being a risk factor of lifestyle disease. Physical exercise is strongly recommended for obese people because it helps to improve lipid metabolism and in turn prevent lifestyle disease. In general, however, it is thought that obese people tend to have a negative impression regarding the performance of physical exercise. It is thus suggested that physical exercise might be detrimental to the mental condition of obese people, in spite of its efficacy in improving physical health. It is well known that mental condition is integrated by brain activity in several regions of the brain. Therefore, it is possible that brain activity related to mental condition in obese people differs from that in the non-obese. In this study, we examined the effects of spontaneous wheel running on the activation of several brain regions related to mental condition in obese (fa/fa) and lean (wild type) Zucker rats. Materials and Methods Male Zucker rats were used in this study. The rats were housed individually in plastic cages with or without an attached running wheel and were randomly assigned to either physically active or sedentary conditions. Physically active rats were allowed voluntary access to their wheels for 2 weeks. Daily wheel revolutions were recorded digitally, and running distance was calculated by multiplying wheel circumference by the number of revolutions. We assessed the expression of c-Fos, the protein encoded by the immediate early gene c-fos, which is well known as a transcription factor and functional marker of neuronal activity. This assessment was performed using immunohistochemistry in various brain regions related to mental conditions, such as the prefrontal cortex, paraventricular nucleus of the hypothalamus, hippocampus, central nucleus of the amygdala, ventral tegmental area, dorsal raphe nucleus and locus coeruleus. Results Two weeks of spontaneous wheel running increased the expression number of c-Fos in all brain regions compared to sedentary conditions in both obese and lean rats. The number of c-Fos immunoreactive cells in specific brain regions was significantly lower in obese rats than that in lean rats. Discussion The results of the present study showed that spontaneous wheel running enhanced c-Fos expression in several brain regions related to mental conditions and that these effects were blunt-

ed in obese rats. The results of the present study, taken together with numerous studies that have shown that spontaneous wheel running has excellent effects on the maintenance of brain functions, suggest that it is necessary for obese people to have the ability to engage in spontaneous physical activity in their daily lives.

### REGULAR PHYSICAL ACTIVITY IMPROVES COGNITIVE PERFORMANCE DURING ODDBALL TASK IN YOUNG ADULTHOOD

Krell, J.1, Putze, F.1, Heger, D.1, Benzinger, S.1, Engelmann, J.1, Schultz, T.1, Bös, K.1, Stahn, A.2

*1 Karlsruhe Institute of Technology (Karlsruhe, Germany), 2 Charité, Center for Space Medicine (Berlin, Germany)*

**Introduction:** Physical activity has been associated with improved health across lifespan. There is also growing interest in the relationship between exercise and cognition. Physical activity has been linked to enhanced cognitive task performance and neurophysiologic measures such as event related brain potentials (ERP). However, most research has focused either on children or elderly. The purpose of this study was to determine the effects of regular exercise on central information processing during a modified oddball-task in a cross-sectional study with young adults. **Methods:** 119 university students who were regularly engaging in physical activity and 33 students who were physically inactive within at least one year prior to the study took part in it (age: 18 to 34 yrs). All participants performed cognitive testing as well as various physical performance tests to determine endurance, strength and gross motor skills. Reaction time (RT) and P3 components of ERP in an auditory oddball task at midline electrode sites (Fz, Cz, Pz) were used as dependent measures for data analysis. **Results:** Active subjects had a significantly lower body-fat percentage and higher VO<sub>2</sub>max, maximum strength as well as coordinative performance than inactive participants. In the oddball task, the active group revealed faster reaction times ( $F=7.20$ ,  $p<.01$ ,  $\eta^2=.052$ ) and larger P3 amplitudes over all electrode sites (Fz:  $F=4.67$ ,  $p<.05$ ,  $\eta^2=.044$ , Cz:  $F=6.04$ ,  $p<.05$ ,  $\eta^2=.056$ , Pz:  $F=7.15$ ,  $p<.01$ ,  $\eta^2=.065$ ) than compared to the inactive group. Coordinative performance, but not aerobic capacity or strength performance, had a significant effect on P3 amplitude ( $F=12.30$ ,  $p<.01$ ,  $\eta^2=.110$ ). **Discussion:** The results suggest that regular exercise increases cognitive information processing during an oddball tasks in young adults. Type of sport as well as type of physical performance may further play a crucial role underlying this relationship. Our results indicate that sports associated with high motor control might be particularly valuable in promoting cognition and brain health. However, in contrast to our hypothesis, no effect of aerobic capacity, amount of physical activity or exercise intensity on ERPs was found in this task. Moreover, an enhanced response speed as seen in the active group could also be explained by a better efficiency of peripheral motor processes. To clarify this problem it should be investigated whether there is still an effect on response speed in a task that does not require motor responses.

### THE RESPONSE OF CORTICAL ALPHA ACTIVITY TO PAIN AND NEUROMUSCULAR CHANGES CAUSED BY EXERCISE INDUCED MUSCLE DAMAGE

Plattner, K., Tam, N., Lambert, M.I., Baumeister, J.

*University of Cape Town and University of Paderborn*

**Introduction** It is known that exercise-induced-muscle-damage (EIMD) is characterized by pain, swelling and shortening of the muscle, increased serum creatine kinase (CK) activity, decreased force output (FO) and altered neuromuscular function. How these symptoms of EIMD affect brain function, in particular cortical activity has not been described. Therefore the aim of this study was to investigate the relationship between the symptoms of EIMD and cortical alpha ( $\alpha$ ) activity during a submaximal biceps movement. **Methods** 37 right-handed male participants were recruited for this study. Before the start of the study all participants were familiarized with the testing equipment and different test protocols. Subjects were divided into a control and experimental group with testing as follows: 12h pre-EIMD and 12h, 36h and 132h post-EIMD. Electroencephalography (EEG) was recorded on all subjects whilst performing a maximal voluntary contraction (MVC) and a self-paced submaximal flexion-extension movement. Data were collected continuously during the premovement, movement and rest phase and therefore represent the common state of the brain during the movement protocol. CK, biceps girth, resting elbow angle and a pain score were also measured at these times. **Results** At 12h neuromuscular functioning was already disturbed whilst the sensation of pain was perceived but not fully developed. Muscle pain scores in the experimental group peaked after 36h with lowest torque reported at 12h.  $\alpha$ -1 activity increased significantly in the motor and somatosensory (SS) area 12h post-EIMD while  $\alpha$ -2 activity increased in the contralateral fronto-central area. At 36h pain had further increased and neuromuscular function improved whilst  $\alpha$ -1 and  $\alpha$ -2 activities had decreased. **Discussion** Whilst it is not clear the cause of increase in  $\alpha$ -1 activity over the motor and SS area in the EIMD group we hypothesize that it may increase in order to counteract the loss of movement steadiness and force output whilst experiencing EIMD. Recording of  $\alpha$ -1 activity in this proximal location we assume it to be a top-down regulator of peripheral function. An increased  $\alpha$ -1 activity may be part of an upstream regulation of motor perception, activation and neuromuscular function. It seems  $\alpha$ -1 activity over the motor and SS cortex may compensatory increase in response to the changes in neuromuscular function during movement, whilst an increase in  $\alpha$ -2 activity is related to the suppression of pain experienced within the first 12h of an EIMD protocol. Mostly peripheral symptoms associated with EIMD have been studied but none have provided adequate explanations for the delayed pain response associated with EIMD. The novelty of this study explored the response of the brain's cortical  $\alpha$ -1 and  $\alpha$ -2 activities, peripheral symptoms and delayed pain response to EIMD. Evidence points towards these brain areas and frequencies may regulate the pain response acutely while experiencing the symptoms of EIMD during movement.

16:05 - 17:35

## Invited symposia

### IS-PM02 ACSM Exchange Symposium/Pacing : Who Got the Turtle's Running Shoes?

#### WHO GOT THE TURTLE'S RUNNING SHOES?

de Koning, J.J.1, Foster, C.2

*(1) VU University, Amsterdam and (2) University of Wisconsin-La Crosse, La Crosse*

Carl Foster, Ph.D., FACSM, University of Wisconsin-La Crosse Why Do they Do it that Way? In 1987, American author Ed Regis wrote a very engaging book 'Who Got Einstein's Office?'. Despite it's name, the book was not about the interfaculty squabbling over who inherited the office of the man who changed the course of physics, but over the interplay between the theoretical and experimental physics communities, and how their work is a complimentary necessity to progress in physics. In the early 1990's, independent interest in how humans distribute their energetic reserves during heavy exercise (pacing strategy) arose nearly simultaneously in Europe (Amsterdam) and the U.S.(Milwaukee). However, the initial approach to answering the question about why the turtle beat the hare was strikingly different, being more of a theoretical-first principles analysis in Europe (van Ingen Schenau and de Koning) and more pragmatic-descriptive in the U.S. (Foster). In this lecture we present a historical overview of how these two decidedly different approaches, which in some ways characterize more fundamental differences between the approach to problem solving in Europe and the U.S., worked in a complimentary fashion, and integrated themselves with approaches to the same problem from other laboratories, to allow progress relative to understanding how the cultural differences between Europe and the U.S. combine to provide insight into problem solving.

#### WHO GOT THE TURTLE'S RUNNING SHOES?

Foster, C.1, de Koning, J.2

*(1) University of Wisconsin-La Crosse, La Crosse, (2) VU University, Amsterdam*

Carl Foster, Ph.D., FACSM, University of Wisconsin-La Crosse Why Do they Do it that Way? In 1987, American author Ed Regis wrote a very engaging book 'Who Got Einstein's Office?'. Despite it's name, the book was not about the interfaculty squabbling over who inherited the office of the man who changed the course of physics, but over the interplay between the theoretical and experimental physics communities, and how their work is a complimentary necessity to progress in physics. In the early 1990's, independent interest in how humans distribute their energetic reserves during heavy exercise (pacing strategy) arose nearly simultaneously in Europe (Amsterdam) and the U.S.(Milwaukee). However, the initial approach to answering the question about why the turtle beat the hare was strikingly different, being more of a theoretical-first principles analysis in Europe (van Ingen Schenau and de Koning) and more pragmatic-descriptive in the U.S. (Foster). In this lecture we present a historical overview of how these two decidedly different approaches, which in some ways characterize more fundamental differences between the approach to problem solving in Europe and the U.S., worked in a complimentary fashion, and integrated themselves with approaches to the same problem from other laboratories, to allow progress relative to understanding how the cultural differences between Europe and the U.S. combine to provide insight into problem solving.

16:05 - 17:35

## Oral presentations

### OP-SH03 Management and economics in sports

#### WHAT BRINGS FANS INTO THE STADIUM? QUESTIONNAIRE ABOUT THE MOTIVES FOR SOCCER ATTENDANCE IN BELGIUM AND IN PORTUGAL

de Carvalho, M.1,2, Sarmiento, J.2, Boen, F.1, Scheerder, J.1

*KU Leuven (België) & UP (Portugal)*

The motives that take people into the soccer stadium have been studied in diverse research domains including marketing, sociology, and psychology. Smith & Stewart(2007) collected 6 factors that moderate sport consumption behaviour: sport context, competition, physical environment, economic, promotional and social context. From a sociological perspective, Funk et al.(2009) provided a parsimonious measuring tool of 5 motives to explain sport event attendance (Socialization, Performance, Excitement, Esteem, and Diversion). From a psychological approach, team identification (Wann&Branscombe,1993) and place attachment (Theodorakis et al.,2010) have also been shown to predict attendance. Nevertheless, we still lack a common language and a model that can integrate all these angles. The aim of our study is to identify the motives that take soccer fans into the stadium or not, taking into account all the above mentioned perspectives. Therefore, a questionnaire was designed to conduct a cross-cultural comparison in Belgium and Portugal. Methods Based on a thorough scrutiny of the available literature, a 1st version of a questionnaire was elaborated in Dutch. A pilot study was conducted with a sample of 70 individuals. The questionnaire had several flaws, namely, in the extension, and organization. The corrected version in Dutch was translated to Portuguese and a pilot study was also performed, with a sample of 40 individuals. Minor changes were executed and a last version was accomplished. Results The final version of the questionnaire includes 3 parts: (i)the person as a soccer fan (including loyalty questions, team and place identification scales and social items) (ii)consumption habits, and choices (iii)socio-demographical items. We expect that for different clusters of individuals the relative weight of attendance predictors differs. We hypothesise that less attached fans will be more influenced by the service quality than more attached fans. Conclusion This questionnaire is being applied on-line in 2 studies reaching: (i) an intercultural wide-ranging population by means of the educational system from one Portuguese (i.e. Aveiro) and one Belgian city (i.e. Leuven), with a soccer club playing in the 1st league (Beira-Mar and OHL); (ii) an intercultural diverse

population by the means of internet. Data is being analysed and further results will be presented. References Funk D, Filo K, Beaton A & Pritchard M(2009). Measuring the motives of sport event attendance: bridging the academic-practitioner divide to understanding behavior. *SMQ*, 18,126-138. Smith A & Stewart B(2007). The Travelling Fan: Understanding the Mechanisms of Sport Fan Consumption in a Sport Tourism Setting. *JS&T*, 12(3-4),155-181. Theodorakis N, Wann D, Carvalho M & Sarmento P(2010). Translation and Initial Validation of the Portuguese version of the Sport Spectator Identification Scale. *NAJP*, 12(1),67-80. Wann D & Branscombe N(1993). Sport fans: Measuring degree of identification with their team. *USP*, 24,1-17.

### **ASSET SPECIFICITY IN SPORT – HOW CENTRALIZED SHOULD AN EFFICIENT PRODUCTION OF ELITE SPORTING SUCCESS BE?**

Flatau, J.

*University of the Saarland*

Research Problem Sporting success is a product of giftedness and training. Since the first can be assumed to be distributed equally and the latter causes costs it is not surprising that virtually all surveys on collective sporting success identify population size and gross income product (a proxy variable for financial power) as explaining variables. Hence, from an economic perspective, the productivity of the promotion of elite sport becomes the focus of attention. Theory Every production can be organized more or less hierarchically. According to Williamson (1985), the general comparative profitability of markets decline as the asset specificity of the product and therefore the market transaction costs increase. Applying this approach to collective sporting success, the question is whether its in many countries currently quite hierarchical promotion system could be decentralized without a decline in effectiveness but in costs. Our hypothesis is that asset specificity varies strongly across the different sport and that therefore this but also national characteristics ought to be taken into account for the design of an efficiency-optimized promotion system. State of Research For the field of the promotion of talent development, Emrich & Pierdzioch (2011) identified over-centralization with regard to productivity and Flatau & Emrich (2011) could prove the dependency of that lack of efficiency on the sport-related site and physical asset specificity as assumed above. Here, we present analogous analyses for the promotion of short-term sporting success. Method Using a questionnaire survey sample of 1,558 elite athletes, we compare the sporting success of those preparing for competition (i.e., training, medical/scientific services etc.) centralized at Olympic Training Centres with that of those preparing decentralized (in sport clubs etc.) and measure in how far this relation is intervened by asset specificity, the popularity and the degree of commercialization of the respective sport. Other than in preceding analyses we use metric parameters for site as well as for physical asset specificity basing on training site/facility density and cost measurement. Results and Discussion The results confirm the assumption that the comparative efficiency disadvantages of centralized production of sporting success decrease with increasing asset specificity. Hence, a cost-optimized production of sporting success ought to confine costly centralized promotion organizations to sport with high asset specificity. References Emrich, E, Pierdzioch, C (2011). Konvergenz und Effizienz? In K. Bohr & A. Krause (eds.), 20 Jahre Deutsche Einheit (p. 105-122). Nomos, Baden-Baden. Flatau, J., Emrich, E. (2011). Sportwissenschaft, 41 (Supl. 2), 100-111. Williamson, O.E. (1985). *The Economic Institutions of Capitalism*. Free Press, New York.

### **CONFIGURATIONS OF EUROPEAN NATIONAL SPORTS SYSTEMS: A SOCIO-ECONOMIC APPROACH.**

Camy, J.

*University of Lyon*

Introduction Is it possible to conceive of sport in Europe as contributing to "national sports systems"? Can we compare these various national sports systems and identify different configurations within them? Our intention here is to test a new, systematic and quantifiable socio-economic theoretical model, to enable us to respond to these questions. Theoretical framework Socio-economics does not consider economics as a distinct and autonomous system to which all other social phenomena must submit (Polanyi, 1944). Our analysis combines two resources; the first, "Economic "regulation theory" (Boyer, 1990) which states as its object, "the study of the transformation of social relations, which creates new forms- both economic and non-economic- organized in structures and reproducing a determined global structure" and the second "constructivist structuralism" which "views each activity including economic ones as 'total social facts' " (Bourdieu 2000). We consider sport as a sector (corresponding to group 93.1 of the NACE 2008 classification). Our basic premise is that the sector is made up of five components, which are all present in most E.U. countries. Each one of these offers specific sport services: professional sport, voluntary competitive sport, commercial sporting leisure, voluntary sporting leisure and public sport services. National sport systems are characterized by a particular combination of these components and by the type of intra- and inter-regulations which are in place. Methodology The characteristics of each of these components can be identified and measured by key indicators. We have tried out our theoretical model against various empirical researches conducted within the E.U. (Vocasport, Eurobarometers, Study on the private and public financing of sport, etc...), along with other sources of information. By making use of social and economic data we have been able to characterize the situation of sport in E.U. countries. Results On the basis of restricted number of key indicators, we have first of all clearly identified different types of national sports systems characterized by both the disparities in economic and social importance of their components and by the form of regulation existing between them. Following this first observation, we would propose a provisional typology of the national sports systems", settling upon four main "configurations" which we have called "entrepreneurial", "missionary", "bureaucratic" and "social". References Amnyos (2008), Study on the public and private financing of sport in Europe, French Ministry of Sports. Bourdieu P. (2005) *The Social Structures of the Economy*, Polity Press. Boyer R. (1990) *The regulation school : a critical introduction*, Columbia University Press EOSE (2004) Vocasport, Report for the European Commission (DG Education and Culture). Polanyi K. (1944), *The great transformation*, Rinehart, New-York.

### **PATHWAYS OF SCIENCE: FROM PHYSICAL EDUCATION AND PHYSIOTHERAPY TO RADIODIAGNOSTICS AND RADIOTHERAPY AT THE STATE UNIVERSITY IN GHENT, 1906-1936**

Delheye, P., Vangrunderbeek, H.

*K.U.Leuven - FaBeR*

Introduction The development of new scientific specializations is partially determined by the migration of researchers between and within universities. This case-study focuses on the complex triangular relationship between medicine, physiotherapy and physical education. As previous research has demonstrated, the first international congress on physiotherapy was organised in Belgium in 1905. Furthermore, the Belgian State was an international pioneer with the creation of the Higher Institute of Physical Education (HIPE) at the State University in Ghent in 1908 (Delheye 2005). Methods The study is based on research in the State Archives of Belgium and in the archives of Ghent

University. Institutional documents and correspondence of protagonists were analyzed. Results In 1908, the Belgian State appointed two physiatrists, Florent Gommaerts and Jules De Nobele, to the HIPE, which was attached to the Faculty of Medicine. During their academic career, Gommaerts and De Nobele profiled themselves almost exclusively within the new field of physiotherapy. As a consequence, research in physical education was hardly developed. As physiatrists (physicians-physiotherapists), Gommaerts and De Nobele struggled with an inferior academic and scientific status, as compared to their colleagues within the Faculty of Medicine. Territorial conflicts and power struggles manifested themselves in several areas. As a result of the succession of this first generation of physiatrists, however, physiotherapy was integrated fully into the Faculty of Medicine in the middle of the 1930s. At the same time, radiography, radiodiagnosics, and radiotherapy – which originally were considered sub-disciplines of physiotherapy – gained independence within the Faculty of Medicine. Discussion/Conclusion At the State University of Ghent, physical education was instrumental to the upwards scientific mobility of physiotherapy. Via the HIPE, indeed, physiatrists could migrate upwards to the Faculty of Medicine. Physical education, for its part, retained its inferior status after physicians-physiologists took over the leadership of the institutes for physical education from 1935 onwards. Further research is needed to demonstrate whether or not these early developments at the State University in Ghent occurred also internationally in a similar way. References Pascal Delheye, Struggling for Gymnastics. The Scientisation and Institutionalisation of Physical Education in Belgium (1830-1914) (PhD. diss, KU Leuven, 2005).

### **SPORT AND IMMIGRATION IN FRANCE IN THE THIRTIES. SPORT PRACTICES OF POLISH MIGRANTS IN BURGUNDY, A MEAN OF INTEGRATION?**

Bretin-Maffioletti, K.

*Université de Bourgogne - Faculté des Sciences du Sport*

In multicultural societies, such as the French society, the integration of « foreigners » is of major interest (Noiriél, 1988). This is particularly true during economical and cultural crisis periods, when social cohesion is endangered. Since the eighties, sport practice is presented and used by politicians as a way to encourage integration (Gastaut, 2004). This vision of sport is inspired by the original thinking of the first English modern sport advocates. It is also built on the mythical and historical figures of great champions coming from the French colonies or from immigration (Gastaut, 2004). For example, Alfred Nakache (swimmer) and Alain Mimoun (runner), coming from Algeria, Alfredo Binda (cyclist), coming from Italy and of course Raymond Kopa and Michel Platini (soccer players), coming from Polish and Italian immigration. However, besides these extraordinary careers, the integrative role of sport for people who arrived in France all along the 20th century remains to be explored. This communication focuses on ordinary sport and leisure practices in a community of Polish migrants, who arrived in a mining region of Burgundy in the thirties. The aim is to determine the effects of sport practice on social integration and on the relationships with the local community. In the absence of archives, the study methodology consists of oral interviews of the first generation of migrants and their descendants. Data extraction is based on content analysis and discourse analysis. Sport appears as an essential aspect of migrants' everyday life, which facilitated their adaptation to new working and living conditions. On the contrary, Polish sport practices took place in community societies. These Polish organizations probably confirmed the distance between French workers and foreigners. Lastly, the accounts traduce identity switches, as revealed by changing competitive situations. The current study suggests that the integrative role of sport can be limited in History. Secondly, and more importantly, this analysis shows a complicated migrants' situation that can't be reduced to an integration/exclusion dialectic. GASTAUT, Y. (2004). "L'intégration par le sport, réalités et illusions". Cahiers français, n°320, Paris : La Documentation française, pp. 58-63. NOIRIEL, G. (1988). Le creuset français, histoire de l'immigration, XIXe-XXe siècles. Paris : Le Seuil, 441 pp.

**16:05 - 17:35**

## **Oral presentations**

### **OP-PM14 Sports Medicine 2**

#### **PHYSICAL PRACTICE AT LOW INTENSITY AND ANTIOXIDANTS STATUS IN ELDERLY PEOPLE**

Bouزيد, M.A.1, Fabre, C.1

*University Lille 2*

Physical practice at low intensity and antioxidants status in elderly people Bouزيد, M-A.1 Fabre, C.1 1: Université de Lille 2, EA-4488: Activité Physique, Muscle Santé, France Introduction There is an imbalance between oxidants/antioxidants with age in favor of oxidants. Moderate or high chronic exercise can reverse this phenomenon. However the majority of elderly people prefer practice low intensity training exercise like gym maintenance. The aim of this study was to demonstrate the effects of low intensity training on both resting and exercise-induced antioxidant status in two groups: active vs sedentary subjects. Methods 10 active subjects whose practice gym maintenance at least since 2 years (Age:  $68.1 \pm 6.6$  years; High:  $1.64 \pm 0.08$  m; Weight:  $68.4 \pm 6.4$  Kg) and 10 sedentary subjects (Age:  $65.1 \pm 3.5$  years; High:  $1.62 \pm 0.15$  m; Weight:  $71.8 \pm 18.6$  Kg) performed an incremental exercise test on cyclo-ergometer. Blood samples were taken, by an intravenous catheter, at rest and at 20 minutes of recovery. The measured parameters were superoxide dismutase (SOD), glutathione peroxidase (GPX), glutathione reductase (GR),  $\alpha$ -tocopherol, and ascorbic acid. Results At rest, active subjects had higher value of SOD (+9,8%) compared to the sedentary subjects ( $p < 0.05$ ). At the recovery, plasma concentrations GR and GPX increased significantly above resting values for both the two groups ( $p < 0.01$ ). A significant increase at the recovery (+10%) was observed on  $\alpha$ -Tocopherol level only for the active group ( $p < 0.05$ ). Discussion Our data showed that active subjects present higher levels on some antioxidants at rest and at the recovery compared to the sedentary group. Many studies reported that physical training improves body's ability to fight against the deleterious effects of free radicals by increasing the effectiveness of the antioxidant system. Cabrera et al [1] demonstrated that reactive oxygen species (ROS) produced during physical training play an important role in the regulation of gene antioxidant expression. The increase of rate of these species produced during exercise activates MAPKs. This in turn activates the NF- $\kappa$ B pathway and consequently the expression of antioxidant enzymes associated with defense against ROS. References [1] Gomez-Cabrera M, Domenech E, Viña J. Moderate exercise is an antioxidant: Upregulation of antioxidant genes by training. Free Rad Bio & Med (2008) 126–131



## ASSESSMENT OF CARDIORESPIRATORY FITNESS IN EPIDEMIOLOGICAL STUDIES – RECOMMENDING STEP TEST OR CYCLING ERGOMETRY?

Trampisch, U.1, Winzen, M.2, Jensen, K.2, Franke, J.3, Platen, P.2

(1+2) Ruhr-University Bochum, (3) University of Saarland

**Introduction** Physical activity and cardiorespiratory fitness (CRF) are both inversely associated to e.g. risk of mortality, type 2 diabetes and coronary heart disease. The effect of CRF itself remains significant even after adjusting for physical activity. Consequently, CRF should be assessed in addition to physical activity as main exposure variable in epidemiological studies. This underlines the need for a valid and precise assessment of physical fitness to avoid the introduction of bias. The gold standard to assess CRF is a standardized maximal treadmill exercise test with direct measurement of maximal oxygen uptake (VO<sub>2</sub>max). But conducting this test for the entire population in epidemiological studies is seldom feasible. The applicability of conducting exercise tests under submaximal conditions is greater. Submaximal tests such as step test or cycling ergometry allow the prediction of VO<sub>2</sub>max. Unfortunately, little is known if these submaximal tests reflect the actual individual's fitness. The aim of the study was to 1) analyze the validity of two submaximal CRF tests, step test and cycling ergometer test, within a cohort of adults and 2) recommend either step test or cycling ergometer test for further application within epidemiological studies. **Methods** Participants were 24 women and 27 men, age 22–67 yr. VO<sub>2</sub>max was assessed by a maximal treadmill exercise test following the modified Bruce protocol. Results served as gold standard for the assessment of criterion validity of the submaximal tests. Step test was performed following the protocol of the modified Canadian Aerobic Fitness Test with slight modifications. Cycle ergometry was performed following the standardized WHO protocol. VO<sub>2</sub>max was predicted for both submaximal tests by regression equations. VO<sub>2</sub>max was correlated with the predicted VO<sub>2</sub>max obtained from step test and cycling ergometry by Intra-Class-Correlation (two-way mixed, consistency). **Results** Directly measured VO<sub>2</sub>max during treadmill test (reference) and predicted VO<sub>2</sub>max from step test were associated with ICC=0.78 (95%CI: 0.63; 0.87), and from cycling ergometry with ICC=0.79 (95%CI: 0.65; 0.87). Bland-Altman Plots did not show any systematic bias. **Discussion** Predicted VO<sub>2</sub>max of submaximal CRF tests, step test and cycling ergometry, showed both comparatively high association to the gold standard. Cycling ergometry turned out to be more feasible and standardisable for participants and study personnel compared to step test during examination. In order to assess CRF in epidemiological studies, we recommend submaximal cycling ergometer test.

## HIGH INTENSITY INTERVAL TRAINING DECREASES MYOCARDIAL GLUCOSE UPTAKE

Eskelinen, J.J.1, Hannukainen, J.1, Savolainen, A.1, Heinonen, I.1, Virtanen, K.1, Kapanen, J.3, Nuutila, P.1, Knutti, J.1, Kalliokoski, K.1

University of Turku

**Introduction** Aerobic exercise training (AET) induces eccentric cardiac hypertrophy with improved contractile function. These changes are associated with changes in cardiac metabolism towards increased glucose utilization and reduced fat utilization. Recent studies suggest that anaerobic high-intensity interval training (HIT) may provide the same health-enhancing effects as AET. However, it is largely unknown what kind of changes HIT induces in cardiac metabolism and function. Thus, the purpose of the present study was to investigate the effects of HIT on myocardial glucose and fatty acid uptake (GU and FFAU) using positron emission tomography (PET) and cardiac structure and function using magnetic resonance imaging (MRI). **Methods** Eighteen healthy sedentary middle-aged men were recruited into the study. They were randomly divided into HIT group (n=9) and AET group (n=9). Within two weeks, the subjects in HIT group finished six training sessions each consisting of 4 to 6 times 30-seconds "all out" sprints (Wingate-type) with 4 min rest between sprints. Correspondingly the subjects in AET group did six training sessions consisting of 40-60 min of cycling at the intensity of 60% of max workload in VO<sub>2</sub>max -test. Myocardial GU and FFAU were measured using PET and <sup>18</sup>F-FDG and <sup>18</sup>F-FTHA tracers before and after the exercise intervention. Structural and functional changes in heart were measured using MRI on second day after the last training session. VO<sub>2</sub>max-test until volitional exhaustion was performed before and after the last training session. **Results** Measurements and data analyses are still partly ongoing, but all the subjects in HIT group have completed the study. HIT enhanced VO<sub>2</sub>max by 5% (from 33.9 ± 3.8 ml/kg/min to 35.5 ± 3.7 ml/kg/min, p = 0.019) and the maximal workload by 8% (224 ± 31 W to 241 ± 31 W, p = 0.010) in the VO<sub>2</sub>max-test. Myocardial GU during euglycemic hyperinsulinemic clamp decreased in HIT group by 22% (34.9 ± 10.0 μmol/100 g/min to 27.3 ± 11.1 μmol/100 g/min, n = 7, p = 0.041), while whole-body glucose uptake increased non-significantly by 11% (p = 0.21). Myocardial FFAU and cardiac functional and structural data for both groups are under analysis. **Discussion** This partly incomplete data suggests that HIT induces different changes in cardiac metabolism (decreased glucose uptake) than previously reported for AET. Interestingly this is similar change as seen in heart failure patients and may suggest that extreme HIT training is not necessarily acutely so healthy for heart of sedentary middle-aged men without good preparation with increasing exercise intensities over longer period of time.

## THE MODERN RUGBY PLAYER: ARE WE BREEDING GIANTS AND WHAT ARE THE CONSEQUENCES?

De Ridder, J.H., Van den Berg, P.H.

North-West University

**Introduction** Although physique is not the only factor determining success in sport, the modern game of rugby union has become a sport in which the physique of the players is a very important predictor of success. Furthermore the economic, political and social drivers of sporting success will act to select body types which conform more and more to an ideal morphology (Olds, 2001). In rugby, the rates of increase in height and body mass appear to have outstripped secular trends in the population from which these athletes are drawn. Therefore, the aim of this presentation is to answer the question resulting from existing anthropometric data, on whether we are busy breeding giants to play rugby and also to demonstrate the consequences this will have in future. **Methods** The anthropometric data of the two most trendsetting studies on this topic were used. The first study was done on 1420 male rugby players drawn from 21 separate reports and communications between 1905 and 1999 on elite, national and state players (Olds, 2001). The second study was done on the national team of South Africa (Springboks). Data of 1349 rugby players between 1896 and 2004 were mapped (De Ridder & Meyer, 2007). **Results** In the study done by Olds (2001) the results suggest that the rates of increase of body mass and BMI are well above those of the general population of young males. The study by De Ridder & Meyer (2007), suggest major shifts in the body size and shape of the rugby players, with the players as a whole becoming taller and heavier. The data also suggests that the rates of increase of body mass and BMI in the Springboks are well above those of the general population of young males. **Discussion** Recognition of the importance of the demands of the game of rugby on the modern player's physique, has led to a tendency for coaches to favour increasingly taller and heavier players, even for backline positions. Taken into consideration that rugby has one of the highest injury rates when compared to

other team sports, this has the potential to result in a big increase in the incidence of injuries in rugby in the future. Conclusion The final rankings of the rugby teams at the recent 2011 World Cup in New Zealand, demonstrate that large body size is a significant predictor of success in rugby union. Rugby has become a fast-moving and high intensity gladiator sport, featuring big tackles and giant players. This could have a great impact on the game in the future and especially the players are going to feel the effects of injuries later in life. References Olds, T. (2001). The evolution of physique in male rugby union players in the twentieth century. *Journal of Sports Science*, 19, 253-262 De Ridder, J.H. & Meyer, E. (2007). The evolution of body size in Springbok rugby players: 1896-2004. *Scientific contributions, Series H: Inaugural address no. 202. NWU: Potchefstroom.*

### **MODERATORS INFLUENCING THE IMPACT OF PHYSICAL EXERCISE ON FATIGUE IN PATIENTS UNDERGOING ALLOGENEIC HEMATOPOIETIC STEM CELL TRANSPLANTATION**

Vandenbergh, D.1, Bohus, M.2, Dreger, P.3, Schwerdfeger, R.4, Jäger, D.5, Ulrich, C.M.1, Kühl, R.1, Wiskemann, J.1,5  
1:Preventive Oncology, NCT/DKFZ, Heidelberg2:Central Institute of Mental Health, Mannheim; 3:University Clinic Heidelberg4:German Clinic for Diagnostics, Wiesbaden5:Medical Oncology, NCT Heidelberg

**Introduction** Allo-HSCT is a curative yet demanding treatment option in the field of hemato-oncology. In a recent randomized controlled trial (RCT) our group could show that a partly self-administered exercise program can improve cancer-related fatigue (CRF)(1). For a better understanding of these findings we are going to investigate possible moderators of this effect. **Methods** The data of 80 patients participating in a RCT were analyzed. Experimental group patients performed strength and aerobic exercise intervention and were compared to a social contact control group. The exact study design is described elsewhere (1). CRF was measured using the Multidimensional Fatigue Inventory (MFI) (subscales General Fatigue (GF), Physical Fatigue (PF)) and the fatigue scale of the Profile of Moods States (POMS-F) questionnaire. Moderator analysis is based on the findings of Baron and Kenny (2). Hypothesis As reported by Courneya et al. (3) we hypothesize that the effects of exercise on CRF is moderated by clinically relevant variables. According to their findings we selected five possible moderators: Age, Body Mass Index (BMI), Risk group, conditioning regime, Sense of Coherence (SOC). **Results** For all dependent fatigue variables (GF, PF, POMS-F), group allocation remained the only significant (all  $p < .05$ ) independent variable when controlled for possible moderators (all  $p > .168$ ). Results were different for SOC. Even though it isn't a moderator for any outcome, its contribution to the analysis of CRF's variance is as significant ( $\beta = -.382$ ,  $p < .0005$ ) as it is for group allocation ( $\beta = -.349$ ,  $p = .001$ ). **Discussion** Our results show that the effect of exercise on CRF in allo-HSCT patients is not moderated by clinically relevant variables. No matter what the patient's age, BMI, conditioning regime or risk group is, the intervention seems to be beneficial for all. This is an important finding because it supports the necessity of an accompanying exercise program for all allo-HSCT patients. **References** (1)Wiskemann J., et al., *Blood*. 2011;117:2604-2613 (2)Baron RM., et al., *J Pers Soc Psychol*. 1986;51(6):1173-82 (3)Courneya K., et al., *Cancer Epidemiol Biomarkers Prev*. 2009;18:2600-2607

**16:05 - 17:35**

## **Oral presentations**

### **OP-PM15 Health and Fitness 2**

#### **EFFECT OF COMBINED EXERCISE TRAINING ON PHYSICAL AND METABOLIC FITNESS IN ADULTS WITH INTELLECTUAL DISABILITY: A CONTROLLED TRIAL.**

Calders, P., Elmahgoub, S., de Mettelinge, T.R., Vandenbroeck, C., Dewandele, I., Rombaut, L., Vandeveldel, A., Cambier, D.

*Arteveldehogeschool / Universiteit Gent*

**INTRODUCTION:** The purpose of this study is to evaluate the effect of combined aerobic and strength training on metabolic and physical fitness in adults with intellectual disabilities compared to endurance training and no training. **METHODS:** This study is a controlled trial with patients receiving either combined (COM), endurance (END) or no training (C). Forty-five adults with intellectual disabilities (mean age: 42 (9,2), mean body mass index (BMI): 24 (3,9), mean IQ: 56 (5,6)) were recruited from two centres for intellectual disabilities (Sterrenhuis, Brasschaat and Emiliani, Lokeren, Belgium). Subjects received either combined aerobic and strength exercise training (n=15) or endurance training (n=15) twice a week for 70 minutes per session for 20 weeks or no training (n=15). Groups were matched for age, sex and intellectual disability. Before and after the training period lipid profile (triglycerides, HDL, LDL and total cholesterol), physical fitness (aerobic capacity, muscle strength); blood pressure (resting systolic and diastolic) and body composition (BMI, waist, fat mass and fat free mass) were evaluated. **RESULTS:** Compared to no training, combined exercise training has significant positive effects on total cholesterol levels, aerobic capacity, muscle strength and resting systolic blood pressure, while endurance exercise training has significant effects on aerobic capacity and resting systolic blood pressure. Compared to endurance training, combined exercise training resulted in a significant better evolution of total cholesterol (mean differences: -18 versus -3mg/dl), 1RM upper (+6 versus +1 kg) and lower limb (+25 versus +8kg) and abdominal muscles (+15 versus +1kg), hand grip strength (+9 versus +2kg), muscle fatigue resistance (+11 versus +5sec), sit-to-stand (+5 versus +2/30sec) and systolic blood pressure (-15 versus -10 mmHg). **CONCLUSION:** This study revealed a tendency towards more beneficial effects of combined exercise training in adults with intellectual disability.

#### **EFFECT OF AN EXERCISE INTERVENTION PROGRAM ON BALANCE, FLEXIBILITY AND MUSCLE ENDURANCE OF PERSONS WITH INTELLECTUAL DISABILITY**

Moss, S.J., Beukes, E., Oosthuizen, C.

*North-West University*

**Introduction:** Persons with intellectual disability are more prone to be inactive than the normal population (Fernhall et al., 1996). This increased level of inactivity may be associated with functional capacity decline with a further reduction in activity levels. The aim of this study was to investigate the effect of a physical exercise intervention program on balance, flexibility and muscle endurance in adults with

intellectual disability (ID). Methods: Participants with severe and profound ID ( $n = 33$ ) were recruited for participation in this study. Consent was obtained after the tests were demonstrated to the subjects. Balance (Biodex), flexibility (sit-and-reach test), and muscle endurance (upper body, lower body and abdominal endurance) were determined at baseline and end of the intervention period. A physical exercise intervention program was conducted four days a week for four consecutive weeks for 1 hour. Descriptive statistics (SPSS vers 15.0) were performed to determine the baseline characteristics of the subjects Independent t-tests were performed to determine differences between the males and females with dependent t-tests performed to determine changes from baseline to end for the variables. Results: The females presented with a BMI ( $31.2 \pm 5.1$  kg/m<sup>2</sup>) significantly higher than the males ( $26.6 \pm 6.5$  kg/m<sup>2</sup>). The females however reported higher values than the males for upper body muscle endurance, lower body muscle endurance, abdominal muscle endurance and flexibility. The males reported better total balance than the females. The results of the exercise intervention indicated that the adherence to the intervention was 64%. Improvements in all variables were reported, with a significant improvement in total balance ( $p=0.023$ ). Discussion: Persons with intellectual disabilities have been neglected with regards to participation in physical activity and exercise interventions. Previous research has found that regular exercise reduces risk factors for coronary heart disease in persons with intellectual disability (Moss, 2009). The major finding of this study is that an exercise intervention of four weeks aimed at functional fitness of persons with ID will improve balance, flexibility and muscle endurance. Improvement of functional fitness in persons with ID may improve self sufficiency in persons with ID. References: Fernhall B., Pitetti K.H., Rimmer J., McCubbin J.A., Rintala P., Millar L., et al. (1996). Cardiopulmonary capacity of individuals with mental retardation including Down syndrome. *Medicine and Science in Sports and Exercise* 28, 366 – 371. Moss, S.J. 2009. Changes in coronary heart disease risk profile of adults with intellectual disabilities following a physical activity intervention. *Journal of Intellectual Disability Research*, 53(8):735-744.

### RELATIONSHIP BETWEEN METABOLIC SYNDROME RISK AND CARDIOVASCULAR FITNESS

Peinado, S., Romero, B., Morencos, E., Peinado, A.B., Butragueno, J., Cupeiro, R., Rojo-Tirado, M.A., Calderon, F.J., Benito, P.J.

*Facultad de Ciencias de la Actividad Física y del Deporte (INEF). Universidad Politécnica de Madrid.*

Introduction There are many epidemiological studies that determine the relationship between metabolic syndrome and cardiorespiratory fitness (1,2). These studies need to be concluded by using randomized controlled clinical trials. The aim of the present study is to determine if there is a correlation between cardiovascular fitness (CVF) and metabolic syndrome risk (MS risk)(3,4) after improving the the VO<sub>2</sub>max in overweight people. Methods Eighty-four overweight people (18–50 years; BMI>25 and <30 kg/m<sup>2</sup>) were randomized to one of the following groups: strength training (S;  $n=19$ ), aerobic training (E;  $n=25$ ), a combined S and E training (SE;  $n=22$ ), 3 times/wk for 24 wk, and diet and physical recommendations group (C;  $n=18$ ). All of them in combination with diet restriction. The measurements took place for all subjects before training at weeks 1 to 2, and after 22 weeks of training in weeks 23 to 24. All groups were evaluated for changes in blood concentrations for lipoprotein-lipids, cardiovascular fitness with an incremental test, body composition and dietary composition. Two-way ANOVA with repeated measures was used to determine differences between pre and post intervention in each training group. The Pearson's correlation coefficients were used to analyze the relationship between cardiovascular fitness and metabolic syndrome risk. The level of significance was set at  $\alpha=0.05$ . Results No significant correlations were found between cardiovascular fitness change and metabolic risk syndrome. S and SE obtained correlations trend toward significance (S:  $r=0.43$ ,  $p=0.06$ ; SE:  $r=0.37$ ,  $p=0.09$ ). Significant improvements in peak oxygen uptake (VO<sub>2</sub>peak) were obtained in all groups S (19%), E (19%), SE (17,76%) and C (19%). MS Risk decreased significantly in S and SE (S: -42,4%, SE: -31,1%,  $p<0,05$ ). Discussion The main finding of the present study was that the groups that improved significantly MS risk obtained correlations trend toward significance with CVF. A randomized controlled clinical trial using a larger sample size would presumably find significant correlations between MS risk and CVF, being able to prove what previous epidemiological studies have evidenced (1,2). References 1. LaMonte M, Barlow C, Jurca R, et al. (2005). *Circulation*,112,505-512. 2. Grundy S, Barlow C, Farrell S, et al. (2012). *Am J Cardiol*. Epub ahead of print. 3. Johnson J, Slenz C, Houmard J, et al. (2007). *Am J Cardiol*, 100,1759-1766. 4. Grundy S, Cleeman J, Bairy C, et al. (2004). *Circulation*,110,227-239.

### LIFE QUALITY AND CARDIOVASCULAR RISK FACTORS IN PARTICIPANTS OF WORLD BIKE TOUR SP

Benetti, M., Sierra, A., Gabriel, E., Kiss, M.A.P.D., Cortez, J.A.A., Martini, J.S.C., Bastos, F.C.

*University of Sao Paulo*

Cardiovascular diseases are responsible for the largest amount of deaths resulting of coronary artery disease (CAD) and are the main cause of expenses in medical assistance. About 85-90% of the patients with CAD present many modifiable cardiovascular risk factors represented by hypertension, smoking, hypercholesterolemia, diabetes mellitus, sedentary lifestyle, and obesity, and no modifiable risk factors as advanced age, familiar history of sudden death. There are evidences that the atherosclerotic process begins in childhood and its severity is proportional to the cardiovascular risk factors (CRF) and life quality, with the cardiovascular prevention requiring primary and secondary interventions. The SF 36 questionnaire produces a health functioning profile based on psychometric measures. The components of life quality are divided into eight concepts: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE) and mental health (MH). Thus, the objective of this research was to determine the life quality profile and the frequency of cardiovascular risk factors in participants of a bike ride called World Bike Tour São Paulo, as well as comparing these concepts according to the gender of the individual. Methods: the event had 8000 participants, 1300 of which , 889 male (68.38%) and 411 female (31.62%), aged between 12 and 80 years ( $34.9 \pm 9.9$  years), answered the SF 36 questionnaire, Portuguese version, and 8 questions about cardiovascular risk factors recommended by the American College of Sports Medicine. For the analysis, we established a raw scale (0-100) average and standard deviation (STDEV) for each concept and a frequency for the cardiovascular risk factors. We used t-Student test to compare the groups by gender. Results: average and STDEV for the general (G), men (M) and women (W) group MH – G  $76.74 \pm 15.88$ ; M  $77.36 \pm 15.45$ ; W  $75.37 \pm 16.70$ \* RE – G  $82.13 \pm 31.11$ ; M  $81.92 \pm 30.85$ ; W  $82.56 \pm 31.68$  SF – G  $86.64 \pm 17.05$ ; M  $87.06 \pm 16.75$ ; W  $85.73 \pm 17.65$  VT – G  $71.35 \pm 16.97$ ; M  $72.18 \pm 16.46$ ; W  $69.53 \pm 17.88$ \* GH – G  $81.41 \pm 14.75$ ; M  $80.83 \pm 14.74$ ; W  $82.64 \pm 14.68$ \* BP – G  $80.40 \pm 17.57$ ; M  $80.33 \pm 17.25$ ; W  $80.52 \pm 18.23$  RP – G  $86.15 \pm 25.14$ ; M  $85.54 \pm 25.09$ ; W  $87.46 \pm 25.20$  PF – G  $92.68 \pm 10.98$ ; M  $93.45 \pm 10.15$ ; W  $91 \pm 12.43$ \* Obesity – G 12.77%; M 13.9%; W 10.4% Sedentary lifestyle – G 27.64%; M 28.6%; W 25.5% Diabetes – G 2.7%; M 3%; W 2% Smoking – G 5.48%; M 7.1%; W 5.1% Hypertension – G 9.46%; M 11.1%; W 5.9%\* Hypercholesterolemia – G 14.26%; M 15.8%; W 10.8%\* Advanced Age – G 15.21%; M 19.3%; W 6.4% Familiar history – G 13.15%; M 13.1%; W 13.3% At least one CRF: G 57.7%; M 50.87%; W 50.77% At least one modifiable CRF: G 47.1%; M 49.09%; W 42.68% \* $P<0.05$  Conclusion: The concepts presented a statistical difference between the gender groups for VT, GH and PF, as well as for the risk factors hypertension and hypercholesterolemia; 57.7% of the general group has at least one CRF and 47.1% has at least on modifiable CRF.

## **EIGHT WEEKS OF ENDURANCE TRAINING BASED ON CRITICAL VELOCITY ASSOCIATED WITH GLUTAMINE SUPPLEMENTATION**

Fontana, K.E., Molina, G.E., Kobayashi, L., Rocco, G.F.

*University of Brasilia - UnB*

**Introduction** The individualized prescription of exercise intensity is critical for obtaining satisfactory results in endurance training. Many practitioners of physical activity are associated with the use of glutamine expecting even better aerobic performance. **Purpose:** Analyze the aerobic capacity and body composition of a supervised endurance-training program associated with glutamine supplementation and placebo. **Methods** Twenty-three physically active healthy young male ( $21.8 \pm 2.1$  years) volunteered to the study and underwent an endurance-training program based on critical velocity (CV) that consisted of three weekly sessions during eight weeks. CV was calculated by the slope of the linear regression between the time obtained through running tests of 400 and 2400 m (T400 e T2400). The peak oxygen output (VO<sub>2peak</sub>), oxygen uptake at anaerobic threshold (VO<sub>2AT</sub>) and at respiratory compensation point (VO<sub>2RCP</sub>) were determined by an incremental running treadmill test with breath by breath gas analyze. Blood lactate samples were used to determine the lactate threshold (LT) and the onset of blood lactate accumulation (OBLA). The experimental design was double blind controlled by placebo and the subjects were randomly assigned to two groups receiving either placebo (PLA, n=11) or glutamine (GLN, n=12) supplementation. Each oral supplement was given solved in a liquid sweetened vehicle once a day (0.003 g/kg). The tests were performed in random sequence, with a minimum interval of 48 hours between them. The training effect was compared by t-student test and the supplementation effect by ANOVA. **Results** Independently of supplementation, after the eight-week endurance training program there were differences on all the variables except VO<sub>2RCP</sub>, VOBLA. When the training effect was observed on supplemented groups (PLA and GLN), both groups differed on T400, T2400, VO<sub>2AT</sub>, CV, VAT and no differences were found on body mass, VO<sub>2RCP</sub>, VLT and VOBLA. Percent body fat, VO<sub>2peak</sub> and VRCP differed only in the PLA group. The VO<sub>2peak</sub> differed between PLA and GLN ( $p=0.027$ ) with higher values on the PLA group. CV was higher than other velocities measured in the study (VAT, VLT, VOBLA, VRCP). **Conclusions:** The critical velocity can be used as an aerobic performance measure, however does not replace the anaerobic threshold measured by direct methods. Moreover, glutamine supplementation did not show an ergogenic effect on aerobic output or on body composition in physically active young male after an eight-week endurance-training program.

## **EFFECTS OF A MODERATE ENDURANCE AND RESISTANCE TRAINING IN GERMAN FIREMEN**

Jaitner, T., Kusch, A.

*TU Dortmund University, University of Kaiserslautern*

**Introduction** Fire emergencies impose high levels of physical stress in hazardous environments (Myhre et al., 1997). A high physical fitness is mandatory for firemen (Williford et al., 1999), and especially endurance and resistance training should be integrated in their daily working routines. Therefore, a specific training program was designed with two restrictions. First, the working capability should not be limited considerably due to fatigue. Secondly, standard exercise tests could not be applied because reservations on physiological testing were reported for different reasons (e.g. restrictions in career opportunities or occupational aptitude). **Methods** 77 firemen participated in a 10 week training intervention with at least two sessions a week. The Borg scale was used to adjust the training load individually. For the endurance training, a standardized 10 min indoor cycling routine was repeated every two weeks, and heart rate, cadence and pedal resistance forces were measured. Progress in resistance training was monitored by dumbbell weight. Based on training frequency, subjects were posthoc divided into a regular training group (RT, >60% of all trainings sessions) and a non regular training group (NRT). ANOVA and non-parametric tests were applied to analyze the training effects of both groups. **Results** During the cycling routines subjects cycled at appr. 81 rpm and reached a heart rate of appr. 142 bps. For the RT group, pedal resistance forces ranged from 176N to 239N in mean and showed a linear increase over the whole intervention phase ( $p \leq 0.01$ ). Heart rate and cadence did not differ significantly. For the NRT group no significant changes in any parameter could be stated. According pedal forces, ANOVA revealed a significant effect of group and time ( $p=0.00$ ,  $F= 15.503$ ). Subjects of the RT groups also increased the weight of the dumbbell from beginning till end of the resistance training by 5,2 kg in mean ( $p \leq 0.01$ ). The NRT group showed a slight but not significant difference in training load. **Discussion** Firemen who trained regularly were afterwards able to master a higher training load while the perceived exertion as well as the corresponding physiological parameters remained constant. Although only moderate training loads were applied, the endurance and resistance training seems to substantially enhance their physical fitness. For specific professions as fire fighting such training regimes might be promising to keep the balance between working capabilities and demands on physical fitness and training during working time. **References** Myhre, L. G., Tucker, D. M., Bauer, D. H., & Fischer, J. R., Grimm, W. H., Tattersfield, C. R., Wells, W.T. (1997). Relationship between selected measures of physical fitness and performance of a simulated firefighting emergency task. Brooks AFB: Armstrong Laboratory. Williford, Henry N., Duey, William J., Olson, Michele S., Howard, Ron and Wang, Naizhen (1999) Relationship between fire fighting suppression tasks and physical fitness, *Ergonomics*, 42, 9, 1179-1186

**16:05 - 17:35**

## **Oral presentations**

### **OP-PM16 Nutrition 2**

#### **POSTPRANDIAL MYOFIBRILLAR PROTEIN SYNTHESIS RATES OF RESTED MUSCLE ARE MAXIMALLY STIMULATED BY INGESTING 20 GRAMS OF WHEY PROTEIN.**

Witard, O., Jackman, S., Breen, L., Smith, K., Selby, A., Tipton, K.

*University of Stirling*

**Introduction:** The dose-response of muscle protein synthesis (MPS) to the provision of free crystalline essential amino acids has been well documented in rested muscle of untrained individuals in the fasted state; however data examining the dose-response to more practical, intact sources of protein remain scarce. We aimed to characterise the dose-response relationship between postprandial myofibrillar-MPS

rates and the single-bolus ingestion of a range (0-40g) of intact whey protein (WP) doses in rested muscle of resistance-trained males. Methods: In this parallel research design, single-blind study, 48 resistance-trained males (age: 21±2y; body mass: 83±11kg; >12mo resistance training) were assigned to one of four groups, ingesting either 0 (WP-0), 10 (WP-10), 20 (WP-20) or 40 (WP-40) g of whey protein isolate ~3h 45min after consuming a standardised energy-rich (30kJ·kg<sup>-1</sup> BW), high protein (30 %Energy) breakfast. The fractional synthesis rate (FSR) of myofibrillar protein, and rates of whole body phenylalanine oxidation and urea production were determined over a 4h post-drink period by combining the continuous isotopic tracer infusion of L-[ring-<sup>13</sup>C<sub>6</sub>]-phenylalanine and <sup>15</sup>N<sub>2</sub> urea with the collection of muscle biopsies. Results: The AUC over 4h post-drink for concentrations of amino acids, insulin and urea increased in a curvilinear manner relative to the dose of ingested WP (40>20>10>0g, P<0.05). Myofibrillar FSR was ~25% higher in WP-10 (0.040±0.002 %·h<sup>-1</sup>) vs. WP-0 (0.032±0.003 %·h<sup>-1</sup>, P<0.05) and a further ~30% higher in WP-20 (0.052±0.005 %·h<sup>-1</sup>, P<0.05). However, no difference in myofibrillar FSR was observed between WP-20 and WP-40 (0.051±0.003 %·h<sup>-1</sup>, P>0.05). The response of MPS to WP ingestion, expressed as change in FSR relative to 0g / mean post-drink amino acid concentration was ~50% lower in WP-40 (0.000073±0.000011 %/nmol/mL) vs. WP-20 (0.000094±0.000004 %/nmol/mL, P<0.05). Conversely, the AUC for whole body phenylalanine oxidation and urea production rates in WP-40 (4.99±1.17 μmol phenylalanine×4h and 232.1±47.7 μmol urea×4h, respectively) was greater than WP-20 (0.12±4.14 μmol phenylalanine×4 h and 57.4±61.8 μmol urea×4 h, respectively, P<0.05). Conclusions: These data are the first to demonstrate that myofibrillar-MPS rates are dose-dependent on ingested intact protein, reaching a maximal stimulation with the ingestion of 20g of whey protein in rested muscle of trained men. Thus, in the postprandial state, ingesting a dose of intact whey protein isolate in excess of 20 g elicits no further stimulation of MPS and instead stimulates non-anabolic processes such as amino acid oxidation. Funded by GlaxoSmithKline Nutrition, Brentford, UK.

### IS THERE A CUMULATIVE EFFECT OF GRAPE POLYPHENOL SUPPLEMENTATION ASSOCIATED WITH TRAINING ON RATS METABOLISM FEED WITH HIGH FAT DIET ?

Lambert, K., Thomas, C., Cassan, C., Hokayem, M., Fabre, O., Mercier, J., Avignon, A.

*INSERM*

Introduction Polyphenols have been associated with improvement of insulin sensitivity both in rodent and obese human. Exercise training is also a well known therapeutic for insulin resistance. The purpose of our study was to investigate the association of grape polyphenol (PP) with exercise training on the mechanisms of insulin resistance in high fat diet fed rats. Methods 40 male Sprague-Dawley rats were used. During 4 weeks they were fed ad libitum with a high fat diet (HFD) (58%kcal from fat, D12330 Research Diet). Then rats continued the HFD for 8 weeks but they were included in one of 4 groups of 10 rats: HF rats with only the diet, PP rats with a supplementation of PP in drinking water (50mg/g body weight), EXO rats submitted to exercise training on treadmill (1h/day; 5days/week; 10% slope at 30m/min) and EXO+PP rats with exercise training and PP supplementation. Before randomization, all rats performed a maximal velocity test which was reproduced at the end of the study. Glucose tolerance tests were performed at rats' arrival, after the 4 weeks of HFD and after the 8 weeks of treatments. Results Compared to HF rats, exercised rats presented a significant decrease in body weight associated with a decrease in adiposity. However, there was no effect of PP on these parameters (no difference between HF and PP as EXO and EXO+PP) although EXO+PP rats presented the smaller values. Training induced a significant increase in maximal velocity compared to basal values without a better improvement in EXO+PP compared to EXO. On insulin sensitivity, HF rats presented a higher glycemia compared to trained rats with a significant increase at 90 minutes after glucose injection. Moreover, hepatic glycogen content was significantly increased in EXO+PP compared to HF. Discussion At this time of analysis, training is able to counteract the deleterious effect of a high fat diet with a small benefit of grape polyphenol supplementation on these alterations.

### DIETARY SUPPLEMENT USE, IMPACT ON MICRONUTRIENT INTAKE OF YOUNG GERMAN ATHLETES

Braun, H., Koehler, K., Geyer, H., Mester, J., Thevis, M., Schaenzer, W.

*German Sport University Cologne*

Introduction It is widely accepted, that the use of Dietary Supplements (DS) does not compensate for an inadequate diet and DS use in young athletes should be discouraged (IOC Statement 2011). In contrast studies have shown a high prevalence of DS use in young athletes (Braun et al. 2009). In most studies, the prevalence of use was assessed, but little is known about dosage and nutrient intake from DS. Therefore, the aim of this study is to evaluate dietary intake, DS use and its impact on total nutrient intake of young athletes. Methods & Subjects Between April and May 2011, 27 young athletes (age 13-18y) reported their diet using a validated 7-d food and activity record (Koehler et al. 2010). Energy intake and micronutrient intake was estimated based on the German food database (BLS II.3) using Ebispro Software. Athletes were asked to name all DS (e.g. company name, dosage pattern, frequency of use) used within the 7 days of food recording. Each DS was included into the food database to evaluate the diet with and without DS use. Results We found 12 athletes (44%) using 16 different DS (15x vitamins and/or minerals, 1x protein powder enriched with vitamins/minerals). None of these athletes had any experience with individual nutrition counseling so far. Assuming that dietary micronutrient intake should be 100% RDA, this level was reached by all athletes only for copper and vitamin K. At least half of the group did not reach the RDA for vitamin D (n=11 athletes), folic acid (n=11), iron, vitamin B12, pantothenic acid, and vitamin A (n=6 each). Micronutrient intake was improved above 100% RDA by DS use only for vitamin D (n=2), vitamin C (n=1) and iron (n=3). Furthermore, DS use increased micronutrient intake towards tolerable upper intake levels for iron (n=3), magnesium (n=3), zink (n=2), and vitamin B6 (n=1). Discussion In the present study, dietary intake of young athletes did not meet the RDA for selected micronutrients. Supplementation with vitamins and minerals did increase micronutrient intake (> 100% RDA) only for few athletes and nutrients. Some athletes took micronutrients leading to intakes higher than the suggested upper intake levels. Based on these preliminary data, the use of DS did not enhance micronutrient intake in young athletes substantially. Therefore, we suggest that young athletes need more information on optimizing their diet, but also more information on a wise use of dietary supplements. References IOC Consensus Statement on Sports Nutrition (2011). J Sp Sci, 29(S1): S3-S4 Braun H., Koehler K., Geyer H., Kleinert J., Mester J., Schaenzer W (2009). Int J Sp Nutr Exerc Met, 19(1), 97-109 Koehler K., Braun H., de Marees M., Fusch G., Fusch C., Mester J., Schaenzer W. (2010). J Sp Sci, 28(13): 1435-1449

### PROTEIN INGESTION PRIOR TO SLEEP IMPROVES POST-EXERCISE OVERNIGHT RECOVERY

Res, P.T.1, Groen, B.1, Pennings, B.1, Beelen, M.1, Wallis, G.A.2, Gijsen, A.P.3, Senden, J.M.G.3, Van Loon, L.J.C.1,3  
 1,3 Maastricht University, 2 GlaxoSmithKline Nutrition, UK

**Introduction** The role of nutrition in modulating post-exercise overnight recovery remains to be elucidated. We assessed the impact of protein ingestion immediately prior to sleep on digestion and absorption kinetics and protein metabolism during overnight recovery from a single bout of resistance type exercise. **Methods** 16 healthy young males performed a single bout of resistance type exercise in the evening (20:00 h) after a full day of dietary standardization. All subjects were provided with appropriate recovery nutrition (20 g protein, 60 g carbohydrate) immediately after exercise (21:00 h). Thereafter, 30 min prior to sleep (23:30 h) subjects ingested a beverage with (PRO) or without (PLA) 40 g specifically produced intrinsically [<sup>1-13</sup>C]phenylalanine labeled casein protein. Continuous intravenous infusions with [ring-2H5]phenylalanine and [ring-2H2]tyrosine were applied with blood and muscle samples collected to assess protein digestion and absorption kinetics, whole-body protein balance and mixed muscle protein synthesis rates throughout the night (7.5 h). **Results** During sleep casein protein was effectively digested and absorbed resulting in a rapid rise in circulating amino acid levels which were sustained throughout the remainder of the night. Protein ingestion prior to sleep increased whole-body protein synthesis rates (311±8 vs 246±9 μmol/kg/7.5 h) and improved net protein balance (61±5 vs -11±6 μmol/kg/7.5 h) in the PRO vs PLA experiment, respectively; P<0.01). Mixed muscle protein synthesis rates were ~22% higher in the PRO vs PLA experiment, which reached borderline significance (0.059±0.005 vs 0.048±0.004 %/h; P=0.05). **Conclusion** This is the first study to show that protein ingested immediately prior to sleep is effectively digested and absorbed, thereby stimulating muscle protein synthesis and improving whole-body protein balance during post-exercise, overnight recovery. Protein ingestion before sleep allows athletes to optimize recovery from resistance type exercise.

### HYDRATION STATUS OF FEMALE BASKETBALL PLAYERS BEFORE AND DURING TRAINING

Mertens, E., Aerenhouts, D., Deforche, B., Clarys, P.  
 Vrije Universiteit Brussel

**Introduction** Data on hydration status of female basketball players and basketball performance are scarce. Dehydration has negative consequences on health and sports performance. In this study we assessed the hydration status of female basketball players. The aim of the present study was to evaluate the pre-training hydration status and to study the influence of the pre-training hydration status on training intensity. **Methods** All 20 female basketball players (age 18,2 ± 3,8, height 167,8 ± 6,4) of a local competitive basketball club participated in this study. Urine specific gravity (PAL-10S refractometer) as an indicator of hydration status was measured before training. Body mass was measured before and after the training session in combination with fluid intake (assessed by weighing a personalized bottle of water before and after training) was used to calculate sweat loss. During training all players had to wear a SenseWear Armband, sampling at the highest rate (1/s), to estimate number of steps and total intensity. **Results** Pre-training urine specific gravity ranged from 1.004 to 1.027 g/ml. Eight out of 20 players started training dehydrated. The mean (± SD) sweat loss during training amounted to 655,4 ± 249,7 ml/h, and mean fluid intake was 446,9 ± 168,6 ml/h. There was a significant correlation between sweat loss and number of steps (6121,9 ± 610,1) during training (r=0.577, p=0.008), but no correlation between sweat loss and intensity (r=0.114, p=0.632). There was no significant difference between pre-training well hydrated and pre-training dehydrated players in number of steps (p=0.499) and intensity (p=0.631). **Discussion** It can be concluded the 40% of the players started the training dehydrated. The hydration status was not related with training intensity, as measured by number of steps and intensity.

### IMPACT OF A HIGH-DAIRY CALCIUM BREAKFAST ON SUBSTRATE METABOLISM DURING EXERCISE AND PERCEPTUAL APPETITE SENSATIONS

Gonzalez, J.T., Rumbold, P.L., Stevenson, E.J.  
 Northumbria University

The aim of this study was to assess the effects of a breakfast, high in dairy calcium on substrate oxidation and appetite regulation before and during exercise. **Methods** Nine recreationally active males completed two trials in a randomised crossover design separated by 7 d. In the control trial (CON), breakfast consisted of skimmed milk and cereal to provide 1.5 g•kg body mass<sup>-1</sup> carbohydrate and 3 mg•kg body mass<sup>-1</sup> of calcium. In the high-calcium trial (CAL) a calcium supplement, extracted from milk, was used to increase the calcium content to 9 mg•kg body mass<sup>-1</sup>. A 60 min treadmill run was performed at 60% VO<sub>2</sub>peak, 180 min after consumption of breakfast. Indirect calorimetry was used to estimate energy expenditure and substrate metabolism, and visual analogue scales were administered to determine subjective appetite sensations. Blood samples were taken in the fasted state, throughout the postprandial period following breakfast, and during and after exercise to determine non-esterified fatty acid (NEFA) concentrations. **Results** The total amount of lipid oxidised during exercise was not significantly different between trials (CON: 30.5 ± 7.6 g, CAL: 31.1 ± 9.2 g; P>0.05). The amount of carbohydrate oxidised during exercise was also similar between trials (CON: 100.4 ± 24 g, CAL: 99.7 ± 27.3 g; P>0.05), hence energy expenditure was not significantly different (P>0.05). There was no difference in serum NEFA concentrations at any timepoint (P>0.05). The time-averaged area under the curve for feelings of fullness was greater during the 180 min following the CAL breakfast (63 ± 17 mm) compared to the CON breakfast (59 ± 20 mm; P<0.05) breakfast, yet there was no significant difference in any of the other appetite ratings (hunger, satisfaction and prospective consumption, all P>0.05). **Discussion** Substrate metabolism was unaffected by the dairy calcium content of the pre-exercise meal. This supports previous findings in trained female runners (White et al., 2006) but conflicts with more recent studies in sedentary populations (Ping-Delfos and Soares, 2011). Differences in meal composition may play a role and warrant further investigation. This study also demonstrates that increasing the dairy calcium content of a meal can increase postprandial fullness. **References** White KM, Lyle RM, Flynn MG, Teegarden D, Donkin S (2006). *Int J Sport Nutr Exerc Metab*, 16, 565-579. Ping-Delfos WC, Soares M (2011). *Clin Nutr*, 30(3), 376-383.

16:05 - 17:35

## Invited symposia

**IS-SH02 It's Natural to Play: Promoting Psychomotor Development in Challenging Environments****WHAT CAN WE LEARN FROM THE STRIP BABY PROJECT?**

Sääkslahti, A.1

*1: University of Jyväskylä, 2: University of Turku*

Introduction Physical activity (PA) and sedentary behavior has been tracked from early childhood. To ensure a healthy lifestyle and support children's overall development, the Specific Turku Coronary Risk Factor Intervention Project (STRIP baby) was launched in 1990 with 1,062 seven-month-old children and their families enlisted. Methods From 1994 onwards, three- to four-year-old children (N = 228) were randomly selected and divided into the PA intervention (n = 116) and control (n = 112) groups. The four-year intervention program was based on Bandura's Social-Cognitive theory (1986), containing an intensive session (duration 1 h) with the parents once a year, printed material twice a year and a PA demonstration session by a physical education teacher once a year. Public media was also used for intervention purposes. Physical activity, motor skills, growth and health parameters were measured. Statistical analysis was performed with repeated measures of ANOVA and the MIXED procedure. Results The children in the PA intervention group spent more time playing outdoors and their play in the high-activity category increased with age, whereas no change occurred in the control group. The girls in the PA intervention group had weaker perceptual motor skills, but performed better in locomotor skills, than the girls in the control group. The boys in the PA intervention group had better perceptual motor skills and locomotor skills than the boys in the control group. Amongst all the girls, low-activity play was related to a higher BMI. At the age of six, high activity play was related to lower serum total cholesterol and triglyceride levels, and positively correlated to the HDL/total cholesterol ratio. Amongst all the boys, positive correlations between playing outdoors and both HDL levels and HDL/total cholesterol ratios were found at the age of four. Conclusions Family-based intervention showed that it was possible to affect positively the physical activity and motor skills of preschool-age children, as well as to promote health by increasing physical activity. For further interventions we suggest that the PA intervention targeted at young children's parents should help to activate parents, be voluntary, be based on a positive motivational climate; and should offer PA knowledge. In addition the PA intervention should include concrete PA models, consider individual differences, take into account possible gender preferences, and utilize public material and information in order to encourage the use of neighborhood play areas as well as the use of professional educators. References Bandura A. (1986). Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, NJ: Prentice hall.

**THREATS AND CHALLENGES OF NATURAL PLAY AMONG CHILDREN**

De Martelaer, K.

*Vrije Universiteit Brussel*

One of the three sessions in the invited workshop of G. Stratton: It's natural to play: Promoting psychomotor development in challenging environments In this presentation an overview will be given of actual threats and challenges among children during physical active natural play. International trends of family characteristics, outdoor play, environmental and didactical aspects will be presented. Based on own research data concerning movement skills of young children and the influences of home and school, the focus will be on possibilities for further research in the domain of natural play and psychomotor development of children.

**PHYSICALLY ACTIVE PLAY AND POLY-VOCALITY: PHYSICALLY ACTIVE PLAY INTERVENTIONS.**

Stratton, G., O' Dwyer, M., Taylor, S., Rosenberg, M.

*Swansea University*

This presentation will review the range of research in physically active play undertaken by the REACH group. We have redesigned school playgrounds and completed increasingly complex studies with parents and pre-school teachers and used multiple methodologies to demonstrate significant increases in physical activity and changes in pro-social behaviour that was maintained for 12 months. We have also found differential effects for girls and boys and for normal and overweight children. Further research work migrated into natural environments and we have found positive effects on active play when environmental and educational changes were implemented. Our collaborators in North Wales and West Australia have also developed interventions using affordable recycled equipment and social marketing. Their findings will also be reviewed. The journey through this research will include discussion using different research approaches, policies paradigms and principles.

16:05 - 17:35

## Invited symposia

## IS-BN05 Musculoskeletal Modelling for Problem Solving in Rehabilitation (\*)

**MAKING THE LINKS BETWEEN REHABILITATION AND MUSCULOSKELETAL MODELLING: REQUIREMENTS AND TOOLS**

Van Sint Jan, S.

*Université Libre de Bruxelles*

MAKING THE LINKS BETWEEN REHABILITATION AND MUSCULOSKELETAL MODELLING: REQUIREMENTS AND TOOLS Van Sint Jan, S<sup>1</sup>; Bontempi, G<sup>2</sup>; Van Summeren, S<sup>3</sup>. 1Lab. Anatomy, Biomechanics & Organogenesis (LABO). 2Machine Learning Group. 3Lab. Web and Information Technology (CoDE-WIT). Univ. Libre de Bruxelles, Belgium. Introduction Musculoskeletal modelling (MSM) showed major recent theoretical progresses including optimisation and prediction algorithms, and improved data visualisation. Despite these efforts, practical applications in daily Clinics remain rare because of a lack of extensive clinical validation. Integration of MSM tools to better understand complex pathologies also remains a challenge. This presentation reports the first results of a running effort of integration of MSM tools within a larger pipeline for the data handling of patients performed by the ICT4Rehab project ([www.ict4rehab.org](http://www.ict4rehab.org)). Methods The project is focuses on the development of an integrated system organised around several tools: - database allowing sharing of clinical data (anamnesis, clinical testing and functional), - biomechanical analysis (including MSM), - and data mining. As such, MSM is not the unique tool available from the overall ICT4Rehab pipeline. Indeed, while it is clear that MSM is useful as a supplementary source of patient's physiological parameters next to the "usual" clinical testing, it however cannot answer all questions arising from the handling of severe disorders such as spasticity. The above-described pipeline is under development in collaboration with several clinical centres that are closely involved in the project development thanks to an active communication channel. From an MSM perspective, models integrated in the analysis pipeline could appear simplistic compared to the literature in the MSM field. The ICT4Rehab models are limited to the study of joint amplitude, muscle excursion and muscle moment arms. On the other hand, such MSM modelling is easily understood by clinicians, and can be validated, for example using medical imaging. Model customization is also of importance. Results Although the project has recently started, the first results are promising at various levels. Even if it is not fully deployed yet, the entire clinical pipeline is now fully defined: - clinical data are stored in the database; - clinical data can be analyzed using modelling tools and biomechanical analysis; - and results are further analyzed in advanced data mining modules. Discussion In contrast to an isolated MSM tool that gives numerous, but often not properly validated results, we believe that the integrated approach taken by the ICT4Rehab project, focusing on the integration of MSM methods with complementary clinical tools, will be more attractive for clinicians. The project has therefore adopted as its main strategy to respect the daily work habits of clinicians by integrating their professional habits in a new work pipeline that is complemented by new and more advanced analysis tools. We believe that this is crucial for clinical acceptance.

**MUSCULOSKELETAL MODELS FOR GAIT ANALYSIS: WALKING THROUGH LIFE**

Kersting, U.

*Aalborg University*

Introduction Studies have compared walking gait of children to that of adults or between certain age groups, i.e., elderly versus younger adults (e.g., Bleyenheuff and Detrembleur, 2012). Comprehensive reference data bases are hampered by variable of marker sets and inter-tester variability being an inherent issue (McGinley et al., 2009). The purpose of this study was to provide a consistent database of healthy controls from childhood to the elderly. Secondly, results obtained from an established gait model were compared to an individually scaled musculoskeletal model. Methods A total of 195 subjects from 6 to 86 years were recruited. Gait was recorded by a Vicon system (612, 8 cameras, Vicon, Oxford, UK) in a gait laboratory. Six trials at preferred walking speed were recorded. The Vicon gait marker protocol was used and processed using the plug-in gait (PIG). Data were exported and processed in the AnyBody Modelling System (AnyBodyTech, Aalborg, DK) using an optimization and scaling algorithm. Age groups were compared by ANOVA and correlations with age and selected anthropometric parameters were performed. Results between models were compared by paired t-tests. Results No age dependency of selected kinematic parameters such as knee angle at TD or the amount of knee flexion during stance was found. Walking velocity did only vary minimally with age while cadence was increased in children compared to all adult age groups. Across all subjects, a significant correlation of leg length and cadence was observed. Integrated ankle joint power decreased with age while hip work increased with age. Model comparisons revealed off-sets between discrete kinematic parameters while ranges of motion were comparable. This also applies to net joint kinetic parameters. Obviously, individual muscle forces or work were not extracted from the PIG calculations. Discussion In summary, gait velocity was highly consistent despite the fact that subject chose their preferred walking speed. In healthy subjects, gait kinematics remain reasonably constant over a large age range. There are, however shifts in total joint work as described by Karamanidis & Arampatzis (2005). Musculoskeletal models allow for a more detailed analysis of changes in particular muscle groups which related well to previous results. It is therefore expected that the inclusion of individualized musculoskeletal models into standard clinical gait analysis will allow for enhanced understanding of alterations in gait function. References Bleyenheuff C., Detrembleur C. (2012). Clin Biomech Mar 2. [Epub ahead of print]. McGinley J.L., Baker R., Wolfe R., Morris M.E. (2009). Gait Posture, 29(3):360-9. Karamanidis K., Arampatzis A. (2005). J Exp Biol, 3907-23.

**TECHNICAL ASPECTS IN SPEED SKATING**

Van der Helm, F.

*Delft University of Technology*

Speed skating requires high technical skills in order to transfer the power generated by the muscles to the propulsion of the skater. Many examples exists of skaters able to generate more power though resulting in less forward speed. Van Ingen Schenau and de Koning have developed a power balance model to analyse the generation and dissipation of power during skating [1,2]. Air friction and ice friction are the major causes of power loss. The skater generates power by shortening muscles, resulting in joint rotations of the lower limb, and finally in a translation of the Center-of-Mass with respect to the push-off at the skate. The push-off is necessarily side-wards from the



skate, though must have a forward component for positive propulsion. There is quite some loss of power in the left and right acceleration of the skater's mass, which does not benefit the forward motion in itself. The skater makes an S-curve over the ice, to go from one side of the lane to the other, necessary to allow a full push-off to generate the required power by stretching the leg. All these elements in the skater's motion are related to each other in the power generation. The goal of this study is to understand the relations between the motions, power generation and power losses. Accurate measurements have been performed to record the skater's motion over the ice, using the LPM system at the Thialf Ice Rink in Heerenveen. Also the forces involved have been recorded. We present a simple 2 dimensional model of speed skating on the straights which mimics observed kinematic and force data. The primary features of the model are: the skater is modeled as three point masses, only motions in the horizontal plane are considered, air drag forces which are quadratic in the forward velocity and coulomb type ice friction forces at the skates are included, and idealized contact of the skate on the ice is modeled by a holonomic constraint in the vertical direction and a nonholonomic constraint in the lateral direction. Using the measured leg extension coordination (kinematic data) we are able to predict reasonably well the forward speed, even if we do not fit for that. In the future, we plan to use the model for finding coordination patterns which results in optimal performance. [1] De Koning JJ, de Groot G, and van Ingen Schenau GJ. A power equation for the sprint in speed skating. *J Biomech* 25: 573 - 580, 1992 [2] de Koning JJ; Foster C; Lampen J; et al. Experimental evaluation of the power balance model of speed skating. *J. Appl. Phys.*, 98(1), 2005

## 16:05 - 17:35

### Oral presentations

#### OP-BN05 Sports Biomechanics 2

##### DOWNHILL TURN TECHNIQUES AND PERFORMANCE IN CROSS-COUNTRY SKIING: ASSOCIATIONS WITH MECHANICAL AND PHYSICAL PARAMETERS

Bucher, S.1,3, Supej, M.2,3, Sandbakk, Ø.4, Holmberg, H.C.3

(1) Nord-Trøndelag University College, Norway, (2) University of Ljubljana, Slovenia, (3) Mid Sweden University, Sweden, (4) Norwegian University of Science and Technology, Norway

**INTRODUCTION:** Downhill turns in cross-country skiing are performed in widely varying conditions. In order to effectively utilize potential energy and accelerating forces, skiers adapt the entrance velocity, the trajectories throughout the turn and the employment of different techniques. The aim of this study was to characterize the main techniques utilized in downhill turns among elite cross-country skiers and to examine how downhill turn performance is influenced by technique distribution, mechanical parameters and the skiers' maximal power characteristics. **METHODS:** 12 female elite cross-country skiers performed six highly standardized subsequent turns using a freely chosen technique. The subjects were continuously monitored by a high-end real time kinematics GNSS and one camcorder. The measured trajectory was used for calculating total and intersection time, velocity and energy dissipation at each point of observation, and was linked to the use of technique. Additionally, maximal isometric squats and counter-movement jumps were performed to characterize the athletes' maximal strength and power. **RESULTS:** Three techniques with significantly different mechanical patterns were employed by the skiers: side stepping, skidding and ploughing. The typical technique distribution for the best skiers was a short phase of skidding at the beginning of the turn, followed by an early transition to and overall greater proportion of side stepping. An early transition between the decelerating and accelerating phase and high velocity at the transition point were strongly correlated to the performance variables (i.e., time and energy dissipation; all  $p < 0.05$ ). Furthermore, better skiers' turns are related both to higher velocities and shorter trajectories (all  $p < 0.01$ ). Peak force, time to peak force and rate of force development in absolute values were most strongly correlated with performance (all  $p < 0.05$ ). **CONCLUSIONS:** This study identified technique distribution and mechanical parameters linked to better downhill turn performance in cross-country skiing. Better skiers preferred skidding to ploughing and showed an earlier initiation and overall greater use of the side stepping technique. The athletes' absolute maximal power is linked to the ability to ski at a high velocity and with short trajectories throughout.

##### THE POLING THRUST IN SKI SKATING IS ACCOMPLISHED BY HIP AND KNEE FLEXION IN V2 BUT NOT IN V1

Hallén, J., Myklebust, H., Losnegard, T.

Norwegian School of Sport Sciences

**THE POLING THRUST IN SKI SKATING IS ACCOMPLISHED BY HIP AND KNEE FLEXION IN V2 BUT NOT IN V1** Hallén, J., Myklebust, H., Losnegard, T. Norwegian School of Sport Sciences, Norway Introduction Ski skating is a complex cyclic technique where both arms and legs are producing the propulsive forces. The main ski skating techniques are V1 and V2. Smith et al. (2009) showed that the leg/ski thrust in V1 and the arm/poling thrust in V2 contributed most to the propulsion. The present study will evaluate how lowering of the center of mass (COM), contribute to the poling thrust during V1 and V2 skate, evaluated by accelerometry. Methods Fourteen elite senior male cross country skiers ( $VO_{2max}$ : 76.2 (4.8)  $ml \cdot kg^{-1} \cdot min^{-1}$ ) volunteered and were all familiar with rollerski treadmill testing. After a warm up, the skiers did two 1-min trials with V1 and V2 skate at 4° inclination and 3  $m \cdot s^{-1}$ . One tri-axial accelerometer (pluX, Lisbon, Portugal) was mounted directly to the skin at the subject's lower back (hip). Hip displacement was calculated by double integration of the signal. Uni-axial accelerometers were attached to the poles and the ski-boots to detect poles and skis hits and lift-offs. Results The hip vertical displacement was 50% larger in V2 than V1 [0.12 (SD 0.02) vs 0.08 (0.02) m,  $p < 0.05$ ] even if the pattern of acceleration was similar. However, in the horizontal direction (for-aft), the patterns were different between techniques and maximal forward acceleration was 28% larger in V2 than V1 [3.7 (0.4) vs 2.9 (0.6)  $m \cdot s^{-2}$ ,  $p < 0.01$ ]. During V2, forward acceleration was linked to the pole thrust and lowering of the hip, while the largest forward acceleration in V1 occurs without pole ground contact. Furthermore, in V1 the hip was elevated during the poling thrust. Discussion Displacement of the hip in the vertical direction approximates change in the skier's potential energy. Hip acceleration in forward direction approximates the size of the propulsive forces. The present results indicate that the potential energy gained by extension of hip and knee joints during the first part of the ski thrust, is transferred to forward kinetic energy by the poling action in V2. Video analysis reveals that during the first 75% of the poling action in V2, only minor changes occur in the angles of the shoulder and the elbow joints. Hence, the poling action is actively performed by knee- and hip flexion more than dynamic action of the arm muscles. Contrary to V2, the reaction forces through the poles are partly used to elevate the hip in V1. Conclusion: The present data shows that the poling

thrust in V2 is accomplished to a large extent by the legs and trunk by first elevating the COM to gain potential energy before lowering COM by gravity and actively flexion of the hip and the knees during the pole thrust. References Smith G, Kvamme B, Jakobsen V (2009) In: Müller E, Lindinger S, Stöggl T (eds) 4th International congress on skiing and science. Meyer & Meyer, St. Anton am Arlberg

### MUSCLE ACTIVITY IN GIANT SLALOM. A CASE STUDY OF AN ELITE SKIER

Gantenbein, C.

*University of Berne*

Authors: Gantenbein C.1, Goepfert B.3, Hoppeler H.2, Vogt M.2. 1: Institute of Exercise and Health Sciences (University of Basel), 2: Institute of Anatomy (University of Bern), 3: Laboratory for Biomechanics and Biocalorimetry (University of Basel). Introduction: Insights into the biomechanical processes and muscle control in alpine skiing are of particular importance in order to improve the quality of the movement, to prevent injury, to sift talents or to optimize training recommendations (Turnbull, Kilding, & Keogh, 2009). Due to the lack of current data on muscle activity patterns in elite ski racers since the carving technology has been invented, the present study shows the relationship between the driving technique and muscle activity patterns that occur. Method: In the following pilot study, a Swiss elite athlete took part from the discipline Alpine Skiing (Junior World Champion 2009 in the combination). Hip and knee angles were recorded and EMG activity of 12 muscles was derived on the right side of the body during four giant slalom races in a medium steep terrain. For the EMG analysis, the wavelet method according to von Tscherner was used (von Tscherner, 2000). Results: The average hip and knee angle at the outer leg ( $44 \pm 2^\circ$ , respectively  $43 \pm 1^\circ$ ) is significantly smaller than the inner leg ( $65 \pm 2^\circ$ , respectively  $81 \pm 3^\circ$ , extended leg =  $0^\circ$ ). The average angular velocity at the outer leg at the knee is  $69 \pm 3^\circ / s$  during knee extension and at the inner leg  $84 \pm 8^\circ / s$  during knee flexion. The M. vastus lateralis and M. vastus medialis show activity during the swing phase on the outer leg and the M. rectus femoris is active while the inner leg phase. The M. biceps femoris shows activity during the outside leg phase and the M. semitendinosus while the inner leg phase. At the beginning of a turn, it shows a visible preactivation of the hamstrings compared to quadriceps muscles. Conclusion: During giant slalom races, knee angular velocities are rather low. Unilateral activation of the muscles M. vastus lateralis and M. vastus medialis at the outer leg and an activation of the M. rectus femoris at the inner leg indicate that the M. quadriceps is not activated synchronously in regular competitive skiing. Differences in activity patterns of the hamstrings show the great importance of the rotational stability of the lower extremity in competitive skiing. The results confirm the great importance of a function-specific training of knee extensors and flexors muscles in alpine ski racing. References: Turnbull, J., Kilding, A., & Keogh, J. (2009). Physiology of alpine skiing. *Scandinavian Journal of Medicine & Science in Sports*, 19(2), 146-155. von Tscherner, V. (2000). Intensity analysis in time-frequency space of surface myoelectric signals by wavelets of specified resolution. *Journal of Electromyography and Kinesiology*, 10(6), 433-445.

### IMPACT CHARACTERISTICS OF DIFFERENT ICE HOCKEY ARENA DASHER BOARDS DURING SIMULATED BODY CHECKS

Poutiainen, P., Peltonen, J., Isolehto, J., Avela, J.

*University of Jyväskylä*

Introduction Incidence and severity of ice hockey related concussions have increased during recent years (Biasca et al., 2002). Modifying and developing the playing environment may serve to reduce concussion rate by influencing impact characteristics during body checks. Thus, the aim of this study was to determine how ice hockey dasher board materials and structures affect impact characteristics and thereby concussion risk. Methods Measurements were divided into two parts; in the first part, the physiological characteristics of body checks were determined in real game measurements (five games of the Finnish National Hockey League and two playoff games of the second highest ice hockey league in Finland) and the second part consisted of simulation of body checks in the laboratory. Four different commercially available dasher boards were tested in body check simulations. High speed cameras and accelerometers were used to collect data and peak forces, stopping distances and stiffness values were subsequently defined. Results Dasher board materials and structures had a major effect on impact characteristics. Flexible protective shielding material (Acryl) resulted in 17 % and 16 % lower peak forces, 110 % and 136 % greater stopping distances and 62 % and 56 % lower stiffness values in the straight and the corner parts of the dasher board, respectively, compared to the reference dasher board (tempered glass). However, the dasher board with flexible protective shielding material including shielding supporting posts yielded inconsistent results, so this kind of dasher board cannot be classified as safe. The single-framed dasher board was found to be 29 % and 11 % more flexible than its dual-framed counterpart, and heavier protective shielding resulted in 33% and 19 % higher element stiffness in the straight and the corner parts of the dasher board, respectively. Discussion In light of the results and the epidemiology of concussions, it seems that the most safe dasher board would be single-framed with light and flexible protective shielding material, and would not include shielding supporting posts. References Biasca N, Wirth S, Tegner Y. (2002). *British Journal of Sports Medicine*, 36, 410-426.

### DOUBLE AND TRIPLE LUTZ IN ARTISTIC ROLLER SKATING: KINEMATIC COMPARISON

Fantozzi, S., Di Michele, R., Ciacci, S., Giovanardi, A., Merni, F.

*University of Bologna*

DOUBLE AND TRIPLE LUTZ IN ARTISTIC ROLLER SKATING: KINEMATIC COMPARISON Fantozzi S. 1, Di Michele R. 2, Ciacci S. 2, Giovanardi, A. 2, Merni F. 2 1 DEIS (Bologna, Italy), 2 Faculty of Exercise and Sport Sciences (Bologna, Italy) Introduction Knowing the biomechanical key factors of each jump is fundamental for figure skating coaches in order to more effectively teach triple jumps to their athletes. Notwithstanding the number of studies on ice skating (King et al., 2004), no biomechanical jump analysis, to the knowledge of the present authors, was performed on roller skating. The purpose of the present study was to compare some kinematic characteristics of double and triple Lutz jumps in roller skating. Methods 5 elite male skaters performing a series of double and triple Lutz were acquired using 10 infrared cameras (Smart-D, BTS, Milan, Italy, 250 Hz). For the trunk, the upper limbs and the foot segments, markers were attached directly on specific anatomical landmarks. For the thigh and the shank segments, the calibrated anatomical system technique was exploited (Cappozzo et al., 1995). The resultant velocity angle was also considered. Five key events were identified for each jump: toe-pick (instant in which the toe-pick impacted the ground), end of gliding (last contact of the left foot), take-off (last contact of the right foot), maximum height (top of the flight phase), and landing (instant of contact with the ground). Results The hip and the knee were flexed at the toe-pick, whereas the flexion was clearly lower at the take-off. On the contrary, the ankle at toe-pick was in the neutral position, and plantarflexed at the take-off, but differently depending on the skater. The skaters' horizontal velocities at take-off for the triple Lutz (mean: 2.69 m/s) were lower than those for the double one (mean: 3.17 m/s). Vertical velocities at take-off showed slightly higher values for the triple (mean: 2.90 m/s) compared to the double (mean: 2.72 m/s) Lutz. The average resultant velocity angle in the 5 athletes was  $40^\circ$  in the

double and 47° in the triple Lutz, at the take-off. The greatest difference between the double and triple jumps was the rotational velocity during the flight estimated from the rotation of the pelvis segment. The pelvis rotation velocity was higher in the triple Lutz already during the toe pick (means: 0.84 rev/s for double and 1.75 rev/s for triple one). Jumping height and flight time were higher for the triple jump for three skaters. Discussion For the first time a biomechanical comparison between the double and the triple Lutz in roller skating was performed. Some of these findings were already roughly known to coaches and skaters, but only in the present study some specific descriptors of the jump were characterized and quantified. References King D, Smith S, Higginson B, Muncasy B, Scheirman G. (2004). *Sports Biomechanics*, 3, 109-123. Cappozzo A, Catani F, Della Croce U, Leardini A. (1995). *Clinical Biomechanics*, 10, 171-178.

### **SPEED AS AN INJURY RISK FACTOR IN COMPETITIVE ALPINE SKI RACING DEPENDS ON EVENTS**

Gilgien, M.1, Spörri, J.2, Kröll, J.2, Chardonnens, J.3, Boffi, G.4, Jahnel, R.2, Cabri, J.1, Müller, E.2

1 Norwegian School for Sport Sciences, 2 University of Salzburg, 3 Swiss Federal Institute of Technology Lausanne, 4 Swiss Federal Institute of Technology Zürich

Introduction It was postulated that speed is an important factor for the increased injury rate in competitive alpine speed events of downhill (DH) and super-giant slalom (SG) compared to giant slalom (GS) skiing (Florenes et al., 2009). The speed characteristics in World Cup racing is not well described in the literature. The aims of this study were to a) map the speed distribution in men's World Cup alpine skiing for the events of GS, SG and DH, and to b) elaborate on potential susceptibility to injuries as result of speed differences between the events. Method Forerunners speed was captured in 6 GS, 2 SG and 4 DH men's World Cup races with a Global Navigational Satellite System (GNSS). The differential GNSS Doppler signal was recorded at 50 Hz using the GPS/GLONASS (L1/L2) with an antenna G5Ant-2AT1 (Anticom, Torrance, CA, USA) affixed to the forerunners helmet and a receiver Alpha (Javad, San Jose, USA). The GNSS-captured speed pattern was time-normalized using the time difference between the winner and the GNSS-forerunner. The mean speed ( $s_{mean}$ ), max speed ( $s_{max}$ ) and the standard deviation ( $\pm SD$ ) were computed. The relative  $s_{mean}$  ratio between SG and GS and between DH and GS was calculated. Based on the  $s_{mean}$  we calculated the mean kinetic energy ( $E_{kin\_mean}$ ) for GS, SG and DH using skier's mass of 100kg (Neumayr et al., 2003). The  $E_{kin\_mean}$  ratio between the race events was computed in relation to the  $E_{kin\_mean}$  of GS. Results For GS:  $s_{mean} = 66$  km/h ( $\pm 13$  km/h) and  $s_{max} = 96$  km/h. For SG:  $s_{mean} = 86$  km/h ( $\pm 16$  km/h) and  $s_{max} = 121$  km/h. For DH:  $s_{mean} = 96$  km/h ( $\pm 20$  km/h) and  $s_{max} = 143$  km/h. The  $s_{mean}$  ratio for SG/GS was 1.31 and for DH/GS = 1.47.  $E_{kin\_mean}$  for GS was 17kJ ( $\pm 7$ kJ), for SG was 28kJ ( $\pm 12$ kJ) and for DH it was 36kJ ( $\pm 17$ kJ). The ratio for  $E_{kin\_mean}$  was 1.72 for SG/GS and 2.16 for DH/GS. Discussion Fifty % increase in  $s_{mean}$  from GS to DH results in doubling of kinetic energy. This is significant in regard to the forces that occur in racer's falls, since the force ratio between GS and DH are equal to the energy ratio. From our analysis, we postulate that the potential for injuries may be associated with the speed differences between the events. Future investigations may pinpoint more accurately the potential factors responsible for ski related injuries. References Florenes, T. W., Bere, T., Nordsletten, L., Heir, S., Bahr, R., (2009). Injuries among male and female World Cup alpine skiers. *British Journal of Sports Medicine* 43, 973-978. Neumayr, G., Hoerthagl, H., Pfister, R., Koller, A., Eibl, G., Raas, E., (2003). Physical and physiological factors associated with success in professional alpine skiing. *International Journal of Sports Medicine* 24, 571-575.

**16:05 - 17:35**

## Oral presentations

### OP-PM17 Training and Testing 2

#### **COMPARISON OF A TEAM SPORT GLOBAL POSITIONING SYSTEM AND A VIDEO BASED MOTION TRACKING SYSTEM IN AN ELITE COMPETITIVE FOOTBALL ENVIRONMENT**

Li, F.X., Dallaway, N., Daley, T.

*University of Birmingham,*

Introduction Professional football clubs are increasingly utilising GPS tracking systems to monitor players speed and distance run during training sessions in order to quantify the work load. Additionally, the video-based motion analysis system Prozone (PZ, Leeds, UK) tracks the players' movements in competitive matches. When both systems are used together they potentially provide a comprehensive account of the total distance and speeds covered by players in both training and competition. However, the relative accuracy of each system has not yet been evaluated. The aim of the study is to investigate the differences in the physical performance data from the PZ and GPS systems in an elite competitive football environment. Methods In a Barclay's premier league reserve team fixture (UK), ten outfield players wore GPSPORT (Fyshwick, Australia) SPI Pro X 15Hz GPS units and were tracked via the PZ motion camera system. Data for overall distance, sprint distance ( $> 7m.s^{-1}$ ) and high speed distance ( $> 5.5m.s^{-1}$ ) was compared between the 2 systems. Results In all cases GPS recorded lower distance and number of sprints than PZ. No significant difference was found for overall distance (GPS: 7717m  $\pm$  2389, PZ: 9341m  $\pm$  3288,  $p > .1$ ). However significant differences were found between the high speed running (241m  $\pm$  140 compared to 645m  $\pm$  252,  $p < .001$ ) and sprint distance (62m  $\pm$  50 compared to 248m  $\pm$  122,  $p < .001$ ) speed zones. Significant differences ( $p < .001$ ) were also found in the number of sprints between the 2 systems with GPS recording (4  $\pm$  3) and PZ (36  $\pm$  17). Discussion Although GPS and PZ recorded similar overall distance run, in the high intensity running zones and in the number of sprints these differences were significant. It is possible that the sampling frequency is the source of these differences. The GPS system only records sprints at 1Hz whereas the PZ system samples at 10 Hz. The accumulative distance of sprints shorter than 1s recorded by PZ accounts for the majority of the differences in this speed zone between the 2 systems. Due to the differences between the 2 systems care should be taken when using data from them interchangeably to log the total load on players, in particular, when the GPS system is used to monitor the work load of a player returning from injury. Future research should be conducted to determine a correction factor between the 2 systems to allow a direct comparison of the data.

## MATCH ANALYSIS OF ELITE FEMALE BASKETBALL DURING COMPETITION

Conte, D.1, Minganti, C.2, Tessitore, A.1

*1 Dpt. of Human Movement and Sport Sciences, University of Rome "Foro Italico*

Introduction Basketball, as team sport, has fascinated worldwide spectators with its dynamic play. However, how the time-motion is structured in a game is more known for male rather than for female competitions. Thus, the purpose of this study was to investigate the duration of live time (LT), and stoppage (ST) playing phases during official Italian female elite basketball games. Methods To this scope three First Division championship games were continuously recorded and analyzed by a very expert match analyst. The LT was considered the actual playing time, while ST was any stoppage in play. Both LT and ST durations were classified according to 5 classes of frequency (1-20; 21-40; 41-60; 61-80; and >80 seconds). The LT phases were further classified in those entirely played on a half court and those on total court, in order to register one or more transfer (TR) phases, using 5 classes of frequency ( $n=1; 2; 3; 4; >4$ ). Chi Square was applied to investigate differences among games, and classes of frequency. Furthermore, a descriptive statistic (frequency and percentage), and LT/ST ratio was calculated. Results No significant differences were found among matches for LT, ST and TR, while a difference was found for half court actions  $p<0.001$ . Moreover, significant differences were found among LT, ST and TR classes of frequency  $p<0.001$ . Descriptive analysis showed, both for LT and ST, higher frequency of occurrence for 1-20s ( $45.9\pm7.7$  and  $49.2\pm9$ , respectively) and 21-40s ( $29.3\pm3.4$  and  $31.7\pm1.5$  respectively). Furthermore, 36.2% and 63.8% of actions were played on half and total court, respectively. The TR analysis showed as 48.4% and 27.1% of TR actions were performed with 1 and 2 transfer phases, respectively. The LT/ST ratio was  $1.09\pm0.28$ . Discussion The findings of this study showed as most of the LT and ST phases lasted less than 40 seconds, with a 1:1 LT/ST ratio, and a reduced number of consecutive TR phases in actions, underlining the intermittent nature of female basketball (Matthew and Delextrat, 2009). These data could help female basketball coaches to set-up drills with a short duration and a reduced number of TR. References Matthew D, Delextrat A. (2009). *J. of Sports Sci*, 27(8), 813-821.

## MECHANICAL POWER MEASUREMENT DURING WALKING <4, 6 KM/H> AND RUNNING <8, 10, 12 KM/H> USING ACCELEROMETERS

Pluk, A.

*KU Leuven*

Mechanical power measurement during walking (4, 6 km/h) and running (8, 10, 12 km/h) using accelerometers Pluk, A.1, Berckmans, D.1, Jonkers, I.2 1: M3-BIORES (KU Leuven, Belgium), 2: FaBeR (KU Leuven, Belgium) Introduction Power and energy expenditure are investigated to determine training intensity in running. Most methods are based on force measurement and speed or segmental energy analysis, limiting these calculations to laboratory conditions. In this study, mechanical power is measured using wearable accelerometers. Methods Six male students between 21 and 23 years old walked and ran at 5 different speeds (4, 6, 8, 10 and 12 km/h). 3D kinematic data was measured using a two camera Krypton system (Nikon Metrology Instruments, Belgium) sampled at 100 Hz. 3D acceleration data from the ankles of the subjects was measured at 125 Hz using 2 Zephyr BioHarness BT accelerometers (Zephyr Technology, Annapolis, USA). 3D ground reaction forces (GRF) were measured using an instrumented, split-belt motorised treadmill (Forcelink, The Netherlands) at 1000 Hz. From the kinematics and GRF mechanical power was calculated. Individual strides were identified by detecting the heel-strike in the GRF data and GRF, acceleration and power were time normalised per stride to 0-100%. For each stride the minimum and maximum values of GRF, power and acceleration were calculated in each direction. Results The relation between acceleration data and power was analysed for each subject. Pearson correlation coefficients are calculated for minimum and maximum values in each direction, resulting in  $R^2=0.197$  and  $R^2=0.737$  for forward;  $R^2=0.004$  and  $R^2=0.118$  for upward;  $R^2=0.177$  and  $R^2=0.235$  for medio-lateral; and  $R^2=0.083$  and  $R^2=0.793$  for the resulting acceleration and power. Discussion A clear disruption in the relation can be seen between the walking speeds (4 and 6 km/h) and the running speeds (8, 10 and 12 km/h). Because only a small number of different velocities were tested, only a very limited number of data points per test subject were available. Therefore statistically sound individual analysis is not possible, where this could be very beneficial to study individually different running characteristics. Looking at the relation between acceleration and power, a moderate relation in maximum forward direction ( $R^2=0.737$ ) is observed, where in the total power a strong linear relation ( $R^2=0.793$ ) between the maximum total power and the maximum total acceleration is seen. Looking at the relation between power and acceleration for the individual subjects, a similar strong relation is present in each of the individual test subjects. Conclusion Triaxial accelerometers were used to measure mechanical power for different speeds. A strong linear relation was established between the total acceleration and total mechanical power, even for individual test subjects. This relation confirms the possible use of accelerometers as a portable technology to evaluate power expenditure during running.

## OPTIMISING TECHNICAL SKILLS AND PHYSICAL LOADING IN SMALL-SIDED BASKETBALL GAMES

Klusemann, M.J., Pyne, D.B., Foster, C., Drinkwater, E.J.

*Australian Institute Of Sport*

Introduction The organisational pattern of small-sided basketball games defines the balance between physical and physiological demands and technical practice needed for competitive success. Differences in technical, physiological and physical demands of small-sided basketball games related to the number of players, court size and work-to-rest ratios are not well characterised. Methods A controlled trial was conducted to compare the influence of number of players (2v2 / 4v4), court size (half / full court) and work-to-rest ratios (2x5 min / 4x2.5 min) on the demands of small-sided games. Sixteen elite male and female junior players (aged 15-19 years) completed eight variations (2 x 2 x 2) of a small-sided game in randomised order over a six week period. Technical elements (e.g. shots, rebounds and passes) and movement patterns were assessed by video analysis. Heart rate responses and rating of perceived exertion (RPE) were measured to assess the physiological load. Results There were ~60% more technical elements in 2v2 than 4v4 and ~20% more in half court than full court games. Heart rate ( $86 \pm 4\%$  v  $83 \pm 5\%$  of maximum; mean  $\pm$  SD) and RPE ( $8 \pm 2$  v  $6 \pm 2$ ; scale 1-10) were moderately higher in 2v2 than 4v4 small-sided games. The 2v2 format elicited substantially more sprints ( $36 \pm 12\%$ ; mean  $\pm 90\%$  confidence limits) and high intensity shuffling ( $75 \pm 17\%$ ) than 4v4. Full court games required substantially more jogging ( $9 \pm 6\%$ ) than half court games. Discussion This is the first study to systematically investigate the effect of the number of players, court size and work-to-rest ratios on the various demands of small-sided basketball games. The main finding is that the number of players has the largest influence on the technical, physiological and high intensity movement patterns in small-sided basketball games. Court size and work-to-rest ratios can influence the frequency of various movement patterns. Basketball coaches can manipulate different variables of basketball drills and small-

sided games to vary the technical, physiological and physical demands of their basketball practice. Applying these training concepts will help coaching staff meet specific training and conditioning goals.

## 16:05 - 17:35

### Oral presentations

#### OP-PM18 The Elite Athlete

##### **ULTRA-ENDURANCE EXERCISE IS ASSOCIATED WITH EXTENSIVE INFLAMMATORY CELL INFILTRATION IN HUMAN SKELETAL MUSCLE OF EXPERIENCED ATHLETES**

Wahlin-Larsson, B., Marklund, P., Mattsson, C.M., Ponsot, E., Lindvall, B., Lindvall, L., Ekblom, B., Kadi, F.

*University of Örebro*

ULTRA-ENDURANCE EXERCISE IS ASSOCIATED WITH EXTENSIVE INFLAMMATORY CELL INFILTRATION IN HUMAN SKELETAL MUSCLE OF EXPERIENCED ATHLETES Wahlin-Larsson, B.1, Marklund, P.1, Mattsson, C.M.2,3, Ponsot, E.1, Lindvall, B.4, Lindvall, L.4, Ekblom, B.2,3, Kadi, F.1. 1School of Health and Medical Sci. (Örebro university, Sweden), 2The Swedish School of Sport and Health Sci. (Stockholm, Sweden) 3Dep of Physiology and Pharmacology, Karolinska Institutet, (Stockholm, Sweden) 4 Dep of Neurology, University Hospital (Örebro, Sweden) Introduction As ultra-endurance exercises impose an extreme physiological stress reflected by high levels of systemic inflammatory markers (Kim et al., 2007; Kim et al., 2009), it is hypothesized that skeletal muscle can be the site of an important inflammatory reaction. To our knowledge, the effects of very prolonged endurance exercise on local skeletal muscle inflammation have not been examined. The aim of this study was to assess the effects of a single 24 h ultra-endurance exercise bout followed by a 28 h recovery period on local muscle and systemic inflammatory responses in well trained ultra-endurance athletes. Method Blood and muscle samples were collected before (PRE), immediately after the exercise (POST) and after 28h of recovery (POST28). CRP and several inflammatory cytokines were assessed together with the evaluation of the occurrence of inflammatory cells (CD3+, CD8+, CD68+) and the expression of major histocompatibility complex class-I (MHC class-I) in skeletal muscle. Result A major finding was the occurrence of an extensive inflammatory cell infiltration in skeletal muscle of all athletes and the number of CD3+, CD8+ and CD 68+ cells were 2-3 fold higher at POST28 compared to PRE (P<0.05). The inflammatory cell infiltration was associated with a significant increase in the expression of MHC class-I in muscle fibers. At POST, the levels of IL-6, IL-8 and CRP were significantly increased. At POST28, IL-8 and CRP continued to increase. There were no significant associations between the magnitude of the systemic and local muscle inflammatory reactions. Discussion In conclusion, an endurance activity at a low intensity (~60% VO2max) but sustained over a very prolonged period (24 h) induces an extensive infiltration of inflammatory cells in skeletal muscle of well-trained athletes 28 h after termination of the exercise bout. The concomitant systemic inflammation usually reported after such exercises (Neubauer et al., 2008; Suzuki et al., 2003), was not correlated with the amplitude of the local muscle inflammatory reaction. References Kim H, Lee Y, and Kim C.(2007) Eur J Appl Physiol 99: 443-447. Kim H, Lee Y, and Kim C.(2009) Eur J Appl Physiol 105: 765-770. Neubauer O, König D, and Wagner K. (2008) Eur J Appl Physiol 104: 417-426. Suzuki K, Nakaji S, Yamada M, Liu Q, Kurakake S, Okamura N, Kumae T, Umeda T, and Sugawara K. (2003) Med Sci Sports Exerc 35: 348-355.

##### **RACE CYCLING: BIOLOGICAL EVOLUTION**

Le Goff, C., Kaux, J.F., Goffaux, S., Couffignal, V., Coubard, R., Laurent, T., Melon, P., Fillet, M., Chapelle, J.P.

*University Hospital of Liège*

Introduction: The metabolic and cardiac impact of a cycling effort on blood biology is not very well described in the literature. We aimed to measure the concentration of different biomarkers (cardiac and metabolic) released during an international cycling race. Materials and methods: Venous blood samples of 15 young men (25.1 ± 6.4 y.o.) were collected just before (T1), just after (T2), 3 hours (T3) after an international cycling race of 179.6 kilometers in Belgium for the determination of cardiac and metabolic biomarkers: red blood cell (RBC), haemoglobin (Hgb), creatinin (Cr), highly sensitive troponin T (hsTnT), myoglobin (MYO) and NT-proBNP. All automated assays were performed according to the manufacturer's specifications. For the statistical analysis, an Anova calculated with the Statistica Software version 9.1 was used. Results and discussions: RBC and Hgb levels varied significantly between T0 and T3 (respectively p=0.0026, and p=0.002). Cr concentration also varied significantly between all times (T0-T1:p<0.0001, T1-T3:p=0.0326 and T0-T3 p=0.0001). These changes might be related to renal flow depletion during exercise. MYO increased significantly between T0 and T1 (p<0.0001), but quickly decreased between T1 and T3, however the T3 level stay higher than T0 (p=0.014). The stress delivered from the physical activity performed during the race induced a significant variation of hsTnT which increased significantly between T0 and T1 (p<0.0001) and stayed higher 3 hours after the end of the exercise (T0-T3: p<0.0001). The intense exercise delivery by the race induced a significant variation of NT-proBNP, that followed the same kinetic of hsTnT but in smaller proportion. We noticed variations statistically significant between T0 and T1 and between T0 and T3 for NT-proBNP. These increases of cardiac biomarkers were significant but reasonable and could not allow us to talk about cellular necrosis or irreversible injury. Conclusion: Our results show that stress generated by a cycling race could be the cause for the different metabolic variations observed. Troponin T stays without a doubt the most specific marker for stress related to myocardial tissue. Its increase can then be considered as being of interest.

##### **EFFECT OF AGE AND BIOLOGICAL SEX ON PERFORMANCE IN SPRINT, OLYMPIC, HALF-IRONMAN AND IRONMAN DISTANCE TRIATHLONS.**

Wu, S.S.X., Peiffer, J.J., Nosaka, K., Abbiss, C.R.

*Edith Cowan University*

Introduction A number of studies have examined the influence of biological sex and age on exercise performance [1]. However, little is known with regards to the interaction of differing modes of locomotion and exercise duration with these factors. The purpose of this study was to examine the interaction of biological sex and age on performance over the three disciplines of triathlon during events of varying

distance. Methods Time for each discipline (swimming, cycling, and running) and overall finishing times of the top 20% of male and female amateur triathletes performing in various age groups (i.e. decade of age >20y) of four standard distance triathlons were examined. The triathlon distances included a sprint (0.75 km swim, 20 km cycle, 5 km run, n=68) an Olympic (1.5 km swim, 40 km cycle, 10 km run, n=76), a half-Ironman (1.9 km swim, 90 km cycle, 21.1 km run, n=256), and an Ironman (3.8 km swim, 180 km cycle, 42.2 km run, n=234). Overall race data was obtained from official event websites. For each event and discipline, performance time of each triathlete was normalised to the fastest age group of the respective sex. Results An age related decline in overall performance during the half-Ironman was observed beyond 40 y for males (P=0.021) and females (P=0.001). Performance decline in the Ironman was observed from 40 y for males and 50 y in females (P=0.018). The age related decline in overall performance was not significantly different between males and females during the sprint and Olympic distance triathlons. Swimming performance of both males (P=0.011) and females (P=0.002) was significantly better in younger (20-29 y) compared with athletes 30 y and older in all events. Fastest cycling times for males was observed at age 30-39 y irrespective of race distance, while females were fastest at age 40-49 y in all events, except for the half-Ironman where 20-29 y were fastest (P=0.034). An age related decline in running performance was observed in the half-Ironman and Ironman > 40 y in males (P=0.009), > 40 y (P=0.001) and 50 y (P=0.012) in females, respectively. Discussion Results from the present study indicate that the age related decline in overall performance in both males and female athletes was more evident in the longer distances (Ironman and half-Ironman), compared with shorter events [2]. These differences appear to be closely associated with decreases in running performance. Further research is needed to understand the physiological factors responsible for age related declines in exercise performance of differing duration and locomotion. References 1. Lepers R, Maffiuletti NA. (2010). *Med Sci Sp Sci*, 43(1), 134-139. 2. Lepers R, Sultana F, Bernard T, Hausswirth C, Brisswalter J. (2010). *Int J Sp Med*, 31(4), 251-256

### THE PHYSIOLOGY OF WORLD-CLASS SLEDGE ICE-HOCKEY PLAYERS

Sandbakk, Ø., Bucher, S., Skovereng, K., Welde, B., Ettema, G.

1) Norwegian University of Science and Technology, Norway, 2) North-Troendelag University College, Levanger, Norway

INTRODUCTION: Sledge ice-hockey is a modified version of regular ice hockey targeting athletes with a physical disability, typically affecting the lower body. An aluminum sledge is used as an adaptive device and each player carries two sticks for puck handling and player movement. Thus, the players rely solely on their upper body to propel themselves across the ice surface. An ice sledge hockey game is performed as 3 periods of 15 minutes on a 60 x 30-m ice rink, characterized by a constant alternation between short dashes, stopping actions and circle moves leading to multiple changes of work load and intensity. In order to better understand the demands of world-class sledge ice-hockey, the present study compared physical and technical abilities of world-class (WC) and national-class (NC) sledge ice-hockey players. METHODS: Six WC and six NC sledge ice-hockey players from the A and B Norwegian national team performed the following sport-specific tests on ice: 1) 30-m maximal sprint, 2) multiple sprints (eight 30-m sprints at 30 seconds intervals with active recovery) and 3) a time-trial technique test where the athletes controlled the puck through multiple turns. In the laboratory, a 3-min all out poling ergometer test was performed sitting in a modified poling machine to determine peak respiratory parameters, and 1 repetition maximal strength and peak power was assessed in the bench press (BPr), bench pull (BPu) and pull-down (PD) exercises. The athletes' training diaries over the last year were analyzed. RESULTS: WC players showed 10-13% faster times both for the single 30-m and throughout all eight sprints in the multiple sprint test, whereas the technique test was ~15% for the WC players (all P<0.05). In the ergometer test, WC players showed ~5% higher VO<sub>2</sub>peak in absolute values and significantly faster oxygen kinetics (both P<0.05). Furthermore, WC players showed 15-25% higher maximal strength and power in all exercises (all P<0.05). WC players trained ~15% higher total volume with 30% more sport-specific training on ice and twice as much low intensity endurance training (all P<0.05). CONCLUSIONS: The current results show that maximal sprint ability, upper-body maximal strength and power, and aerobic capacities differentiate world-class from national-class sledge ice-hockey players. It is therefore suggested that these physical capacities are important for reaching world-class level in this sport. In addition, also technical ability showed clear differences between performance levels. The current study also indicates that the combination of sport-specific training on ice and low-intensity endurance training are important in attaining an international level in sledge ice-hockey.

17:45 - 19:15

### Invited symposia

#### IS-PM08 Towards an Integrative Approach of Exercise-Induced Fatigue

##### CELLULAR MECHANISMS OF SKELETAL MUSCLE FATIGUE

Westerblad, H.

Karolinska Institutet, Stockholm

Intense, repeated activation of skeletal muscles causes a decline in performance known as muscle fatigue. The decline in performance includes reduced force production and slower contractions. Changes in many properties may be involved in fatigue development, including impaired neural activation of muscle cells (central fatigue) as well as impairments intrinsic to the muscle cells (peripheral fatigue). Peripheral fatigue may include defects in action potential propagation, sarcoplasmic reticulum (SR) Ca<sup>2+</sup> handling and/or the function of the contractile elements. A range of mechanisms have been identified which may contribute to the decline of performance and these include changes in ionic composition, metabolite concentration, phosphorylation status and production of reactive oxygen species. Many different types of exercise cause fatigue and an important challenge is to identify the relative importance of various mechanisms in different conditions. Most of the mechanistic studies of fatigue have been performed on isolated muscle and another major challenge is to use the knowledge generated in these studies to identify the mechanisms of fatigue in humans under normal conditions and in association with various diseases.

## CENTRAL MECHANISMS IN MUSCLE FATIGUE

Taylor, J.L.

*Neuroscience Research Australia and the University of New South Wales, Sydney*

In humans, muscle fatigue can be defined as an exercise-related decrease in maximal voluntary force or power of a muscle or muscle group. Some of this fall occurs because cellular mechanisms reduce the maximal output of the muscle fibres, and some occurs because of reduced drive from the central nervous system to the muscle. The relative muscular and neural contributions vary with different types of exercise (Taylor & Gandevia 2008). As each muscle fibre receives input from one motoneurone, and each action potential in a motoneurone generates an action potential in the muscle fibres it innervates, the firing rates of motoneurons are critical for the production of force. If they are too low, the muscle fibres will not produce all the force of which they are capable. When not fatigued, some people produce firing rates which drive some muscles fully on some occasions, but most do not. With fatigue, ability to drive the muscles is reduced. During fatiguing contractions, motoneurons become less responsive to synaptic input. Multiple mechanisms may contribute to this decrease. Responses to stimulation of the corticospinal axons decrease despite maximal voluntary effort (Butler et al. 2003), and removal of voluntary drive reveals that motoneurone excitability is profoundly depressed (McNeil et al. 2009, 2011). This depression is likely a consequence of repetitive firing of motoneurons. In addition, fatigue-sensitive small-diameter afferents can inhibit some motoneurone pools although they facilitate others (Martin et al. 2006). If motoneurons are harder to drive during fatigue, their firing rates will slow unless they receive extra input. Extra descending drive from the cortex is easily supplied during submaximal exercise to maintain task performance. During maximal efforts, force increments evoked by transcranial magnetic stimulation of the motor cortex increase, which implies that descending input becomes less able to drive the motoneurons and that there is cortical output untapped by the voluntary effort. However, it does not reveal if descending drive has increased or decreased in absolute terms. While the cause of insufficient descending drive remain unclear, it is exacerbated by firing of fatigue-sensitive small-diameter muscle afferents (Gandevia et al. 1996). In fatigue, motoneurone firing rates during maximal voluntary effort become too slow to drive the muscle fibres maximally. Changes in motoneurone excitability may be an important factor. References Butler JE, Taylor JL, Gandevia SC. (2003) *J Neurosci*, 23, 10224-10230. Gandevia SC, Allen GM, Butler JE, Taylor JL. (1996) *J Physiol*, 490, 529-536. Martin PG, Smith JL, Butler JE, Gandevia SC, Taylor JL. (2006) *J Neurosci*, 26, 4796-4802. McNeil CJ, Martin PG, Gandevia SC, Taylor JL. (2011) *J Physiol*, 587, 5601-5612. McNeil CJ, Giesebrecht S, Gandevia SC, Taylor JL. (2011) *J Physiol*, 589, 3533-3544. Taylor JL, Gandevia SC. (2008) *J Appl Physiol*, 104, 542-550.

## BEYOND CENTRAL AND PERIPHERAL MECHANISMS IN MUSCLE FATIGUE

Enoka, R.M.

*University of Colorado, Boulder*

At least since the seminal work of Mosso (1894), physiologists have distinguished between central and peripheral mechanisms in the study of muscle fatigue. With this approach, muscle fatigue is quantified as the decline in an objective measure of muscle function and experiments are designed to identify the rate-limiting adjustments that contribute to the reduction in performance. These studies have informed us that muscle fatigue can be produced by a number of impairments, including such diverse mechanisms as the management of calcium by muscle fibers and the excitability of neural networks. The translational interpretation of such observations, however, remains challenging (Enoka, 2012). Three examples underscore the limitations of this traditional approach to the study of muscle fatigue. First, although the decrease in maximal voluntary contraction force (torque) is greater for old adults than young adults after performing a series of anisometric contractions (Baudry et al. 2007), old adults can sustain a submaximal isometric contraction for a longer duration than young adults (Hunter et al. 2004). These observations indicate that the relative fatigability of old adults, and presumably the underlying mechanisms, varies across tasks, but the findings provide no insight on the functional significance of the contrasting results. Second, the traditional approach to muscle fatigue does not accommodate the fatigue reported by clinical populations in the absence of physical activity. Persons with multiple sclerosis, for example, typically report fatigue as a major debilitating symptom, yet fatigability as measured on standardized performance tests often does not differ from healthy control subjects (Steens et al. 2012). Rather, self-reported levels of fatigue in multiple sclerosis and other neurological diseases are more related to psychological factors and the function of supraspinal networks (Morgante et al. 2011). Third, it is difficult to reconcile the traditional approach with the viewpoint that perceptions of fatigue can be related to the regulation of homeostatic factors required to maintain the energetic and physical integrity of the body (Swart et al. 2009). Given these limitations of the traditional approach to the study of muscle fatigue, it seems necessary to reiterate the perspective described by Mosso: "On an examination of what takes place in fatigue, two series of phenomena demand our attention. The first is the diminution of the muscular force. The second is fatigue as a sensation." A scheme will be described in which fatigue comprises two domains, one related to factors that influence fatigability (decrease in muscle force) and the other to factors that modulate perceptions of fatigue (sensation). References Baudry S, et al. *Eur J Appl Physiol* 100: 515-525, 2007. Enoka RM. *J Biomech* 45: 427-433, 2012. Hunter SK, et al. *J Appl Physiol* 97: 1723-1732, 2004. Morgante F, et al. *J Neurol* 258: 263-272, 2011. Steens A, et al. *Neurorehabil Neural Repair* 26: 48-57, 2012. Swart J, et al. *Br J Sports Med* 43: 782-788, 2009.

**17:45 - 19:15**

## Oral presentations

### OP-SH04 Sport Psychology 2

#### THE IMPACT OF AN ALTERNATIVE SPORT-BASED EDUCATION CURRICULUM ON CONFIDENCE AND MOTIVATION.

McCann, B., Shaw, D.

*Robert Gordon University*

THE IMPACT OF AN ALTERNATIVE SPORT-BASED EDUCATION CURRICULUM ON CONFIDENCE AND MOTIVATION. McCann, B.1 & Shaw, D.J.1  
1 Robert Gordon University (Aberdeen, Scotland) Introduction The Scottish Executive estimates that each young person (aged 16-18 years) not currently engaged in education, employment or training (NEET) has an approximate per capita cost to society of £100,000. The innovative 'Alternate Academy' concept, a 12-week training programme jointly developed by Transition Extreme and Robert Gordon Universi-

ty, sought to provide opportunities for this group of young people to increase their confidence and motivation, whilst serving as a catalyst for re-engagement with education or training to assist participants in progressing to a positive destination. Alternative, adrenaline-based extreme sport (i.e., climbing, skateboarding, BMX and in-line skating) was the medium through which participants were to be re-engaged. Methods Ongoing evaluation data was gathered from five cohorts of participants (n=72; 66 male and 6 female) over an 18 month period, comprising of both qualitative and quantitative methods. These data were used to inform key themes for subsequent focus groups (to understand intra- and inter-cohort journeys) and individual interviews (to understand individual journeys), both of which explored pre-, during- and post-academy experiences. Results Analyses of evaluation data indicated a trend towards increased participant confidence and motivation. Focus group outcomes highlighted that participants were initially motivated to engage with the Alternative Academy through an interest in sport, but that the curriculum subsequently increased motivation to re-engage with education, employment or training. Participants qualitatively indicated increased confidence in situations other than sport. Interviews indicated that participants experienced increased levels of confidence and motivation at various stages during and following participation on the programme, with individual journeys demonstrating the impact of each. Discussion Quantitative and qualitative results indicated the positive impact of the Alternative Academy on participant confidence and motivation which were believed to have developed due to involvement in the training programme. Participants articulated that both were transferable to other aspects of their lives such as seeking employment or future training opportunities. Inter cohort comparisons indicated common themes related to the positive impact of sport in a wider context. The long lasting effect for participants was also demonstrated, some of whom had completed the programme 15 months prior to the focus groups and interviews being carried out. Sport, and in particular adrenaline-based and extreme sports, should continue to be researched in the future as possible mechanisms of not only addressing health and wellbeing concerns in young people, but also employability and personal development amongst the disengaged, NEET population.

### ANTI-DOPING COMPETENCE DEVELOPMENT AMONG STUDENTS OF SPORT SCIENCES

Bondarev, D.

*Lund University*

Introduction. Doping behavior may be explained both by individual predispositions (Sniehotta, Scholz & Schwarzer, 2005) and by underlying values and processes leading to this behavior, namely situational opportunities (Ajzen, 1985). The second one in many respect is influenced by norms and values promoted by surroundings of the athlete. Recent approaches in anti-doping initiatives target mostly athletes with little emphasis on coaches or medical practitioners. Relatively little has been done to target and adequately prepare students of sport sciences who considered being the main future figurants of sport and exercising world to deal with doping issues. Therefore, the aim of this study is to develop a model of anti-doping competence which could be incorporated to the curricula of sport sciences students. Methods. Data was obtained through questionnaires of 321 Sport Sciences students and during four focus group interviews with 40 students. Results. Results of the factor analysis identified three groups of variables. First group (68 % of the total variance) accounted following variables: intention to use doping (.76), attitude towards doping (.68), knowledge about doping (.67), motivation to comply (.66), self-efficacy to dope (.53), physical self-concept (.51). Second group (42 % of variance) consisted of such a variables as past use (.62), motivation to comply (.58), knowledge about doping (.55), subjective norms (.51). Third group (26 % of variance) and consists of the following variables: negative attitude towards doping (-.64), mastery goals (.52), self-efficacy to resist (.52), and motivation to comply (-.51). In addition transcriptions of focus group interviews had been analyzed to identify possible missing issues of questionnaires. Discussion. The results of the study show that it is possible to distinguish between three levels of anti-doping competence among sport science students. First level refers to potential doping users who accept doping use for their purpose, highly susceptible to complying with sport community norms and identifying themselves strictly with athletes, neglecting other parts of social life. At the second level of anti-doping competence are those who recognize that doping is illegal but may be used in exceptional situations. Under pressure of competition or influence of surroundings such athletes may rationalize an action that they had earlier categorized as being wrong. Third level of competence in anti-doping is related to those who are able to critically assess sport community norms and believe in their own ability to perform well. The results suggest that possible anti-doping interventions have to be suited to the level of anti-doping competence.

### INCREASING PHYSICAL OR SPORTS ACTIVITY LEVELS IN TRANSITION UNIVERSITY STUDENTS

Soares, A., Pereira, M., Canavarró, J.

*Universidade de Coimbra*

Soares, A.1, Pereira, M.1, Canavarró, J.1 1: FPCEUC (Coimbra, Portugal) Introduction: Health-compromising behaviors such as physical inactivity are difficult to change. Most social-cognitive theories assume that the intention to change is the best direct predictor of actual change, but people often do not behave in accordance with their intentions. The Health Action Process Approach (HAPA) suggests a distinction between (a) preintentional motivation processes that lead to a behavioral intention, and (b) postintentional volition processes that lead to the actual health behavior. Objective: The prediction model, as well as the effects of intervention, were examined in a study with University of Coimbra first-year-student sample who was enrolled in a health intervention project (N=224). Participants were assigned to one of the intervention groups (educational group and HAPA intenders/actors group) or to a control group. Main Outcome Measure: The study included 2 measurement points in time, covering a period of 2 months. Motivational variables, intentions, planning, coping, self-efficacy and physical or sports activity levels were assessed. Results: Structural equation modeling revealed that the model fit data sets well. Participants in the HAPA group did significantly more physical or sports activities than those in the other groups. Conclusions: HAPA volition variables were effective predictors of physical or sports activities adherence. Parsimonious interventions might contribute to health behavior change. References: Schwarzer, R., Luszczynska, A. (2008). How to overcome health-compromising behaviors: The Health Action Process Approach. *European Psychologist*, 13(2), 141–151.

### STUDY INTO THE GENDER-SPECIFIC TRANSITIONS AND CHALLENGES FACED BY FEMALE ELITE ATHLETES.

Tekavc, J., Wylleman, P., Cecic-Erpic, S., Reints, A., Rosier, N.

*Vrije Universiteit Brussel*

STUDY INTO THE GENDER-SPECIFIC TRANSITIONS AND CHALLENGES FACED BY FEMALE ELITE ATHLETES. Tekavc, J.1/2, Wylleman, P.1, Cecic-Erpic, S.2, Reints, A.1, Rosier, N.1 1: Vrije Universiteit Brussel (Brussels, Belgium), 2: Univerza v Ljubljani (Ljubljana, Slovenia) Introduction Although researchers have examined how talented and elite athletes develop through (as well as after) their athletic career (Wylleman & Reints, 2010), and despite the increased participation of women in elite sport, most empirical data on the athletic career development is



related to male talented and elite athletes. Methods Taking into account the multi-level factors of influence on career development, the developmental lifespan model (Wylleman & Reints, 2010) was used as conceptual framework to conduct a preliminary study into the empirical data available on the development of female talented and elite athletes. Results Research shows that differences in biological determinants (e.g., pregnancy) may explain the existence of female-specific career transitions and why women may show a different career path than men. At athletic level, female athletes typically specialize, achieve their peak, and end their athletic careers one to two years earlier than male athletes in the same sports. At academic/vocational level, female athletes have been found to more often continue their studies into higher education than male athletes, to benefit less from having a university degree than male athletes and also get less often jobs in the sport system, like coach or manager. Discussion While recognizing gender differences in athletes' career development, no attempt has been made to develop gender-specific athlete career transition models. More research on the role of gender on multi-level challenges (e.g., transition into higher education, sponsorship, lifestyle) faced by female athletes is therefore warranted. This research should not only add to the development of athletic career transition models specific to elite female athletes, but extend and detail the knowledge base currently available on the gender-specific transitions faced by elite female athletes. References Wylleman P, Reints A (2010). *Scandinavian Journal of Medicine & Science in Sports* 20(2), 88–94.

### **STUDY INTO THE FACTORS CONTRIBUTING TO THE CONTINUED DEVELOPMENT OF TALENTED AND ELITE YOUTH ATHLETES INTO ELITE SENIOR LEVEL USING A DEVELOPMENTAL AND HOLISTIC PERSPECTIVE.**

Rosier, N.1, Wylleman, P.1, De Bosscher, V.1, Van Hoecke, J.1, Reints, A.1, Tekavc, J.2

1: *Vrije Universiteit Brussel (Brussels, Belgium)*, 2: *Univerza v Ljubljani (Ljubljana, Slovenia)*

Introduction Researchers have examined how talented athletes develop through (as well as after) their athletic career. While different normative challenges have been studied (e.g., initiation into competitive sport, dropout from competitive sport, retirement from elite sport), few empirical data is available on the challenges talented athletes face during as well as after making the junior-senior transition. Methods Taking into account the multi-level factors of influence on career development, the developmental lifespan model (Wylleman & Reints, 2010) was used as conceptual framework to conduct a preliminary study into the empirical data available on the junior-senior transition. Results At athletic development the junior-senior transition generally entails that first-year senior athletes will generally be at a lower end in terms of athletic prowess and/or achievement and that, on average, only one junior elite athlete in three actually makes a successful transition into senior elite ranks. In comparison to challenges faced at other levels of development (e.g., psychological, academic) this transition is also a 'point of no return' as athletes cannot return to an earlier period or point in their athletic career. As the junior-senior transition occurs during adolescence, talented athletes will face challenges at psychological level including developing an own identity, coping with unexpected situations, higher expectations and pressures, and developing higher self-initiated/self-regulated behaviors. At psychosocial level, it was found that at the onset of the junior-senior transition, coaches become more personally involved, emphasize more the technical proficiency, and expect from them progress through discipline and hard work; with first-year senior athletes, coaches were found to make them more responsible for the training and competitions, as well as placing great demands upon them. At academic level, talented athletes will in first instance face challenges as they make the transition out of secondary education; during and after the junior-senior transition those talented athletes who continue into higher education will in second instance be required as 'student-athletes' to cope with challenges that strongly differ from that at secondary education level. Discussion As past research has been restricted (e.g., retrospective, limited number of participants, restricted to characteristics at athletic level), a clear need exists for research allowing not only to understand the developmental (stage-like) process occurring during the junior-to-senior process but also to look beyond the individual athlete characteristics and take into account the (structural and organisational aspects) of the environment in which talents develop. References Wylleman P, Reints A (2010). *Scandinavian Journal of Medicine & Science in Sports* 20(2), 88–94.

### **CORNER REFEREES IN JUDO CONFORM TO THE HEAD REFEREE BECAUSE OF THE OPEN FEEDBACK SYSTEM**

Boen, F., Ginis, P., Smits, T.

*KU Leuven*

CORNER REFEREES IN JUDO CONFORM TO THE HEAD REFEREE BECAUSE OF THE OPEN FEEDBACK SYSTEM Boen, F. 1, Ginis, P. 1, Smits, T. 2 1: Department of Kinesiology (KU Leuven, Belgium), 2: Department of Communication Sciences (KU Leuven, Belgium) Introduction This experiment tested whether the conformism observed among panels of judges in aesthetic sports (Boen et al., 2006, 2008; Vanden Auweele et al., 2004) also occurs among referees in a combat sport. Similar to aesthetic sports, judo refereeing relies upon a form of open feedback. However, in judo this system is reactive (i.e., two corner referees have to publicly 'correct' the score given by the higher-status head referee), whereas it is active in aesthetic sports (i.e., judges with equal status report their score simultaneously and can use the feedback about the scores of their colleagues for evaluating later performances). In order to test whether such reactive open feedback system leads to conformism among referees in judo, we designed an experiment in which this feedback was manipulated. Methods Participants were twenty certified Flemish referees, who had to score two sets of 11 video-ambiguous fragments that are used during formation and training of judo referees: one set with feedback about the head referee's score, and one set without feedback. Results When participants knew the head referees' score, their scores were significantly more in line with this score than when they did not know this score. More specifically, for both sets of fragments at least 10% less deviations from the head referee were observed when participants were given feedback about the score of the head referee. Discussion These results suggest that preventable conformism can occur in typical judo refereeing, i.e. with reactive open feedback. Consequently, judo federations should contemplate eliminating the reactive open-feedback system to avoid conformism and facilitate divergent opinions by the corner referees. One possibility is to give all referees an electronic device with which they can input their score without seeing the score of the head referee. References Boen F, Van Hoye K, Vanden Auweele Y, Feys J, Smits T. (2008). Open feedback in gymnastic judging causes conformity bias based on informational influencing. *J Sport Sci*, 26 (6), 621-628. Boen F, Vanden Auweele Y, Claes E, Feys J, De Cuyper B. (2006). The impact of open feedback on conformity among judges in rope skipping. *Psychol Sport Exerc*, 7 (6), 577-590. Vanden Auweele Y, Boen F, De Geest A, Feys J. (2004). Judging bias in synchronized swimming: open feedback leads to nonperformance-based conformity. *J Sport Exercise Psy*, 26 (4), 561-571.

17:45 - 19:15

## Oral presentations

### OP-PM19 Training and Testing 3

#### CARDIO-RESPIRATORY ORIGIN OF THE VO<sub>2</sub> DECREASE OBSERVED DURING A CONSTANT SUPRAMAXIMAL CYCLING EXERCISE.

Hanon, C.

*INSEP*

Cardio-respiratory origin of the VO<sub>2</sub> decrease observed during a constant supramaximal cycling exercise. Hanon C 1, Dorel S 1,2, Delfour-Pereyhton R 1,2, Leprêtre P-M 3, Bishop D.J. 5, Perrey S 4 and C. Thomas 1,6 1) INSEP, Paris, 2) Nantes, France, 3) Amiens, France, 4) Montpellier-1, France, 5) ISEAL Melbourne, Australia, 6) Evry Val d'Essonne, France. Introduction: A significant decrease in whole-body at the end of supra-maximal running exercise has previously been reported (1). This decrease was concomitant with a decrease in running velocity that could be considered as one of the possible explanations for this phenomenon. A strong correlation ( $P < 0.0001$ ) between the regrouped 400-, 800- and 1500-m tidal volume (VT) and responses has been observed in the last 100 m (1). It has also been reported that a reduction in systemic and locomotive skeletal muscle O<sub>2</sub> delivery limits aerobic capacity in trained humans (2). Therefore, the aims of this study were to confirm the occurrence of the decrease during severe, supra-maximal exercise without confounding influence of a decrease in power output, and to identify the primary factors that limit the ability to maintain in healthy, trained subjects. Methods: Eleven specifically trained male subjects volunteered for this testing protocol consisted of two sessions: 1) basal spirometric monitoring (volume and flow), a torque-velocity cycling test (muscular profile) and an incremental test (aerobic capacities) on calibrated cycle ergometer; 2) a constant-load supra-maximal cycle test performed until exhaustion. Ventilatory and cardiac responses were recorded continuously during the entire experimental session and arterialised capillary blood samples (85 µL) were taken at 0, 5 and 8 min of recovery. Results: The mean performance was  $51.4 \pm 6.9$  s with a mean power of  $640.5 \pm 50.8$  W corresponding to  $185 \pm 24$  % of MAP and  $49 \pm 3.8$  % of Pmax. A decrease in greater than 5% was observed in 6 of our 11 subjects with 5/6 subjects presenting also a decrease in stroke volume (SV). The magnitude of the decrease was correlated with SV decrease ( $R=0.75$ ,  $P < 0.01$ ), peak exercise end tidal O<sub>2</sub> partial pressure ( $R=0.80$ ,  $P < 0.005$ ) and rest forced expiratory volume in 1 s ( $R=0.72$ ,  $P < 0.05$ ), but with any metabolic variables. Discussion: Our results corroborate the relationship reported between SV and changes in intrathoracic pressure consecutively to voluntary lungs inflation and suggest that in those subjects with high levels of expiratory flow, greater positive expiratory intrathoracic pressure could increase the ventricular afterload and reduce the rate of ventricular filling during diastole (3). Therefore, the occurrence of decrease during a mild-acidosis strenuous exercise (pH = 7.21) results mainly from cardio-ventilatory factors. 1) Hanon C, Thomas C. *J Sports Sci*, 2011. 29(9): p. 905-12. 2) Gonzalez-Alonso J, Calbet JA. *Circulation*, 2003. 107(6): p. 824-30. 3) Amann M. *Experimental physiology*, accepted article. 2012

#### COMPARISON OF OBJECTIVE AND SUBJECTIVE RESISTANCE TRAINING QUANTIFICATION

Brown, N., Bubeck, D., Alt, W.

*University Stuttgart*

Introduction Quantification of training intensity in resistance training is difficult, since there are no valid objective methods to monitor how hard a subject is working during a training session (McGuigan et al., 2004). Therefore various authors recommend the use of the RPE-scale (Singh et al., 2007; McGuigan et al., 2004). Although recommended, it is unclear which objective biomechanic or physiologic parameters the RPE represents. Chen et al. (2002) compared RPE and different physiologic parameters. No significantly high correlations were found. The purpose of this study was to determine if RPE is related to objective mechanic parameters during training sessions and to analyse if a difference in RPE between two intensities can be found. Methods The subjects ( $n=13$ , 69% male, age=24.69 years) had at least one year of strength training experience and were randomly assigned to two groups (g1:  $n=8$ , g2:  $n=5$ ) providing a cross-over design for the different training protocols. Subjects performed 10 training sessions (5 hypertrophy 8-12RM (HYP), 5 strength 1-3RM protocol (MAX)) with 10 standard exercises. After each training session-RPE was measured 30 minutes after the end of the exercise. Training load, number of repetitions, contraction mode, RPE-AM (active muscle) and recovery times were protocolled for each set and exercise during the training session. Pearson correlation coefficients were calculated between RPE, objective protocolled training parameters and RPE-AM. A Wilcoxon signed rank test was used to determine differences in RPE between the two training protocols. Results No statistical significant correlations were found between RPE and the objective training parameters. Correlations between session RPE and RPE-AM were low ( $r=0.45$ - $-0.39$ ). A significant difference in session RPE between the two training protocols was found (HYP=  $6.30 \pm 1.74$ , MAX=  $4.47 \pm 2.17$ ,  $p < 0.01$ ). Discussion A correlation between an objective training parameter and subjective training quantification using RPE could not be found. Therefore a more complex interaction of objective training parameters is assumed. In agreement with the findings of Chen et al. (2002) the representational factor of the RPE remains unclear. In this study a difference between HYP and MAX-protocol was found to be consistent with the findings of Singh et al. (2007). However, in our study MAX produced lower RPE values than HYP, which is contrary to recent findings. Further research should focus on the development of a valid and reliable objective quantification method, since quantification of resistance exercise using subjective measurements is critical. References Chen, M., Fan, X. & Moe, S. (2002). *J Sports Sci*, 20(11), 873-899. McGuigan, M. R. & Foster, C. (2004). *Strength Cond J*, 26(6), 42-47. Singh, F., Foster, C., Tod, D. & McGuigan, M. (2007). *Int J Sports Physiol Perform*, 2(1), 34.

#### NEUROMUSCULAR FATIGABILITY OF TRUNK EXTENSORS AND FLEXORS FOLLOWING 10 WEEKS OF SPECIFIC EXERCISE AT DEVICES

Alexander, N., Ullrich, B., Stening, J., Felder, H., Hökelmann, A.

*Universität Magdeburg and OSP Rheinland-Pfalz/Saarland*

Introduction A deficiency in lower back muscle endurance is a risk-factor for low-back pain (Demoulin et al, 2006). This study analyzed the effects of 10 weeks of endurance-oriented strength training for the major trunk muscles on maximum voluntary isometric capacity

(MVC) of the major trunk muscle groups and EMG estimated neuromuscular fatigability of the trunk extensors and flexors. Methods Adolescent regional athletes were separated into two groups: training group (n = 11) and control group (n = 10). The total duration of the experimental period was 13 weeks. The first two weeks were used as a control period. Thereafter, training subjects started a 10 weeks progressive strength training period for the trunk extensors, flexors, lateral flexors and rotators on training machines equipped with a biofeedback system. Testing was performed during the baseline (weeks -2, -1) and after 10 weeks of training. Measurements included MVC force measurements of the major trunk muscles and analysis of the neuromuscular fatigue resistance of specific trunk muscle groups. Surface EMG of m. erector spinae, m. latissimus dorsi, m. rectus abdominis and m. obliquus externus was collected during sustained isometric trunk extension and flexion contractions at 40% of pre-exercise MVC. Results No significant enhancement for any parameter was detected in controls. Significant increases in MVC of the major trunk muscle groups and endurance time during sustained isometric trunk extensions and flexions occurred following training. Normalized [% Max pre fatigue] EMG-RMS values of all analyzed muscle groups were higher during the fatiguing contractions at the first baseline compared to the second baseline measurement and the end-measurement. However, no significant differences in normalized EMG-RMS values during fatiguing trunk extensions occurred among the second baseline testing and the end-measurement. Contrary, significant lower normalized EMG-RMS values of the analyzed trunk flexor muscles were found after the training period compared to both baseline measurements. Discussion The present exercise increased the maximum voluntary isometric capacity and endurance-time during sustained isometric trunk extensions and flexions in adolescent athletes. EMG-RMS analysis during fatigue suggests a rapid learning effect, rather than training-induced alterations. Although without statistical significance, average EMG activity during fatigue was lower after training indicating some neuromuscular adaptations. The present results indicate that baseline variability in EMG traces has to be considered when neuromuscular fatigability is analyzed in training studies. References Demoulin C, Vanderthommen M, Duysens C, Crielaard JM (2006). *Joint Bone Spine*. 73,43-50

### **CUSHIONING AND STABILITY DURING TREADMILL RUNNING: EFFECTS OF TREADMILL AND FOOTWEAR**

Delattre, N., Roux, M.

*Oxylane*

Introduction Treadmills are increasingly used in both physical activity and research fields. However, treadmills can be made of various constructions and materials resulting in a wide range of mechanical behaviours. In shoe research field, the main studied features are cushioning and stability. Ferris and Farley (1997) reported an interaction between ground or shoes properties, and body stiffness, while Lafortune et al. (1992, 1996) highlighted the link between body stiffness and lower limb shock propagation. However, no study assessed how ground and shoe properties influence the shock propagated to the lower limb. On the other hand, Clarke et al. (1983) and De Wit et al. (1995) have studied the relationship between stability and shoe sole properties. However, no work had yet integrated the ground and shoes properties in stability assessment. This study aimed at assessing both ground and shoe sole properties on cushioning and stability during treadmill running. Methods Nine subjects ran at 3.5m/s on five treadmills (T1-T5: stiffness from 107 to 538 N/mm) with soft midsole shoes (40 AskerC, 88 N/mm), hard midsole shoes (65 AskerC, 119 N/mm) and barefoot. The analysed parameters were tibial acceleration (accelerometer), vertical ground reaction force (VGRF, custom-made force plate underneath each treadmill) and foot inv/eversion angle (gyroscope). Cushioning was assessed through peak tibial acceleration (PTA), acceleration slope (AS), and VGRF loading rate (LR). Stability was assessed through inv/eversion angle amplitude (IEAA), and angular velocity (IEAV). Results The analysis showed an effect of treadmill stiffness on PTA and AS, but not on LR, IEAA, and EIIV. AS was significantly lower for T1 (89±26 g/s), T2 (97±30 g/s) and T3 (119±30 g/s), than for T4 (186±82 g/s) and T5 (219±111 g/s). Barefoot induced significantly higher values of PTA, AS, and lower LR compared to shod conditions. No difference between soft, hard and barefoot conditions was found for PTA, AS and LR. EIIV was only affected by the footwear conditions: 406±145 °/s (soft), 513±170 °/s (hard), 615±192 °/s (barefoot). Discussion The results showed that, during treadmill running, 1) cushioning was affected by treadmill stiffness, not footwear; 2) stability was influenced by footwear, not treadmill stiffness. The results allowed to distinguish between two treadmill conceptions. These findings strongly influenced the conception of treadmills and indoor footwear running shoes. References Clarke TE, Frederick EC, Hamill CL. (1983). *Med Sc Sports Ex*, 15, 376-381. De Wit B, De Clercq D, Lenoir M. (1995). *J Appl Biomech*, 11, 395-406. Ferris DP, Farley CT. (1997). *J Appl Physiol*, 82(1), 15-22. Lafortune MA, Hennig EM. (1992). *Clin Biomech*, 7(3), 181-184. Lafortune MA, Hennig EM, Lake MJ. (1996). *J Biomech*, 29(12), 1523-1529.

**17:45 - 19:15**

## **Oral presentations**

### **OP-PM20 Health and Fitness: Elderly population**

#### **STRENGTH AND BALANCE PERFORMANCE IN HEALTHY OLDER ADULTS: COMPARISON BETWEEN HIGH FREQUENCY VIBRATION, RESISTANCE AND POSTURAL SENSORIMOTOR TRAINING.**

Iodice, P., Bellomo, R.G., Di Pancrazio, L., Saggini, R.

*University of Chieti*

Introduction. Aging is characterized by a gradual decrease in muscle mass and muscle strength which contributes to a decline in physical functions, increase disability, frailty, and loss of independence. Age related loss of muscle mass is referred to as sarcopenia. The study have the purpose to compare three different methods of specific training for the sarcopenic elderly with the aims to obtain increase in strength and balance. Methods. 40 male volunteers diagnosed with sarcopenia (CDCP) (70,9±5,2yrs). The patients were randomly assigned to three different training programs for 12 wk, global sensorimotor training, high intensity focused vibrational program (intensity: 300hz) and resistance program (intensity:60-80% of maximum theoretical force, 10-12 repetitions for 3sets). Before and after the training programs the isometric lower limb force was measured by dynamometer. At the same time, stabilometric test and analysis of walk were performed. Results. All the training, in a different manner, shows an increase in muscular isometric strength. Both the sensorimotor and the vibrational training increase stability with a reduction of sway area and surface of ellipse (p<0.01). The analysis of walking shows a significant increase in the length of the half-step in all three groups (respectively 107%, p <0.01; 91% p < 0.01; 65% p <0.05;). Discussion. Our results suggest that all our training counteract sarcopenia progression and each of them are able to stimulate a specific effects.

Sensorimotor and vibrational training have better results against the instability associated with aging. A training program to strengthen muscles for elderly including a sensorimotor intervention can counteract sarcopenia and increase stability.

### THE IMPACT OF MORPHO-FUNCTIONAL PARAMETERS TO THE QUALITY OF LIFE FOR WOMEN AGED 55 – 65 OLD

Haxholli, S.1, Kacurri, A.1, Haxholli, K.2, Haxholli, M.2

*Albanian Agency of Sports Services*

Introduction Especially assessing the morpho – functional parameters and body composition are essential to determine the quality of life in this age. Therefore, developing intervention programs that focus restoring or optimizing physical and psycho-social capabilities has been one of the main efforts of this study. The main purpose of this study is to evaluate and discuss the changes or not in strength, flexibility, balance, and anthropometric parameters improved with training program. Methods Pre-test/Post-test control group design was used in this research. This design enables the evaluation of effectiveness of the intervention used in similar one from Alfieri et al 2010 as well model program plan has been rely on ACSM, 2006. Quality of life questioner (paper and pencil) was asked for both groups (intervention & control) to write their feelings and psycho-social status before starting and after intervention. According to the gain scores,  $D = Y_2 - Y_1$ , represent the dependent variable difference from pre-test to post-test assessment that were used in ANOVA comparisons. Results The circumference of waist is meliorating by 9.4% and the biceps by 9.8 %. Vvariables of gluteus and thigh couldn't meet the difference of 5 %, all other anthropometric variables as waist and weight are improved by 5.5 % and 8.8 %. So far and functional parameters have the same trend and even more stressed always in favour of intervention group like as: balance 22.68%, flexibility 38.4 % and strength 44.5%. Discussion Regular physical activity provides multitude benefits, adult who maintain a regular routine of physical activity that is of longer duration or of greater intensity are likely to derivate greater benefits. Systematic training can help individuals how to be efficient in daily life (Waneen W. Spiriduso, EdD, et al 2005). Implementing combined and planed programs of physical activity base on aerobic, strength and balance with moderate to vigorous intensity arranged per individuals to develop the morph functional parameters in broadly recommended and applied in the similar studies, intervention program shaped in period of 12 – 16 weeks (Dishman et al 2002), (Barbosa et al 2002) and to (Brill et al 2000), as well Cousins, S.O. (1998). References American College of Sports Medicine. (2006). ACSM's, seventh edition. Philadelphia: Lippincott, Williams & Wilkins. Bouchard C., PhD, Steven N Blair, PED, William L. Haskell, PhD (2007). Physical Activity and Health. Human Kinetics. 272- 284 Michele Kettles, Colette L. Cole, Brenda S. Wright (2006). Women's Health and Fitness Guide. Human Kinetics

### BRISK WALKING PROGRAM IN POSTMENOPAUSAL WOMEN: EFFECTS ON PERCEIVED HEALTH, CARDIORESPIRATORY FITNESS AND LIPID-LIPOPROTEIN PROFILE TWO YEARS AFTER THE INTERVENTION

Garnier, S., Gaubert, I., Auneau, G., Mauriège, P.

*Université Paul Sabatier*

Introduction Walking being considered as the commonest and most feasible form of sustainable dynamic aerobic exercise for sedentary subjects (Lee and Buchner, 2008; Hamer and Chida, 2008), helps postmenopausal women to feel better (Lean and Lara, 2003) and improves their metabolic risk profile (Roussel et al., 2009). However, these beneficial effects at long term have not been fully investigated. Aims of the present study were thus to examine the effects of a brisk walking program on perceived health, cardiorespiratory fitness (CRF), body composition and selected metabolic risk factors, two years after the intervention. Methods 248 initially sedentary and overweight-to-obese (mean body mass index, BMI =  $30 \pm 4$  kg/m<sup>2</sup>) postmenopausal women ( $60 \pm 5$  yr-old) were recruited. 196 women were subjected to a 4-month endurance-training program walking (3 sessions of 45 min each/week at 60 % of their heart rate reserve) (exercise group) and 52 women did not exercise during the 4-month study period (control group). Following measurements were performed before and after the 4-month study-period as well as two years later: . perceived health estimated by a visual analogue scale (six questions) . CRF assessed by the 2-km walking test (Laukkanen et al., 1993) and estimated VO<sub>2</sub>max then calculated, . height, weight (BMI calculated) and waist circumference measured using standardized procedures, . fat mass and fat-free mass determined by bioelectrical impedance . lipid-lipoprotein profile measured for the exercise group, only Results Two years later, the decrease in body weight, fat mass, resting systolic and diastolic blood pressures as well as the increase in CRF ( $p < .001$ ) were maintained in the 91 women who completed the study. Changes in the lipid-lipoprotein profile and perceived health were maintained for five out of six items ( $p < .05$ ). Discussion The brisk walking program reduced body fatness, improved selected metabolic risk factors, CRF and perceived health of postmenopausal women. These improvements were sustainable two years later. References Hamer M, Chida Y. (2008). Br J Sports Med, 42, 238-43. Laukkanen RMT, Kukkonen-Harjula TK, Oja P, Pasanen ME, Vuori IM. (1993). Scand J Med Sci Sports, 3, 267-272. Lean MEJ and Lara J. (2003). In: Progress in Obesity Research, Medeiros-Nito G, Halpern A & Bouchard C eds, vol 9, 859-865. Lee IM, Buchner DM. (2008). Med Sci Sport Exerc, 40(Suppl 7): S512-8. Roussel M., Garnier S., Lemoine S., Gaubert I., Bessodès L., Auneau G. and Mauriège P. (2009). Menopause, 16, 566-575.

### MORE ACTIVE AGEING IMPLEMENTATION OF A LIFESTYLE INTERVENTION IN OLDER ADULTS, REGARDING FUNCTIONALITY AND OTHER HEALTH OUTCOMES – BASELINE RESULTS.

Ramalho, F.1,2, André, H.1,1,3, Moniz-Pereira, V.1,3, Machado, M.1,3, Carnide, F.1,3, Santos-Rocha, R.1,2, Veloso, A.1,3

*1.CIPER-Neuromechanics of Human Movement group, FMH-UTL, Portugal; 2.Sport Sciences School of Rio Maior - IPS, Portugal; 3.Biomechanics and Functional Morphology Laboratory, FMH-UTL, Portugal.*

Background: Ageing results in a progressive loss of functionality and mobility that decreases the quality of life and may lead to a high prevalence of falls (PF) among elderly population. "More Active Ageing" (MAA) is an exercise intervention implemented in the senior Portuguese community, focused on postural stability, balance and strength, aiming falls reduction and its severity. Purpose: A cross sectional study was designed to: 1) assess the baseline data of the MAA program on Health, Functional Fitness (FF) and Physical Activity; 2) identify which of those parameters can be correlated with falls in this group. Methods: 715 independent elderly ( $72.3 \pm 5.2$  y) were assessed by trained examiners who administered a fall & health questionnaire and a FF battery including U-G, C-5 and 2minStep tests from SFT2, items 4-7 of FAB Scale3, Calf Raise (CR) and Calf Stretch (CS) tests (in validation process). Spearman's Correlation Coefficient (SPSS) was used to analyze age, fear of falling (FoF) and medicine intake (Meds) influence on FF results inside groups of non-fallers (NF), fallers (F) and recurrent fallers (RF),  $p < 0.05$ . Discussion: All the FF results were correlated with FP (40.6%) for the entire sample. Age was negatively associated with FF tests results, especially in RF group. FoF was correlated with FF results in NF and F groups, but in the RF group only CR test was associated with this variable ( $r = -0.4$ ). Meds presented also a negative correlation with FAB6 and 2min tests in all groups (NF, F,

RF) and in the F group this variable also appears to affect the CR test results ( $r=-0.4$ ). Conclusions: FF tests showed to be relevant factors for falls and Age, Meds and FoF seems to influence negatively functional fitness status in this group. 1.Skelton, D. A. (2001). Age and ageing, 30(suppl 4), 33. 2.Jones, C. J. et al. (1999). Res Q Exerc Sport, 70(2), 113-119 3.Hernandez, D. et al. (2008) Arch of Phys Med & Rehab, 89(12), 2309-2315.

### **MUCOSAL IMMUNE MARKERS AND FUNCTIONAL FITNESS IN MIDDLE AGED MEN UNDERGOING DIFFERENT LEVELS OF PHYSICAL ACTIVITY**

Teixeira, S.

*University of Coimbra*

Mucosal immune markers and functional fitness in middle aged men undergoing different levels of physical activity. Teixeira, S.I, Ferreira, J.P1., Teixeira, A.M1. 1 Research Centre for Sport and Physical Activity, Faculty of Sport Sciences and Physical Education, Coimbra University, Coimbra, Portugal. Introduction Medical care is improving and resulting on a longer life expectancy for us and for the future generations. The aim of this study was to see if there were differences in mucosal immunity between groups that have different levels of physical activity routines (sedentary, regular moderate exercise and regular athletics training and competition). Methods The study participants were 52 men age, divided into 3 groups: sedentary (74.5+/-10.2 years old, 1.7+/-0.1m stature and 77.1+7-11.0kg body mass), active (69.9+/-6.4 years old, 1.7+/-0.1m stature and 81,0+/-13.1kg body mass) and veteran athletes (62.5+/-5.6 years old, 1,7+/-0.1m stature and 76.6+/-7.3kg body mass). They all signed an informed consent form. Functional fitness was evaluated using the senior Fitness Test battery tests (1). Anthropometric measures (BMI and navel perimeter) were also assessed. Saliva samples were also collected and levels of IgA, alpha-amylase were determined by ELISA. Statistical analysis was done using the ANOVA one way for differences between groups and the bivariate Pearson's correlation for the association between variables. The significance level was set at  $p<0.05$ . Results As expected the veteran athletes (middle distance and marathon runners) showed the best results for the functional fitness tests with significant differences for lower and upper body strength, aerobic resistance and agility and balance between the sedentary and active groups and between the sedentary and veteran athletes groups. Differences in salivary alpha-amylase concentration, salivary IgA concentration and secretion rate were also found between the veteran and active groups, with higher values for the veteran athletes. No anthropometric differences were found between the 3 groups. Correlations were found between the navel perimeter and all the functional fitness tests analyzed. The navel perimeter also correlated with salivary flow rate. Discussion The veteran athletes show better mucosal immunity values than the elderly active, which could be due to their higher activity levels. Very prolonged exercise and periods of intensified training can lead to a decrease in salivary IgA values (2), which does not seem to be the case with our veteran athletes probably because their training load is not as heavy as expected (minimum 1h running, 3x week). In turn an increase in mucosal immunity seems to have occurred which is in accordance with studies showing improved salivary IgA and alpha-amylase levels in subjects undergoing regular moderate exercise. References 1.Rikli RE, & Jones CJ. (2001) Senior fitness test manual. Human Kinetics 2. Walsh N. et al. (2011) Exercise Immunology Rev 17:6-63.

### **ELDERLY PEOPLE IN OUTDOOR ACTIVITY PARKS**

Diketmüller, R., Kolb, B., Mayrhofer, R., Studer, H.

*University of Vienna*

Introduction The City of Vienna has recently constructed several outdoor activity parks to promote physical activity for elderly people. Although there is no evidence yet as to whether the target group is actually using these parks, politicians are intrigued to set up similar parks across the city. The project „Let's go outside!“ focuses on: who is using the existing parks in what manner, how elderly people evaluate the parks and what are the specific needs of elderly people to exercise in open spaces. The aim was to develop guidelines for planning and managing outdoor activity parks for the city. Methods Following McKenzie's System for Observing Play and Recreation in Communities an observation method was developed to qualitatively describe and quantitatively evaluate elderly's usage patterns of outdoor activity parks (n=246 hours). Five outdoor activity parks were systematically observed and analysed focusing on the target group (60+). A subgroup of elderly was invited to inspect the parks, assess and evaluate the equipment and the suitability of the infrastructure for their target group. Results The results show that elderly people (60+), for whom the parks were explicitly constructed, only seldom visit (5-21%) or use aphysically actively the outdoor activity parks (0,3 - 8%). The five analysed cases are very different and appeal to heterogeneous user groups. In order to encourage the use of the parks it is essential to consider the setting of the equipment, the material quality, physical activity instruction and programmes and accessibility. The outcomes of the park observations, interviews and focus group discussions provided the basis for the guidelines, which were developed in a participatory process with elderly people, park advisors, as well as social workers, planners and experts in the field of physical activity and sports. Discussion and conclusions The results illustrate the importance of the specific needs of the heterogeneous target group for the planning of new outdoor activity parks. Supervised physical activity programmes support elderly in their engagement in public open space. The integration of the results of the focus group into the urban planning guidelines have been a major contribution from a setting-based (health promotion) perspective. References Diketmüller, R., Kolb, B., Mayrhofer, R. & Staller, S. (2010). Project „Let's go outside!“. Online at: <http://gemmaraus.univie.ac.at> Giles-Corti, B. (2006). People or places: What should be the target? J Sci Med Sport, 9(5), 357-366. Hoffenträger, G., Jacoby, J. & Maurer, E. (2008). Genderdifferenzierte Untersuchungen zur Freiflächennutzung älterer Menschen. Projektbericht: Geisenheim. McKenzie T.L., Cohen D.A., Sehgal A., Williamson S & Golinelli D. (2006). System for Observing Play & Recreation in Communities (SOPARC): Reliability & Feasibility Measures. Journal of Physical Activity & Health, 3, 208-222.

17:45 - 19:15

## Oral presentations

### OP-PM21 Molecular Biology 2

#### **DISTINCT AND ADDITIVE EFFECTS OF SODIUM BICARBONATE AND MILD HEAT STRESS ON A FIBER TYPE SHIFT VIA CALCINEURIN-NFAT PATHWAY IN HUMAN SKELETAL MYOBLASTS**

Tetsuo, Y.1, Naoshi, F.2

*National Hospital Organization Sagami Hospital*

**Introduction** Ingestion of sodium bicarbonate (NaHCO<sub>3</sub>) is known to enhance performance, probably via increased buffering of intracellular acidity. So far, little is known about direct effects of NaHCO<sub>3</sub> on myogenesis, especially in vitro. We have previously shown that continuous mild heat stress (CMHS) at 39°C induces a fast-to-slow fiber type shift of mammalian myoblasts. In this study, we examined the effects of NaHCO<sub>3</sub> and the combined effects of NaHCO<sub>3</sub> and CMHS on the differentiation of human skeletal muscle myoblasts (HSMMs) under culture conditions. **Methods** We used commercially available HSMMs of normal human skeletal muscle. Cells were seeded in the growth medium and incubated at 37°C until they reached 60-70% confluency. Then, the medium was changed to differentiation medium and supplemented with either 11, 22, or 33 mM NaHCO<sub>3</sub>. The cells were cultured at 37°C or 39°C for 7 d and harvested for Western blot analysis and real time PCR. We also performed loss- and gain-of-function experiments of individual NFATc isoforms. **Results** With increasing NaHCO<sub>3</sub> concentration, the mRNA levels of myosin heavy chain (MyHC) type I were increased, whereas those of MyHC IIx were unaltered. The NaHCO<sub>3</sub>-induced fast-to-slow shift was enhanced by CMHS. Likewise, intracellular calcium levels, the expression levels of NFATc2, NFATc4, and mitochondria related genes (PGC-1α, mtFA, and COX I) were upregulated with increasing NaHCO<sub>3</sub> concentration, which were additively enhanced by incubation at CMHS. Overexpression and knockdown experiments demonstrated that NFATc2 and NFATc4 regulate MyHC I expression. **Discussion** NaHCO<sub>3</sub> and/or CMHS induced a fast-to-slow fiber type shift, in which NFATc2 and NFATc4 acted as functional molecules. NaHCO<sub>3</sub> and/or CMHS also upregulated mitochondria related genes expression and membrane potential. From the viewpoint of cells under culture condition, we postulate that the supplementation of NaHCO<sub>3</sub> enhances mitochondrial function. NaHCO<sub>3</sub> and CMHS have an additive effect on a fast-to-slow fiber type shift and PGC-1α expression, which may provide insight into prevention of metabolic disease. **References** Yamaguchi, T., T. Suzuki, H. Arai, S. Tanabe, and Y. Atomi. 2010. Continuous mild heat stress induces differentiation of mammalian myoblasts, shifting fiber type from fast to slow. *Am J Physiol Cell Physiol* 298:C140-148.

#### **RECOMBINANT ERYTHROPOIETIN TREATMENT ENHANCES VO<sub>2</sub> MAX AND MYOGLOBIN CONCENTRATION IN HUMAN SKELETAL MUSCLE.**

Guadalupe Grau, A.1,3, Helbo, S.2, Plenge, U.4, Marianne Kristensen, M.3, Fago, A.2, Dela, F.3, Boushel, R.3,4, Belhage, B.4, Helge, J.W.3

*University of Las Palmas de Gran Canaria, University of Copenhagen, University of Aarhus*

Recombinant erythropoietin (rEPO) treatment has been shown to enhance endurance performance to a greater extent than what can be accounted for by increased blood oxygen carrying or diffusion capacity. This could be explained by peripheral adaptations in target tissues such as skeletal muscle, where EPO receptors are present, yet their function has not been elucidated. Moreover, mitochondrial oxidative capacity has been recently demonstrated to be higher after rEPO treatment. This led to our hypothesis that part of the ergogenic effect rEpo treatment resides in an effect on skeletal muscle myoglobin expression. **Methods.** Human EPO was administered by muscular injection (5000 IU IM once weekly) in 6 healthy volunteers over 8 weeks. One week of daily sub-cutaneous (SC) injections of 5000 IU of rEpo, followed by one week without treatment. Followed by one weekly SC injection for seven weeks, titrating the rEpo dosage to maintain haematocrit level at 50% IU. Oral iron (100 mg) supplementation was also given daily. Body composition was measured by DXA. Subjects performed a graded cycle ergometer exercise test where VO<sub>2</sub>max was measured. Capillarization was measured by immunohistochemical staining, whereas the concentration of myoglobin (Mb) was measured spectrophotometrically. VEGF protein expression was measured by Western Blot. **Results.** As expected, rEPO significantly increased blood haematocrit by 51%, and VO<sub>2</sub>max (from 54±3 to 58±3 ml.kg<sup>-1</sup>.min<sup>-1</sup>, P<0.05) without any exercise intervention. In the muscle myoglobin expression was higher after rEPO treatment (from 5.75 ± 0.70 to 6.89 ± 0.90 mg/g; P<0.05), whereas both the skeletal muscle capillarisation (from 4.89 ± 0.26 to 4.68 ± 0.49 Cap. per fiber) and the VEGF to tubulin α protein expression (from 3.8 ± 1.0 to 5.3 ± 3.9 a.u. P=0.3) remained unchanged. **Conclusion.** Higher myoglobin concentration was found in human skeletal muscle after rEpo treatment. The higher muscle oxygen transport capacity supports the presence of higher VO<sub>2</sub>max and may also be beneficial during endurance exercise. **Acknowledgements** This study was supported by grants from the ULPGC, Manuel Morales Foundation.

#### **DOWN-REGULATION OF INTERLEUKIN-1 RECEPTOR AND TOLL-LIKE RECEPTOR PATHWAYS IN NEUTROPHILS FOLLOWING PROLONGED, INTENSE EXERCISE**

Neubauer, O.1,2, Sabapathy, S.2, Lazarus, R.3,5, Ashton, K.4, Desbrow, B.2, Jowett, J.3, Cameron-Smith, D.6, Haseler, L.2, Wagner, K.H.1,2, Bulmer, A.2

*1: Univ. Vienna, Austria; 2: Griffith Univ.; 3: Baker IDI Heart and Diabetes Inst.; 4: Bond Univ.; 2-4: Australia; 5: Harvard Medical School, USA; 6: Univ. Auckland, New Zealand*

**Introduction** Prolonged, strenuous exercise induces a systemic inflammatory response that is followed by counter-regulatory and anti-inflammatory responses during the recovery period (Neubauer et al., 2008). Neutrophils play an essential role in these responses, and they are critical for tissue repair, remodelling, growth (Walsh et al., 2011), and the resolution of inflammation (Theilgaard-Mönch et al., 2006). Evidence is emerging that the underlying mechanisms in neutrophils are regulated by highly coordinated transcriptional programs (Radom-Aizik et al., 2008). **Aim** This study aimed to investigate the gene expression changes in circulating neutrophils following an experimental exercise trial (EXTR1) consisting of two hours (h) of intense, continuous cycling and running. We hypothesised that gene expression responses in neutrophils during recovery reflect the regulation of pathways involved in the systemic inflammatory response, and in sub-

sequent counter-regulatory mechanisms. Methods Eight healthy, endurance-trained, male subjects (age:  $25.0 \pm 4.1$  years;  $VO_2$  peak:  $56.3 \pm 6.7$  mL.kg<sup>-1</sup>.min<sup>-1</sup>) participated. Skeletal muscle and blood samples were taken one week before the EXTRI (baseline), and 3 h, 48 h, and 96 h post-EXTRI under standardized conditions. Microarray analysis was performed using the Illumina iScan platform. Differential expression in a paired design was tested using lumi and limma from Bioconductor. Gene set enrichment analysis (GSEA) was used to identify enriched molecular signatures chosen from the Molecular Signatures Database. Differential expression of selected genes was confirmed via RT-qPCR. Results Circulatory neutrophil counts increased 3 h post-EXTRI ( $P < 0.001$ ) and returned to baseline 48 h post-EXTRI. Genes associated with neutrophil activation (eg., CAMP), viability (eg., SOD2, MCL1), and tissue damage (eg., S100A12) were up-regulated 3 h post-EXTRI ( $P < 0.05$ ). GSEA indicated an up-regulation of the interleukin (IL)-1 receptor (IL1R) and toll-like receptor (TLR) pathways 3 h post-EXTRI (FWER  $p$ -value  $< 0.05$ ). Up-regulated genes that are associated with these pathways included IL1RN (encoding the anti-inflammatory cytokine IL-1 receptor antagonist), IRAK3 (a negative regulator of IL1R-/TLR-signalling), IL1R1, TLR6, and FADD (a regulator of TLR-mediated apoptosis, and a negative regulator of innate immune signalling). Discussion The transcriptional regulation of IL1R- and TLR-pathways indicates the acute activation of innate immune cellular activity in response to exercise. The up-regulation of IL1RN, IRAK3, and FADD appear to contribute to an early counter-regulation of these pathways. These data suggest a novel mechanism, by which neutrophils negatively regulate the innate immune response to exercise to avoid overshooting inflammation. References Neubauer O. et al. (2008). *Eur J Appl Physiol.* 104 Radom-Aizik S. et al. (2008). *J Appl Physiol.* 104 Theilgaard-Mönch K. et al. (2006). *Curr Opin Immunol.* 18 Walsh N. et al. (2011). *Exerc Immunol Rev.* 17

### MORNING-TYPES ARE PREVALENT IN ATHLETES PARTICIPATING IN INDIVIDUAL SPORTS

Rae, D.E., Kunorozva, L., Stephenson, K.J., Roden, L.C.

*University of Cape Town*

Introduction Recently, a link between an individual's diurnal preference (i.e. chronotype) and a variable number tandem repeat (VNTR) polymorphism in the Period 3 gene (PER3) has been demonstrated. The longer PER35 and shorter PER34 alleles have been associated with a preference for mornings and evenings respectively. The extent to which this chronotype-genotype relationship exists in athletic populations has not been determined. Methods Caucasian, male cyclists (CYC,  $n=125$ ,  $37.2 \pm 7.1$  years old,  $9.5 \pm 7.1$  years training), runners (RUN,  $n=120$ ,  $35.6 \pm 7.1$  years old,  $9.4 \pm 7.1$  years training), Ironman triathletes (IM,  $n=287$ ,  $36.8 \pm 6.5$  years old,  $2.2 \pm 1.8$  years training) and a control population of active, non-competitive individuals (CON,  $n=96$ ,  $32.9 \pm 8.1$  years old,  $6.1 \pm 6$  years of training) participated in this study. The chronotypes of all CYC, RUN and CON participants and a sub-sample of the IM group ( $n=49$ ) were assessed using the Horne-Östberg Morningness-Eveningness Personality Questionnaire. The PER3 VNTR genotype for each participant was determined by a PCR-based test using DNA extracted from buccal or blood samples. Results The CYC, RUN and IM groups contained more morning-type individuals (CYC: 79%; RUN: 72%; IM: 65%) than the control group (42%,  $p < 0.001$ ). Furthermore, the athletic populations contained more individuals genotyped as PER35/5 – i.e. homozygous for the "morning-type" allele – (CYC: 41%; RUN: 23%; IM: 28%) than the control group (9%,  $p < 0.001$ ). The prevalence of the PER35 allele was greater in the athlete groups (CYC: 61%, RUN: 58%, IM: 56%,  $p < 0.001$ ) than the control group (38%,  $p < 0.001$ ), and differed from reported frequencies in other populations world-wide. When the data from all four groups were pooled, a strong relationship between chronotype and PER3 VNTR genotype was observed ( $p < 0.001$ ). Finally, the time of day at which the athletes preferred to train was related to their chronotype ( $p < 0.001$ ). Of all the morning-types in this study 77% reported preferring to train in the morning. Similarly, 79% of the evening-types preferred to train in the evenings. Discussion This is the first study to demonstrate the chronotype-PER3 VNTR genotype association in an athletic population. Based on our data, Caucasian males participating in individual endurance sports with early start times in South Africa are more likely to be morning-type individuals. Furthermore, the PER3 VNTR may be one of the factors contributing to this observation. Future investigation into the relationships between chronotype, genotype, performance and efficacy of training time of day is warranted.

### INVOLVEMENT OF INFLAMMATORY TRANSCRIPTION FACTORS IN THE RESPONSE OF ELDERLY WEIGHT LIFTERS AND SEDENTARY CONTROLS TO A SINGLE BOUT OF RESISTANCE EXERCISE

Wessner, B.1, Gryadunov-Masutti, L.1, Ferunaj, P.2, Erindi, A.2, Ploder, M.3, Tschan, H.1, Bachl, N.1

1: *University of Vienna, Centre for Sport Science an University Sports, Austria*, 2: *Academy of Physical Education and Sport "Vojo Kushi", Tirana, Albania*, 3: *Medical University of Vienna, Austria*

Introduction: Ageing is associated with progressive loss of muscle mass and function. It is known that resistance exercise training provides an effective measure to counteract this process even at a very old age (ACSM et al., 2009). However, intense resistance exercise has been shown to cause a significant inflammatory response by transiently activating nuclear factor- $\kappa$ B (NF- $\kappa$ B) signalling in human skeletal muscle of young subjects during the first few hours post exercise (Velle et al., 2011). It is not clear whether this holds true for trained and untrained elderly subjects. The aims of the current study were to evaluate whether the NF $\kappa$ B signalling pathway would be activated and differentially regulated between elderly elite weight lifters and sedentary age-matched controls after a single bout of resistance exercise. Methods: Eight elderly ( $61 \pm 9$  y) still active master weight lifters (WL) and 8 ( $61 \pm 8$  y) sedentary controls (SED) were recruited from the Tirana (Albania) area. At least 2 d after assessment of 1-RM, a unilateral leg extension exercise session was applied (3 sets, 70-75% of the 1-RM until voluntary fatigue, 2-min rest between the sets). Three hours after termination of the exercise, skeletal muscle biopsies were taken from m. vastus lateralis of the exercised leg (EX) as well as the control leg (CO). Tissues were immediately stored in RNAlater solution and frozen until analyses. After extraction of RNA and cDNA synthesis, PCR arrays (RT<sup>2</sup> Profiler™ PCR Array Human NF $\kappa$ B Signaling Pathway, SABiosciences) were applied on pooled samples. Up-regulation of genes was confirmed on the individual samples using real-time PCR and GAPDH as endogenous control. Results: The groups did not differ in age, BMI, height, and weight. As expected the relative 1-RM was significantly higher ( $+24\%$ ,  $p < 0.05$ ) in WL than in SC. The PCR array provided evidence that EGR1, FOS, and JUN would probably be up-regulated due to resistance exercise whereas none of the tested genes was identified to be differentially regulated between SC and WL. This was confirmed by the evaluation study showing a 13.6- ( $p=0.003$ ), 3.2- ( $p=0.043$ ), and 2.7-fold ( $p=0.036$ ) increase in EGR1, FOS, and JUN mRNA due to resistance exercise but no differences between SED and WL. Conclusion: We could show that a single bout of exercise is able to affect inflammatory transcription factors in trained as well as in untrained elderly individuals. Interestingly, EGR1 was highly up-regulated due to resistance training. Although the exact role of EGR1 is unclear up to now, there is a link to SIRT1 which is involved in the regulation of factors involved in differentiation, survival, apoptosis, inflammation and stress response. References: American College of Sports Medicine, Chodzko-Zajko WJ, Proctor DN, et al. (2009). *Med Sci Sports Exerc.* 41(7),1510-1530. Vella LD, Caldwell MK, Larsen AE, et al. (2011). *Am J Physiol Regul Integr Comp Physiol*, Dec 21. [Epub ahead of print].

## CO-INGESTION OF CARBOHYDRATE AND WHEY PROTEIN ISOLATES ENHANCE PGC-1A MRNA EXPRESSION IN TRAINED ATHLETES

Hill, K., Stathis, C., Grinfeld, E., Hayes, A., McAinch, A.

*Victoria University*

**Introduction** Adaptations with endurance training induce improvements in muscle oxidative energy capacity and mitochondrial biogenesis. The regulation of protein synthesis involves several signalling pathways which are influenced by amino acids, insulin and mechanical stimulation. PGC-1 $\alpha$  plays a vital role in regulating mitochondrial biogenesis by co-activating a number of transcription factors involved in the adaptation process. Limited research exists on the benefits of protein supplementation for endurance athletes, in particular the effects of co-ingestion of whey protein isolates and carbohydrate on endurance training adaptations. The aim of the present study is to therefore, investigate the effects of 2 weeks of co-ingestion of whey protein isolate and carbohydrate supplementation on endurance recovery processes. **Method** Six endurance trained male cyclists and triathletes (age  $29 \pm 4$  years, weight  $74 \pm 2$  kg,  $VO_2$  max  $63 \pm 3$  ml oxygen. kg<sup>-1</sup>. min, height  $183 \pm 5$  cm; mean  $\pm$  SEM) were randomly assigned to one of two dietary interventions in a single blind cross over design; carbohydrate (CHO) or carbohydrate and whey protein isolates (CHO+WPI). Each dietary intervention was followed for 16 days which included 2 days having increased CHO content, re-presenting a loading phase. The dietary interventions were iso-caloric and carbohydrate content matched. Participants then performed a controlled exercise bout, followed by time trial to exhaustion. Blood samples and muscle biopsies were taken at various time points. **Results** Plasma insulin was significantly increased in the recovery period at 180 mins ( $P < 0.05$ ) and PGC-1 $\alpha$  mRNA expression was significantly up regulated in the CHO+WPI group at the end of 6 hours of recovery ( $P < 0.05$ ), compared to CHO group. Muscle glycogen concentration were comparable at rest, decreased ( $P < 0.05$ ) following exercise and increased at the end of 6 h recovery. **Conclusion** The results suggest co-ingestion of CHO+WPI supplementation benefits recovery and adaptations to endurance exercise. Protein supplementation with adequate carbohydrate availability during training did not influence pre and post muscle glycogen levels. However, increases in plasma insulin content and muscle PGC-1 $\alpha$  mRNA expression, indicates a response in metabolism for improved adaptations to training.

17:45 - 19:15

## Invited symposia

### IS-SH01 Intervention Development Using Social, Environmental and Psychological Approaches

## PSYCHOLOGICAL AND ENVIRONMENTAL DETERMINANTS OF BEHAVIOUR CHANGE FOR PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR

Brug, J.

*VU University Medical Center*

**Introduction** Lack of physical activity (PA) is an important determinant of avoidable burden of disease. Planned promotion of PA requires insights into important and changeable determinants of behaviour change. The modest effects of health education have induced a shift in focus from personal to environmental correlates of PA. **Methods** This presentation will use results from systematic reviews, mediation analyses and original observational studies conducted within the European Commission FP7 projects HOPE and ENERGY to provide an overview of recent evidence regarding the importance of psychological and environmental factors as potential determinants of PA. **Results** The series of reviews indicate that there is still lack of consistent evidence for the importance of contextual factors as determinants of PA. This lack of evidence for association should not be interpreted as evidence for lack of associations because the reviews made clear that few studies had been replicated, many studies used weak research designs and non-validated measures, were restricted to micro-environmental factors, and failed to apply multilevel analyses. Furthermore, the evidence shows that perceived environments may be more important correlates of behaviour than objective environmental characteristics, and the relative importance of environments may differ substantially according to the specific PA studied. Additionally, socio-cultural environments may be more important than physical or build environmental factors. Further mediation analyses suggest that the influence of environmental factors is often mediated by individual level, social cognitive factors, such as attitudes, beliefs and intentions. **Discussion** The available intervention studies confirm that interventions that focus on trying to change individual level and environmental determinants, i.e. that try to improve motivation, abilities and opportunities for PA, are more likely to be successful. **References** Brug J, Te Velde SJ, Chinapaw MJ et al. Evidence-based development of school-based and family-involved prevention of overweight across Europe: the ENERGY-project's design and conceptual framework. *BMC Public Health* 2010;10:276. Brug J, Lien N, Klepp KI, Van Lenthe FJ. Exploring overweight, obesity and their behavioural correlates among children and adolescents: results from the Health-promotion through Obesity Prevention across Europe project. *Public Health Nutr* 2010;13:1676-9. Brug J, Van Lenthe FJ, Kremers SP. Revisiting Kurt Lewin: how to gain insight into environmental correlates of obesogenic behaviors. *Am J Prev Med* 2006;31:525-9.

## DEVELOPING, EVALUATING AND IMPLEMENTING A COMMUNITY PHYSICAL ACTIVITY INTERVENTION: FROM 10,000 STEPS GHENT TO 10,000 STEPS FLANDERS

De Bourdeaudhuij, I.1, De Cocker, K.1, Van Acker, R.1, Brown, W.2, Cardon, G.1

*Ghent University*

**Introduction** Previous studies showed the potential of multi-strategy community-based approaches to changing physical activity. The first aim of this presentation is to describe the effectiveness of the physical activity promotion project '10,000 Steps Ghent' after 1 year and after 4 years of intervention. The second aim is to report on the wide-scale dissemination of this effective whole-community program in Flanders using the RE-AIM framework. **Methods** A multi-strategy community-based intervention was implemented in Ghent (about 240.000 inhabitants) in 2005 with 1 year follow-up measurements in 2006 (n=866) and 4 year follow-up measurements in 2009 (n=420). A local media campaign, environmental approaches, the sale and loan of pedometers, and several local physical activity projects were concurrently implemented. Based on the positive results in this pilot study, this evidence-based intervention was disseminated in Flanders (about



6 million inhabitants), a large region in Belgium from 2009 onwards. Dissemination included media strategies and peer networks of specific professional organizations, such as local health promotion services. Two consecutive evaluation moments were executed, one in 2010 and one in 2011 including organizations that disseminated the program and citizens living in the work area of these organizations. Measures were structured according to the RE AIM dimensions (reach, effectiveness, adoption, implementation, maintenance). Results The multi-strategy community-based intervention proved to be effective after one year with an increase of 8% in the number of people reaching the 10,000 steps standard, and with an average increase in daily steps with about 900 in the intervention community (Ghent), compared to no increase in the comparison community. After four years, a slight increase in steps was still visible in the intervention community compared to a decrease in the comparison community. The dissemination and wide-scale implementation of the program was found to be effective with 90% of all organizations being aware of the 10,000 Steps program, and with an increase of 9,2% of the population meeting the 10,000 Steps recommendation between the pilot baseline measurement in 2005 and the follow-up measurement in 2011. Discussion The multi-strategy '10,000 Steps' program shows potential for wide-scale dissemination but a supportive linkage system seems recommended to encourage adoption levels and high quality implementation.

### **MAKE YOURSELF COMFORTABLE – STAND UP! THE DEVELOPMENT OF AN INTERVENTION TO REDUCE SEDENTARY BEHAVIOUR IN YOUNG ADULTS AT RISK OF TYPE 2 DIABETES**

Biddle, S.

*Loughborough University*

Sedentary behaviour has become a popular area of research with evidence building for significant deleterious effects of prolonged sitting. The rising prevalence of Type 2 Diabetes Mellitus (T2DM) is a major public health problem and sedentary behaviour has been identified as a risk factor for diabetes, often independent of the time spent in moderate-to-vigorous physical activity. Project STAND (Sedentary Time ANd Diabetes) aims to reduce sedentary behaviour in younger adults at high risk of T2DM. A reduction in sedentary time is targeted using theory driven group structured education and participants are encouraged to self-monitor and self-regulate their behaviour. The intervention is being assessed in a randomised controlled trial with 12 month follow up. Inclusion criteria are a) aged 18-40 years with a BMI in the obese range; b) 18-40 years with a BMI in the overweight range plus an additional risk factor for T2DM. Participants are randomised to intervention or control arms. The primary outcome is a reduction in sedentary behaviour at 12 months as measured by an accelerometer (count <100/min). Secondary outcomes include physical activity, sitting/lying time using the ActivPAL posture monitor, fasting and 2h oral glucose tolerance test, lipids, inflammatory biomarkers, body weight, waist circumference, blood pressure, illness perceptions, and efficacy beliefs for behaviour change. This presentation will describe the rationale for the study of sedentary behaviour and outline the principles behind the intervention.

**17:45 - 19:15**

## **Oral presentations**

### **OP-PM22 Training and Testing: Youth population**

#### **PHYSICAL RESPONSES OF DIFFERENT SMALL-SIDED GAME FORMATS IN ELITE YOUTH SOCCER PLAYERS**

Brandes, M.1, Heitmann, A.2, Müller, L.2

*1 University Oldenburg, 2 University of Bremen*

Introduction A major use of small-sided games (SSGs) in soccer training is the concomitant development of game-specific aerobic fitness (Hill-Haas et al., 2008). We hypothesize that the SSG formats of 2 vs. 2, 3 vs. 3, and 4 vs. 4 players reveal game-like intensities and therefore are most adequate to increase game-specific aerobic fitness. Methods Heart rate (HR), percentage of maximum heart rate (HRmax), blood lactate concentration (La), and time-motion characteristics of 17 elite male youth soccer players (aged 14.9 ± 0.7 years, VO2max 61.4 ± 4.5 ml/kg/min, HRmax 199.6 ± 7.3 beats/min) were collected by global positioning systems while performing the SSG formats. Play time (2 vs. 2: 3 x 4 min, 3 vs. 3: 3 x 5 min, 4 vs. 4: 3 x 6min) was interrupted by 1.5 minutes of passive rest. Grid area was adjusted to keep a constant grid area per player at 1:150. Repeated-measures analysis of variance and effect sizes according to Batterham & Hopkins (2006) were calculated to demonstrate the differences between SSG formats. Results Highest physiological responses were obtained in 2 vs. 2 (HR: 186±7 beats/min, HRmax: 93.3 ± 4.2%, La: 5.5 ± 2.4 mmol/l) followed by 3 vs. 3 (HR: 184 ± 8 beats/min, HRmax: 91.5 ± 3.3%, La: 4.3 ± 1.7 mmol/l) and 4 vs. 4 (HR: 179 ± 7 beats/min, HRmax 89.7 ± 3.4%, La: 4.4 ± 1.9 mmol/l). Time spent with an intensity above 90% or between 85-89% of HRmax did not differ significantly between 2 vs. 2 and 3 vs. 3, but was less prominent in 4 vs. 4. Pronounced differences were found for time spent in the speed zones "walking" (<5.3 km/h), "moderate-speed running" (10.3–13.9 km/h), and "maximum sprinting" (>26.8 km/h). Discussion The findings suggest that all the formats reveal game-like intensities and are suitable for aerobic fitness improvements. The time-motion characteristics of the SSG formats tested indicate a shift towards higher velocities if the grid and the number of players increases, suggesting that the players make use of the larger pitch and off-the-ball movements. However, we found pronounced demands on the anaerobic energy supply in 2 vs. 2, whereas 3 vs. 3 and 4 vs. 4 remain predominantly on an aerobic level. As the effect sizes demonstrate a higher heart rate response in 3 vs. 3 compared to 4 vs. 4, we suggest using 3 vs. 3 for soccer-specific aerobic fitness training. If higher loads with extended anaerobic demands are aimed for, soccer coached might prefer 2 vs. 2. References Hill-Haas S, Coutts A, Rowsell G, Dawson B. (2008) J Sci Med Spo 11, 487-90. Batterham AM, Hopkins WG. (2006) Int J Spo Phy Perform, 1, 50-7.

## EVALUATION OF AN EYE-HAND COORDINATION TEST FOR TALENT IDENTIFICATION IN TABLE TENNIS; A VALIDITY AND REPRODUCIBILITY STUDY

Faber, I.R., Nijhuis-van der Sanden, M.W.G., Oosterveld, F.G.J.

*Saxion University of Applied Science*

**Introduction** Talent identification programs (TID) in sports can provide an optimal advise to connect personal preferences, talents and choices in sports. As a result, both elite sports and sports on amateur level benefit from these programs. TID often contain tests to assess specific sport skills in athletes which are considered to be key-predictors for success (Régnier et al., 1993). In this context, valid and reliable tests are essential to obtain trustworthy results. In this study, an eye-hand coordination test was evaluated, which could be used in a test battery for motor skills for TID in table tennis. Good eye-hand coordination is suggested to be a necessary trait to excel in table tennis (Rodrigues et al., 2002) but also in other racket sports, hockey, volleyball or basketball. **Methods** In total 43 youth table-tennis athletes (age 7-12 years) from national (n=13), regional (n=11) and local training-level (n=19) were tested. The children were instructed to throw a ball to a vertical positioned table tennis table with one hand and to catch the ball correctly with the other hand as frequently as possible in 30 seconds. The best of two attempts was registered as final score. The test consisted of four subtests in which the distance to the table tennis table (1 or 2 m) and the ball (table tennis or tennis ball) were varied. 10 children did a retest after 4 weeks to calculate reproducibility. For validity a one-way ANOVA was used to test whether the test could discriminate between the children from different training-levels. Mean differences for test-retest were used to present results of reproducibility (Bland-Altman plot). Results Subtest-means (SD) ranged from 15-29 (SD 5-7) for the national level, 15-26 (SD 3-5) for regional level and 8-17 (SD 5-7) for local level. All subtests were able to discriminate between national and local level and between regional and local training level ( $p < 0.05$ ). However, there was no significant difference between the national and regional training level. Reproducibility seems sufficient for all subtests; mean differences for test-retest were between -2.7 and 0.2 (SD 2.9-4.5). **Discussion** This eye-hand coordination test appears to be a valid and reproducible tool and implementation in a test battery for motor skills in TID for table tennis seems legitimate. Further research is desirable to obtain evidence for the use of the test in other sports. **References** Régnier G, Salmela JH, and Russell SJ (1993). A Handbook of Research on Sports Psychology; 290-313. New York: Macmillan Rodrigues ST, Vickers JN, Williams AM (2002). J Sports Sci 20(3), 187-200

## THE RELATIONSHIP BETWEEN AGILITY AND LINEAR SPRINT PERFORMANCE IN YOUNG ELITE SOCCER PLAYERS

Stöcker, F., Herdener, L., Oberhoffer, R., Schulz, T.

*Technische Universität München*

**Introduction** The diversity of sprint ability is an integral part in soccer and has often game-winning relevance. Sprint actions represent approx. 11% of the total covered distance in a soccer match (Little & Williams, 2005). Detailed researches show: About 50% of sprint actions in professional soccer are finished after 10m. Nearly 40% of these actions have one or more changes in direction (Rehagel, 2011). Therefore the ability to change running direction while moving with high speed is very important in soccer. As a result, agility sprint ability is crucial for soccer-specific performance (Svensson & Drust, 2005). This study aims to investigate the relative loss of time (RLT) while performing an agility sprint protocol (AS) in comparison to a linear sprint (LS). **Methods** 142 elite youth soccer players participated in this study; they were divided into three groups (G1: 11-12j, n=52; G2: 13-14j, n=63; G3: 15-16j, n=26). LS consisted of a 30m linear sprint with 1m flying start. The course of the AS is also 30m long and has the same starting conditions but is arranged in a triangled shape. Section lengths (5m-4m-1m-1m-4m-1m-1m-4m-5m) and angles of the turns (135°-45°-90°-45°-90°-45°-90°-45°-135°) in AS were designed matching soccer-specific changes in directions and running distances (Rehagel, 2011). All persons performed both the AS (once in both directions) and the LS with full recovery period in between. The results of AS for each direction were summarized (AS<sub>total</sub>). The RLT (%) was calculated as followed:  $(AS_{total} - (2 \times LS)) / LS \times 100$ . Statistical analysis were using Pearson's correlation coefficient. Normal distribution was not granted for LS in G2, therefore Spearman's rank coefficient was calculated. Results AS<sub>total</sub> and LS had a significant correlation in all groups (G1: 0.752,  $p < 0.001$ ; G2: 0.591,  $p < 0.001$ ; G3: 0.536,  $p = 0.002$ ). Also RLT and LS were correlated at high levels of significance (G1: -0.461,  $p < 0.001$ ; G2: -0.643,  $p < 0.001$ ; G3: -0.636,  $p < 0.001$ ). **Discussion** Although agility sprint performance is significantly positively correlated with linear sprint performance in young elite soccer players, these findings suggest, the better the linear sprint ability, the bigger gets the relative loss of time. In conclusion the LS seems to be a reasonable test to predict the agility sprint performance. In higher level of sprint performance testing designs should include both linear and multidirectional tests. **References** Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. Journal of strength and conditioning research / National Strength & Conditioning Association, 19(1), 76-78. doi:10.1519/14253.1 Rehagel, J. (2011). Entwicklung einer Testbatterie zur Diagnostik und Steuerung der Schnelligkeit im Sportspiel Fußball. Dissertation. Deutsche Sporthochschule Köln Svensson, M., & Drust, B. (2005). Testing soccer players. Journal of Sports Sciences, 23(6), 601-618.

## A MULTIDISCIPLINARY APPROACH TO SELECT JUNIOR HANDBALL PLAYERS: GENERAL MODEL

Massuca, L.1,2,3, Fragoso, I.3

1: UL-FEFD (Portugal); 2: ICPOL-ISCPSP (Portugal); 3: FMH-UTL (Portugal)

**Introduction** Research on expertise or in talento identification has tended to be mono-disciplinary (Phillips et al., 2010) or focused in the inter relationships between morphologic and fitness profiles. In accordance, this study aims to evaluate: (1) the contribution of morphologic, fitness, handball-specific skill, psychological and biosocial profiles to the prediction of handball players' success; and (2) the applicability of said model to the prediction of success in junior handball players. **Methods** A sample of male handball players (HB; n=225) were divided into three groups: (1) top elite (n=41); (2) non-top elite (n=126); and (3) junior elite (n=58). Morphologic, fitness, handball-specific skill, psychological and biosocial profiles were determined according to Massuca, Fragoso and Teles (in review). One logistic regression (Forward: LR) was performed, with success as dependent variable (Success=1, if the HB is a top elite athlete; Success=0, if the HB is a non-top elite athlete) and each category as predictors. Results When the entire sample was considered, logistic regression revealed that the fitness ( $b=3.828$ ,  $X^2_{Wald}(1)=17.180$ ,  $P < .001$ ,  $OR=45.978$ ), the psychological ( $b=-20.343$ ,  $X^2_{Wald}(1)=37.484$ ,  $P < .001$ ,  $OR=0.000$ ) and the "biosocial" profiles ( $b=2.011$ ,  $X^2_{Wald}(1)=4.986$ ,  $P < .05$ ,  $OR=7.471$ ) have a significantly contribute to the prediction of success ( $G^2(3)=106.802$ ,  $P < .001$ ; correct class. = 91.1%). This multidisciplinary model allowed us to identify 4 HB junior athletes with more than a 50% of probability of success. **Discussion** It seems that fitness profile plays an important role and contributes to a great extent to high performance in handball. However, it seems that only an ideal fitness profile is not sufficient to be successful in handball. In fact, this study also showed that "biosocial" profile is also associated with handball players' success (see Massuca & Fragoso, 2010). Given the complexity of handball, it is understandable that a degree of scepticism exists as to the relevance of talent selection but, the present

study investigated the relationship of a 5 categories of variables with success at a senior elite level. Furthermore, athletes are target for inclusion in development squads at a junior level therefore it is appropriate that investigations are carried out with these age groups. Moreover, our findings may provide a useful contribution to a first examination of the "Long Term Athlete Development Model" (Ford et al., 2011) in handball players. References Ford P, Croix DS, Lloyd R, Meyers R, Moosavi M, Oliver J, Till K, Williams C (2011). The Long-Term Athlete Development model: Physiological evidence and application. *J Sports Sci*, 29(4), 389-402. Massuça L, Fragoso I (2011). Study of Portuguese handball players of different playing status. A morphological and biosocial perspective. *Biology of Sport*, 28(1), 37-44.

### THE D-TEST: A NEW TOOL FOR ASSESSING THE AGILITY OF YOUNG SOCCER PLAYERS IN PRE-FORMATION CATEGORIES

Segui, R., Dellal, A., Pialoux, V., Hautier, C.

*UFR-STAPS*

**Introduction** The development of the agility is essential in young soccer players, and it constitutes the aim of the training in the process of pre-formation. However, the majority of agility test is destined for the talent identification or adult players. Therefore, it appears that there is a lack of specific tool to test the agility and motricity especially in pre-formation categories. Consequently, the aim of this study was to examine the interest of a new tool, the D-Test, and to show if this test discriminate the agility skills in soccer either by category or the playing positions in youth players of pre-formation. **Methods** 60 young elite players from the pre-formation categories of the same club (Olympique Lyonnais FC) participated in this study: U13(n=19, height: 151.4±7.8 cm, body mass: 42.1±6.4 kg), U14 (n=21, height: 163.7±7.6 cm, body mass: 52.32±7.8 kg) and U15 (n=20, height: 167.7±8.2 cm, body mass: 54.2±9.2 kg) including in whole categories 6 goalkeepers, 7 central defenders, 14 full-backs, 13 axial midfielders, 13 external midfielders and 7 forwards. All players performed 3 times the D-Test (2 trials) in 3 different period of the competitive season 2011-2012. The conditions were standardized with the application of the test on a new-generation artificial turf in the same of the day and the performances were measured using photocell (Polifemo® Microgate, Bolzano-Bozen, Italy) placed at hip height. Practically, the D-Test consisted by the combination of the following sequence (on 20m): rolling start, lateral motricity (3m + 3m), ground reaction footwork with a rhythm hurdle (4x40cm), three short acceleration short (3x4m) interspaced by two 180° changes of directions with an alternance of the leg used (one time with the right leg and the other time with the left leg). **Results** A significant difference between age group (F= 6-60, p<0.01) was found. The U13 had significantly slower performance in the D-Test compared to U14 (p<0.01) and U15 (p<0.01). Moreover, the inter group analysis showed no significant difference between playing positions (p<0, 05), whereas a significant difference were observed in U13 and U14 with greater performance of external midfielders and forwards (p<0.05). **Discussion** The major findings of the present study demonstrated that the D-Test is an interesting assessment tool in the determination of the agility skills of young soccer players according to the playing position, allowing to direct the specific method of individual training.

17:45 - 19:15

## Invited symposia

### IS-PM07 Exercise to Reduce Musculoskeletal Pain (\*)

#### STRENGTH, ENDURANCE, AND BALANCE TRAINING TO CONQUER WORK RELATED MUSCULOSKELETAL PAIN

Sogaard, K.

*Institute of Sports Science and Clinical Biomechanics*

Physical exercise has been shown to be effective in the prevention and treatment of work-related musculoskeletal disorders (2), with most evidence obtained from interventions targeting sedentary jobs (8) and by use of intense strength training (1). Physical exercise may also benefit employees with physically heavy work and MSD. Probably, to optimize a health enhancing effect the content of the suggested physical exercise training program should be modified, when implemented among employers with physically heavy jobs (4). A number of Danish RCTs have used the concept Intelligent Physical Exercise Training, tailoring an exercise intervention to work exposure, employee health status and physical capacity (4). The recent interventions are among jobs with highly different exposure profiles i.e. lab technicians, cleaners, health care, pilots, and construction workers (3,5,6,7,8,9). The interventions use a broad variety of available types of training to tailor the health enhancing physical activity. The interventions are in general successful in obtaining an acute effect, such as improved musculoskeletal health, muscle strength, balance, aerobic fitness, and body weight. Therefore, the workplace as an important arena for general health promotion are supported across job with different exposure profiles. In contrast there was no consistent findings or major improvements in long term effect such as productivity, work ability and sick leave. Therefore, it is suggested that future studies should consider implementation strategies and how to introduce sustainable behavioural changes. Possibly, multi dimensional interventions, a participatory approach, and introducing individual preference in the physical activity program could optimize a long term effect. 1) Andersen LL et al. 2008;59(1): 84-91 2) Blangsted A.K. et al. *Scand J Work Environ Health*. 2008;34(1):55-65 3) Christensen JR et al. *BMC Public Health* 2011;11:671. 4) Holtermann A. et al. *BMC Musculoskeletal Health*. *BMC Public Health* 2010;10:120 5) Jorgensen, et al. *BMC Public Health* 2011;11:776. 6) Jørgensen MB et al. *BMC Public Health* 2011;11:840. 7) Lange B, et al. *Clin J Pain* 2012 (in press) 8) Zebis MK, et al *BMC Musc Dis*. 2011;12:205. 9) Gram, B et al *Scand J of Work, Environ & Health* (E-pub).

#### MECHANISMS OF SHOULDER MUSCLE PAIN AND ACTIVATION DURING EXERCISES

Madeleine, P., Vangsgaard, S., Samani, A.

*Aalborg University*

**Introduction** Shoulder injuries are frequent in relation to physical activity in sports and at work with both overhead and repetitive arm movements (Madeleine 2011). Low load movement are also found to be associated with neck-shoulder disorders. These disorders are often accompanied by pain located in deep structures of the shoulder girdle. Despite important scientific effort, our knowledge about pathophysiology of these disorders is still scarce. Moreover, these disorders have consequences for muscle function and overall perfor-

mance. The aim of this presentation is to review muscular activation in the neck-shoulder girdle in relation to various pain stages, i.e. acute, sub-acute and chronic pain. Methods Experimentally induced pain (exogenous, e.g. injection of hypertonic saline and endogenous: high level eccentric exercise inducing delayed onset muscle soreness) and clinical pain were studied. Pain intensity as well as pressure pain thresholds were assessed. Surface electromyography (bipolar and high-density) from the upper, middle and lower trapezius muscle were recorded during both static and dynamic contractions. Analyses consisted of computing pressure pain mapping and temporal and spatial changes in muscular activation. Focus will be given to a newly developed method to assess functional connectivity among muscles, i.e. normalized mutual information (Madeleine et al., 2011). Results Pressure pain mapping enabled to study the extent of hyperalgesia induced by high level eccentric exercise. We found that mechanical sensitivity is heterogeneously distributed over the trapezius prior and during DOMS (Binderup et al. 2010, Kawczynski et al., 2011) in agreement with clinical findings. Both experimental and clinical pain changed the activation profile of the trapezius sub-divisions during static and dynamic contractions (Samani et al., 2010; Madeleine 2011). The normalized mutual information among upper-middle trapezius sub-divisions increased in presence of delayed onset muscle soreness (Madeleine et al., 2011). Discussion The various extent of hyperalgesia as well as the spatial reorganization of the trapezius muscle activity in response to experimental and clinical pain during shoulder functional movement provided new information about the sensory-motor interactions. Our results provide new evidence of sensory and neuromuscular partitioning in the shoulder girdle. References Binderup AT, Arendt-Nielsen L, Madeleine P. (2010). *Eur J Pain*, 14, 705-712. Kawczynski A, Samani A, Fernández-de-las-Peñas C, Chmura J, Madeleine P. (2011). *J Strength Cond Res*, doi: 10.1519/JSC.0b013e318234e589. Madeleine P, Samani A, Binderup AT, Stensdottir A-K. (2011). *Scan J Med Sci Sports*. 21, 277-286. Madeleine P. (2011). *Acta Physiol*, 199, 1-46. Samani A, Holtermann A, Søgaard K, Madeleine P. (2009). *Clin Biomech*, 24, 619-625.

### EXERCISE AND RHEUMATOID ARTHRITIS: MOVE TO IMPROVE

Häkkinen, A.

*University of Jyväskylä*

Rheumatoid arthritis (RA) is characterized by a chronic poly-arthritis, synovial hyperplasia and erosive synovitis, progressive cartilage and bone destruction and an accelerated loss of muscle mass (rheumatoid cachexia). RA is responsible for considerable amount of disability and in turn decreases in physical activity (PA). In a large multicenter study the majority (80%) of the RA patients were physically inactive. RA patients have been found to have a 25-70% reduction in muscle strength. However, only quite a small number of studies are reporting the effects of strength training in RA. Most of these studies have expectedly reported increases from 14% to 75%, in muscle strength when the training period has been from 3 weeks up to 2 years. One study reported increased muscle mass (5.5%) after 6-month training and one positive but small effect of exercise on bone mineral density. In RA patients have also lowered cardiorespiratory fitness and higher risk of cardiovascular diseases. There are seven randomized aerobic exercise studies with RA patients. In those studies, intervention has lasted 8-12 weeks, with intensity of 50-85% of maximal heart rate and frequency of 2-5x/week. Four of these studies reported significant increase in aerobic capacity or exercise tolerance, while in 3 studies no changes were observed. Both in strength and aerobic training studies physical function and walking speed have improved and only occasional adverse effects were found (e.g. increase in pain or number of tender joints). Exercise is safe treatment for adults with RA. From all the subjects (N=590) included in 9 strength training studies, only 2 discontinued due to increased joint pain. Most of the studies reported no changes in disease activity and none of them reported progression of joint damage. However, exercise may have detrimental effect on large joints in patients with an extensive pre-existent large joint damage. Overall physical activity as well as specific exercise can be recommended as non-pharmacological treatment of RA due their generic and local health benefits. Regular exercise in RA is associated with significant reductions in morbidity and mortality and increase in health related quality of life and functional capacity. Physical activity and exercise should be a regular life-style. Therefore motivation and barriers to exercise, and beliefs about its benefits and risks, should be discussed with the patient to improve long-term adherence. References: 1. Sokka T et al. *Arthritis Rheum*. 2008;15:59:42-50. 2. Häkkinen A. *Curr Opin Rheumatol*. 2004; 16:132-7. Review 3. Munneke M et al. *Arthritis Rheum*. 2005;53:410-7. 4. Häkkinen A, *Ann Rheum Dis*. 2004;63:910-6. 5. van den Ende CH et al. *Ann Rheum Dis*. 1996 ;55:798-805.

**17:45 - 19:15**

### Oral presentations

#### OP-PM23 Cardiovascular Physiology

### REGIONAL DIFFERENCES IN LEFT VENTRICULAR CONTRACTILE BEHAVIOUR FACILITATE A PROGRESSIVE RISE IN KINETIC ENERGY DURING INCREMENTAL EXERCISE

Stöhr, E.1,2, González-Alonso, J.2, Shave, R.1,2

*1 Cardiff Metropolitan University, 2 Brunel University West London*

Introduction Whilst the linear relationship between heart rate and exercise intensity is widely accepted, the response of regional (base vs. apex) LV contractile rate to incremental exercise has never been examined. Furthermore, differences in the contribution from circumferential and radial planes of motion at the LV base and apex may limit the rise in LV kinetic energy (EK) required for enhanced ejection at progressively increasing exercise intensities. We hypothesised that during incremental exercise, 1) the rise in contractile rate would significantly differ across LV regions and 2) despite an enhanced contractile rate, the increase in absolute Ek produced during each contraction would be limited by the progressively shortened systolic duration. Methods Nine healthy men (age: 26±4 yrs, peak heart rate: 173±14 bpm) performed continuous and discontinuous incremental exercise on a supine cycle ergometer. At rest and throughout exercise, we measured strain rate (SR, index of contractile rate) in the circumferential and radial planes of motion at the LV base and apex, respectively. Data were collected using novel 2D speckle tracking ultrasound. LV mass was estimated as myocardial area multiplied by the specific gravity of muscle (1.05g/m<sup>2</sup>). Total systolic Ek per beat was calculated as the integral of (1/2 regional mass)•(regional strain rate<sup>2</sup>) over the systolic ejection time. Results During continuous incremental exercise, circumferential and radial SR increased progressively from rest to 90% of maximal exercise capacity (r<sup>2</sup>= .82 to .98, P≤0.01). The regional rise in SR was significantly greater for circumferential SR at the apex (P<0.0001). Despite a significant shortening of systolic ejection time (P<0.001), systolic Ek increased continuously at both the LV base

and apex ( $r^2 = .86$  to  $.99$ ,  $P < 0.01$ ). However, the rise in systolic  $E_k$  was achieved with a progressively greater contribution from radial function at the LV base and circumferential function at the LV apex. Responses were confirmed during discontinuous exercise, despite significantly different heart rates compared with the continuous exercise test ( $P < 0.001$ ). Conclusions In accordance with our first hypothesis, the rise in peak LV contractile rate during incremental exercise is non-uniform across the LV. However, in contrast to our second hypothesis,  $E_k$  increases progressively at the LV base and apex during incremental exercise. This uniform rise in  $E_k$  is achieved by region-specific contributions of LV circumferential and radial function at the base and apex, respectively. Exploration of these novel findings in other populations could provide important insight into cardiac function in health and disease.

### LEFT VENTRICULAR TWIST MECHANICS FOLLOWING EXERCISE TRAINING IN POST-MYOCARDIAL INFARCTION PATIENTS

McGregor, G.S.1,2, Stohr, E.1, Oxborough, D.3, Shave, R.E.

1Cardiff Metropolitan University, Cardiff, UK. 2University Hospital, Coventry, UK. 3University of Leeds, Leeds, UK

**INTRODUCTION:** Endurance exercise training has been shown to reduce left ventricular (LV) end diastolic and end systolic volumes in patients with myocardial infarction (MI). Whilst these structural changes are reasonably well characterised, the effects of exercise training on LV function are less well understood. The development of novel echocardiographic techniques such as speckle tracking imaging (STI) has enabled a more detailed study of global LV function. LV systolic twist, the net difference between basal and apical rotation, is a key component of efficient LV systolic contraction. The effect of exercise training on LV twist mechanics in post MI patients has not been previously reported. **PURPOSE:** To determine the effect of exercise training on resting LV twist mechanics in post MI patients following successful percutaneous coronary intervention (PCI). **METHODS:** Cardiopulmonary exercise testing (CPET) and resting echocardiography were performed on 33 male ( $56 \pm 9$  yrs) clinically stable post MI patients at baseline ( $34 \pm 7$  days post MI) and 10 weeks later. Patients were assigned to either supervised exercise training ( $n=21$ ) or control ( $n=12$ ). Supervised exercise training consisted of mixed modality (treadmill, cycle, rower, cross-trainer) exercise training for 30-40 minutes twice weekly at 60-80% of  $V_{O2}$  peak. Controls received standard general physical activity advice. **RESULTS:** The exercise training group showed significant improvements in peak  $V_{O2}$  ( $3.2 \pm 3.1$  ml.kg<sup>-1</sup>.min<sup>-1</sup>,  $P < 0.001$ ) and ejection fraction (EF) ( $2.0 \pm 4.4\%$ ,  $P < 0.05$ ) and significant reductions in EDV ( $-6.1 \pm 6.7$ ml,  $P < 0.001$ ) and ESV ( $-4.3 \pm 5.6$ ml,  $P < 0.001$ ). In contrast, peak  $V_{O2}$  ( $-0.6 \pm 3.4$  ml.kg<sup>-1</sup>.min<sup>-1</sup>,  $P > 0.05$ ), EDV ( $0.4 \pm 7.2$ ml,  $P > 0.05$ ), ESV ( $1.0 \pm 5.4$ ml,  $P > 0.05$ ) and EF ( $-1.0 \pm 4.7\%$ ,  $P > 0.05$ ) were unchanged in the control group. LV twist mechanics in the exercise training group were characterised by a reduction in apical rotation ( $-2.3 \pm 4.6^\circ$ ,  $P < 0.05$ ), unchanged basal rotation ( $-1.1 \pm 3.5^\circ$ ,  $P < 0.05$ ) and a resultant reduction in peak LV twist ( $-3.4 \pm 5.3^\circ$ ,  $P < 0.01$ ). Conversely, controls demonstrated an increase in peak LV twist ( $4.1 \pm 4.2^\circ$ ,  $P < 0.01$ ) secondary to an increased basal rotation ( $2.0 \pm 2.5^\circ$ ,  $P < 0.05$ ) and unchanged apical rotation ( $1.6 \pm 3.2^\circ$ ,  $P > 0.05$ ). **CONCLUSION:** Consistent with findings in previous studies, exercise training improves  $V_{O2}$  peak and facilitates favourable change in EDV, ESV and EF in post MI patients. Furthermore, LV systolic twist mechanics appear to be influenced by exercise training in these patients. These data offer a valuable insight into the effects of exercise training on LV function in post MI patients.

### POST-REVASCULARISATION EXERCISE TRAINING FOR PERIPHERAL ARTERIAL DISEASE

Askew, C.D., Stefanovic, B., Russell, F.D., Green, S., Walker, P.J.

Queensland University of Technology

**POST-REVASCULARISATION EXERCISE TRAINING FOR PERIPHERAL ARTERIAL DISEASE** Askew, CD. 1,2; Stefanovic, B. 2; Russell FD. 2; Green, S. 3; Walker, PJ. 4. 1: Institute of Health and Biomedical Innovation, Queensland University of Technology, 2: University of the Sunshine Coast, 3: University of Western Sydney, 4: School of Medicine, Discipline of Surgery and Centre for Clinical Research, University of Queensland (Australia). **Introduction** Peripheral arterial disease (PAD) is an atherosclerotic disease characterised by blockages in the arteries of the lower limbs. Although supervised exercise training is recommended for patients with early stage PAD and claudication, the effects of exercise training in patients who have undergone revascularisation are not clear. This study aimed to determine the effect of post-revascularisation exercise training on walking tolerance, muscle fatigue and lower limb blood flow in patients with PAD. **Methods** Fifteen patients who had recently (<6 weeks) undergone surgical or percutaneous revascularisation for PAD were randomised to either supervised exercise training (SET;  $n = 8$ , age =  $61 \pm 6$  y) or standard care (CON;  $n=7$ , age =  $65 \pm 10$  y). Patients in SET attended three training sessions per week for six weeks, and completed interval treadmill walking and progressive plantar flexion resistance exercises. Before and after the intervention period, walking capacity was determined with a six-minute walk test. Maximum voluntary contraction (MVC) force, muscle endurance, and fatigue of the calf muscles were assessed using an isometric plantar flexion dynamometer in both the revascularised and non-revascularised legs. Blood flow was assessed at rest and during exercise using strain gauge plethysmography. **Results** Six-minute walk distance increased with SET (pre  $405 \pm 89$ ; post  $452 \pm 94$  m) compared with CON (pre  $412 \pm 67$ ; post  $413 \pm 79$  m). Plantar flexion MVC force tended to increase with SET in both the revascularised (~11%) and non-revascularised legs (~15%), although this was only significant compared with CON in the non-revascularised leg. Plantar flexion endurance increased with SET in both the revascularised (pre  $541 \pm 318$ ; post  $1108 \pm 909$  s) and non-revascularised legs (pre  $623 \pm 319$ ; post  $1143 \pm 556$  s) compared with CON. The calf fatigue profile included an initial rapid exponential decay phase followed by slower linear phase, and there tended to be a shift in fatigue kinetics whereby there was a delay in the onset of the later phase following SET. There were no changes in resting or exercise blood flow in either group. **Discussion** This study demonstrates that supervised exercise improves walking capacity and calf muscle function in patients with PAD who have recently undergone revascularisation. These changes occurred in the absence of any change in blood flow, which supports notion that exercise tolerance is limited by both haemodynamic and non-haemodynamic factors in PAD.

### THE IMPACT OF LOCALISED EXERCISE TRAINING ON RADIAL ARTERY FLOW-MEDIATED DILATION AND LOW-FLOW CONSTRICTION RESPONSES FOLLOWING TRANSRADIAL CATHETERISATION

Dawson, E.A., Marsman, D.E., Alkarmi, A., Cable, N.T., Wright, D.J., Thijssen, D.H.J., Green, D.J.

Liverpool John Moores University

Transradial catheterisation leads to radial artery endothelial dysfunction. However, exercise training may ameliorate this response. Whilst the effect of exercise training on vascular dilator function has been studied, no previous study has examined the role of local handgrip exercise training on vasoconstrictor function of the radial artery following catheterisation. The aim of this study was to determine the effect of 6-week local handgrip exercise training post-transradial catheterisation on low-flow mediated constriction (L-FMC), flow mediated

dilation (FMD) and the difference between both responses (L-FMC+FMD). Eighteen patients were randomly assigned to either exercise handgrip training (N=9) or control group (N=9). Radial artery L-FMC and FMD of the catheterised radial artery were assessed using ultrasound one week prior to catheterisation and following six weeks of exercise training or similar control period. Data were compared using a 2 factor general linear model (GLM). L-FMC was unchanged in the exercise group ( $-2.14 \pm 1.42$  to  $-3.58 \pm 1.04\%$ ), but deteriorated in the control group ( $-3.26 \pm 1.19$  to  $-1.34 \pm 1.27\%$ ; interaction-effect,  $P=0.05$ ). Similarly, FMD was maintained in the exercise group ( $6.84 \pm 0.79$  to  $6.85 \pm 1.16\%$ ), but was impaired in the control group ( $8.27 \pm 1.52$  to  $4.66 \pm 0.70\%$ ; interaction-effect  $P=0.06$ ). Consequently, a reduction in L-FMC+FMD was found in the control ( $11.52 \pm 2.42$  to  $6.00 \pm 1.63\%$ ) which was prevented in the exercise group ( $8.99 \pm 1.57$  to  $10.43 \pm 1.97$ , interaction-effect  $P<0.01$ ). Our results demonstrate that exercise training prevents the prolonged decrease in FMD after catheterisation. Moreover, this is the first study to demonstrate the beneficial effects of exercise training on the L-FMC, given that training protects the decline in L-FMC and L-FMC+FMD after catheterisation.

### CHANGE IN SHEAR RATE IN THE COMMON FEMORAL ARTERY UPON CESSATION OF ISOMETRIC LEG EXERCISE PERFORMED AT INCREASING INTENSITIES

Swaine, I., Smith, J., Wiles, J.

*Canterbury Christ Church University*

**Introduction** Despite numerous reports of shear rates during dynamic exercise (Thijssen et al, 2008; Gonzales et al, 2009; Johnson et al, 2012), little is known about the shear rates during and after isometric exercise (IE). Therefore, the purpose of this study was to determine the shear rate responses in the common femoral artery during, and immediately after each stage of an incremental IE test. **Methods** 13 male participants ( $22.54 \pm 2.54$  years;  $180.02 \pm 4.20$  cm;  $77.83 \pm 10.16$  kg) completed a discontinuous incremental, bilateral leg-extension IE test. Each stage was 2 minutes, separated by 5 minutes rest. IE intensity was started at 10% EMGpeak (0.25 seconds prior to maximum voluntary contraction peak torque), and increased by 5% EMGpeak until participants reached volitional fatigue. Peak shear rate (s<sup>-1</sup>) was obtained in the common femoral artery during, and upon cessation of each IE stage, using Doppler Ultrasound. **Results** ANOVA revealed peak shear rates measured after IE were higher than those measured during IE ( $P<0.05$ ) for all IE intensities except for the lowest (30-40%). Mean peak shear rate (PSR) after IE was  $70.15 \pm 17.39$  s<sup>-1</sup>, whereas it was  $59.18 \pm 5.85$  s<sup>-1</sup> during exercise. PSR during and after exercise increased linearly with relative exercise intensity ( $r = 0.941$ ;  $p<0.005$  during;  $r = 0.993$ ;  $p<0.001$  after exercise). There was also a strong correlation between change in shear rate, upon cessation of IE, and relative exercise intensity ( $r=0.961$ ;  $p<0.001$ ). **Discussion** Shear rates during and after exercise were greater than those observed in dynamic exercise (Thijssen et al, 2008; Gonzales et al, 2008; Johnson et al, 2012) and they were intensity-dependent. Because shear rates were higher after exercise, than they were during it, this might indicate that the stimulus for training-induced adaptations might not only arise during this type of exercise, but immediately after it too. However antegrade and retrograde flow patterns need to be analysed before this can be confirmed. **References** Gonzales, J.U., Thompson, B.C., Thistlethwaite, J.R., Scheuermann. (2008). Role of retrograde flow in the shear stimulus associated with exercise blood flow. *Clinical Physiology Functional Imaging*, 28(5): 318-325. Gonzales, J.U., Parker, B.A., Ridout, S.J., Smithmyer, S.L., & Proctor, D.N. (2009). Femoral shear rate responses to knee extensor exercise: an age and sex comparison. *Biorheology*, 46(2): 145-54. Johnson, B.D., & Wallace, J.P. (2012). A comparison of postexercise shear rates following different intensities and durations of running in healthy men. *Clinical Physiology Functional Imaging*, doi: 10.1111/j.1475-097x.2011.01116.x Thijssen, D.H.J., Green, D.J., Steendijk, S., & Hopman, M.T.E. (2008). Sympathetic vasomotor control does not explain the change in femoral artery shear rate pattern during arm-crank exercise. *American Journal of Physiology: Heart and Circulatory Physiology*, 296: H180-H185.

### GENDER AND ETHNIC INFLUENCES ON AUTONOMIC CONTROL OF THE HEART IN CHILDREN

Eyre, E.L.J.1, Duncan, M.J.1, Franklin, C.1, Birch, S.L.1, Cox, V.1

*1Coventry University*

**Introduction** Reduced heart rate variability is associated with increased risk of cardiovascular disease (Tsuji et al., 1996). A number of physiological factors are known to influence heart rate variability (HRV) including gender and obesity. People from South Asian backgrounds have an increased risk of cardiovascular disease/metabolic diseases (Williams et al., 2011) which begin in childhood (Whincup et al., 2002) but no studies have examined or compared HRV in South Asian children. The aim of this study was to examine the effect of ethnicity and gender on heart rate variability in prepubertal children. **Methods** Following ethics approval and informed consent, weight status (BMI and waist circumference) was assessed in 150 healthy children (boys= 75, girls= 75, South Asian=40, White = 110, mean age  $\pm$  SD =  $8.01 \pm 0.05$  years) from primary schools in central England. R-R interval was measured during 5 minutes supine rest using Sunnto T6 heart rate monitors. Time domain (mean R-R, SDNN, NN50, pNN50 and RMSSD) and frequency domain measures (HF power and LF power) of HRV were calculated using Kubios HRV software (Biomedical Signal Analysis Group, University of Kuopio, Finland). A 2 (gender) by 2 (ethnicity) factor analysis controlling for both age and BMI was used to assess differences ( $P<0.05$ ). **Results** Preliminary results suggest no main or interaction effects of gender and ethnicity for mean RR, SDNN, RMSSD, pNN50, LF Power ( $P>0.05$ ). Girls had significantly higher NN50 scores (girls =  $94 \pm 65$  vs. boys =  $72 \pm 51$ ms,  $P = 0.002$ ). A significant ethnicity and gender interaction was observed for NN50. Girls had significantly lower VLF power scores (girls =  $23.95$  vs. boys=  $35.4\%$ ,  $p = 0.002$ ). Main effects of gender ( $P= 0.001$ ) and interaction effects of gender and ethnicity ( $P = 0.042$ ) were also observed for HF power whereby White girls had significantly higher HF power than South Asian girls and South Asian boys. **Discussion** Decreased vagal modulation of the heart has been associated with increased risk of cardiovascular disease (Thayer & Lower, 2007). Our results indicate that high frequency measures (nn50 and HF power) of HRV, which give an indication of vagal modulation of the heart, are higher in girls compared with boys ( $P<0.05$ ), and in White girls compared with South Asian boys and girls ( $P<0.05$ ) indicating increased vagal modulation of the heart in these groups and thus possibly a cardioprotective mechanism. Future studies need to explore mechanisms to improve HRV in children, especially those in groups where reduced HRV may prevail. **References** Thayer JF & Lane RD (2007). *Biological Psychology*, 74(2), 224- 242 Tsuji H et al., (1996). *Circulation*, 94, 2850-2853 Williams ED et al., (2011). *Heart*, 97(8), 607-9 Whincup P et al., (2002). *BMJ*, 242, 1-6

## 17:45 - 19:15

## Oral presentations

## OP-PM24 Exercise Physiology 2

**EFFECTS OF LOW-INTENSITY SHIVERING ON ENERGY METABOLISM DURING EXERCISE IN THE COLD**

Gagnon, D.D., Kyröläinen, H., Herzig, K.H., Gagnon, S.S., Rintamäki, H.

*University of Jyväskylä*

**Introduction** Metabolically, shivering and exercise are not analogous processes (Tipton et al. 1989) as shivering relies more heavily on carbohydrates (CHO) as fuel (Haman et al 2005). Inconsistent findings in energy metabolism during submaximal exercise in the cold may partly be explained by the appearance of shivering which preferentially recruits type II muscle fibers. Therefore, the purpose of this study was to examine the influence of low-intensity shivering (LIS) on energy metabolism during exercise in the cold. **Methods** Nine male subjects, dressed in shorts and t-shirt, exercised on 4 separate days. Subjects entered a climatic chamber set at 0°C, then exercised for 60-min on a treadmill or, sat during a cooling period, prior to exercise, until LIS was induced (40% of shivering peak [ $\sim 15\%$   $\dot{V}O_{2\max}$ ]). Exercise was performed at 50% and 70% of maximal oxygen uptake in both LIS and non-shivering control (CON) conditions. Core temperature ( $T_{\text{core}}$ ), weighted mean skin temperature ( $T_{\text{skin}}$ ), heart rate (HR), and respiratory quotient (RQ) values were averaged over the last 10-min of every 15-min period during exercise. Blood samples were collected before entering the chamber (baseline) and at 30- and 60-min to measure serum non-esterified fatty acids (NEFA), glycerol (GLY) and glucose (GLU). Data was analyzed using a three-way ANOVA (factors: shivering, exercise intensity and time) for repeated measures with significance at  $p < 0.05$ . **Results** Both  $T_{\text{core}}$  and  $T_{\text{skin}}$  indicated lower values in LIS compared to CON within both exercise intensities from 15- to 45-min ( $p < 0.05$ ). HR was lower in LIS ( $129 \pm 10$  bpm) compared to CON ( $137 \pm 10$  bpm) in the first 15-min of exercise only ( $p < 0.05$ ). NEFA and GLU were not affected by shivering ( $p \geq 0.91$ ). Meanwhile, GLY concentration was greater in LIS ( $0.39 \pm 0.13$  mmol/L) vs. CON ( $0.31 \pm 0.11$  mmol/L) at 70%  $\dot{V}O_2$  ( $p < 0.05$ ). Finally, shivering did not modulate the RQ response across time or intensities (LIS  $0.87 \pm 0.04$  vs. CON  $0.86 \pm 0.04$ ,  $p = 0.84$ ). **Conclusion** LIS combined with submaximal exercise influenced  $T_{\text{core}}$ ,  $T_{\text{skin}}$ , HR and GLY, mostly in the early stage of exercise. Nonetheless, energy sources remained unaffected. The increase in CHO reliance from shivering was likely concealed by its limited contribution to total muscle activity and its partial inhibition from exercise. Future work should address higher intensities of shivering and lower levels of activity to examine possible interactions between both processes. **References** Haman et al. (2005) *J Physiol*, 566 (1), 247-256 Tipton et al. (1989) *Eur J Appl Physiol*, 76, 103-109

**EFFECTS OF HYDROTHERAPY ON ADAPTATION FOLLOWING A SIMULATED CYCLING GRAND TOUR**

Halson, S.L.1, West, N.P.2,3, Bartram, J.2, Stephens, J.2, Hopkins, W.G.4, Martin, D.T.2

1: AIS Performance Recovery (Canberra, Australia). 2: AIS Physiology (Canberra, Australia). 3: Griffith University (Gold Coast, Australia). 4: AUT University (Auckland, New Zealand).

**Introduction** Although cold water immersion is beneficial for recovery between bouts of high-intensity exercise, it may impair long term performance by attenuating the stimuli responsible for adaptation to training. Here we report a comparison of effects of cold-water immersion and passive rest on performance over a 39-day training block. **Methods** Thirty-four male endurance-trained competitive cyclists were randomized to cold water immersion or control (no recovery) groups for a simulated cycling grand tour consisting of 7 d of baseline training, 21 d of intense training, and an 11-d taper. Criteria for completion of training and testing were satisfied by 10 cyclists in the cold-water immersion group (age,  $20.2 \pm 1.7$  y; mass,  $70.9 \pm 6.5$  kg; maximal aerobic power,  $5.13 \pm 0.21$  W/kg) and 11 in the control group ( $19.8 \pm 1.7$  y;  $68.9 \pm 8.0$  kg;  $5.01 \pm 0.41$  W/kg). Cyclists completed two sets of performance tests each week: a combination cycling test consisting of 6-s sprints (MMP1s), a series of varying intervals, and a 10-min time trial on one day, and two 4-min bouts separated by 30 min of recovery (2xMMP4m) the next day. Cold-water immersion was performed 4 times per week for 15 min at 15°C following training and testing sessions. Uncertainty in mean differences between groups in the changes in mean performance power between tests following baseline and taper periods was estimated as 90% confidence limits and evaluated probabilistically in relation to a smallest important effect on mean power of 1%. **Results** Cyclists in the cold water group had an unclear change in overall 4-min power relative to control (2.7%,  $\pm 5.7\%$ ); however when subtracting the power in the first effort from the second effort, the cold water group showed a clear likely beneficial effect compared with control (3.0%,  $\pm 3.8\%$ ). The change in MMP1s in the cold water group also demonstrated a clear likely beneficial effect compared to control (4.4%,  $\pm 4.2\%$ ). Observed differences between groups for the 10-min time trial were trivial but the effect was unclear (-0.4%,  $\pm 4.3\%$ ). **Discussion** The primary objective of this study was to evaluate whether cold water immersion during a 3-wk phase of rigorous cycling training (simulating aspects of a Grand Tour) would impair cycling performance. In summary, data from this study do not support recent speculation that cold-water immersion is detrimental to adaptations to 3 weeks of increased training load in competitive cyclists.

**EFFECTS OF LOWER BODY COLD WATER IMMERSION ON PERFORMANCE OF SUBMAXIMAL ISOMETRIC CONTRACTIONS**

Willems, M.E.T., Clarkson, S.L.

*University of Chichester*

**Introduction** Muscle temperature influences the performance of successive isometric contractions of m. quadriceps femoris (QF) (Edwards et al., 1972). Muscle fatigue during sustained isometric contractions results in increased force fluctuations, i.e. a decline in steadiness. Such fatigue is associated with compensatory neuromuscular responses but less is known on the effect of cold water immersion on submaximal isometric performance. We examined the effect of cold water immersion of the lower body on the performance of submaximal isometric contractions of m. quadriceps femoris. **Methods** Men ( $n=11$ ,  $26 \pm 4$  yr,  $179 \pm 9$  cm,  $79 \pm 14$  kg, thigh skin fold:  $15 \pm 1$  mm) were tested in a temperature-controlled laboratory (control (C), 19°C) and following cold water immersion (CWI, 12°C) of the lower body for 30 minutes and ice-pack cooling of the leg during muscle testing. Skin temperature during muscle testing in CWI conditions was  $12 \pm 1^\circ\text{C}$  (Edale Instruments, UK). Subjects produced maximal voluntary isometric force (MVIF) of QF (knee angle  $90^\circ$ ), a 20%MVIF until exhaustion and 2 seconds after completion of the 20%MVIF a measurement of MVIF to quantify fatigue. Steadiness during 20%MVIF was quantified

by the coefficient of variation (SD/mean·100%). Surface EMG (Bagnoli-8, Delsys, USA) of m.vastus medialis (VM), m.rectus femoris (RF) and m.vastus lateralis (VL) was analysed for root mean square (RMS) and median frequency (MF). Data were analysed with 2-way ANOVA and paired t-tests with significance set at  $P < 0.05$ . Results There were no differences between conditions for MVIF (C:  $616 \pm 112$  N, CWI:  $615 \pm 102$  N), steadiness at similar time periods during 20%MVIF (e.g. 90-100% of time to fatigue (Tf), C:  $9.2 \pm 3.5\%$ ; CWI:  $7.4 \pm 2.3\%$ ) and fatigue index (C:  $30 \pm 16\%$ , CWI:  $29 \pm 11\%$ ). CWI resulted in 34% higher Tf (C:  $319 \pm 121$ s, CWI:  $426 \pm 166$  s) ( $P < 0.01$ ). During 20%MVIF, changes in RMS were lower for VL after CWI (0-10% to 90-100%Tf, C:  $25 \pm 5$  to  $48 \pm 14\%$ RMS; CWI:  $21 \pm 4$  to  $34 \pm 8\%$ RMS) with substantially lower MF values for all muscles after CWI and decreased MF values for VL only for control (0-10% to 90-100%Tf, C:  $96 \pm 15$  to  $87 \pm 18$  Hz; CWI:  $76 \pm 9$  to  $74 \pm 14$  Hz) (all  $P < 0.01$ ). Discussion Cold water immersion increased the time to fatigue for a sustained 20% isometric force of m.quadriceps femoris. Neuromuscular responses to cold water immersion were different for submaximal isometric contractions of the m.quadriceps femoris with lower levels of activation and no decrements in median frequency for the m.vastus lateralis but without an overall effect on steadiness for the m. quadriceps femoris. Peripheral mechanisms contributing to isometric fatigue of submaximal sustained contractions following cold water immersion seem to be muscle-dependent. References Edwards RH, Harris RC, Hultman E, Kaijser L, Koh D, Nordesjö LO. (1972). J Physiol 220, 335-352.

### EFFECTS OF RECOVERY INTERVENTIONS ON POSTEXERCISE PARASYMPATHETIC REACTIVATION IN ELITE SYNCHRONIZED SWIMMERS

Schaal, K., Le Meur, Y., Bieuzen, F., Petit, O., Toussaint, J.F., Hausswirth, C.

*Institut National du Sport, de l'Expertise et de la Performance*

The practice of synchronized swimming at the elite level has become increasingly demanding physically, combining high-intensity exercise with large hourly training volumes. In this context, improving postexercise recovery between sessions is a priority in order to manage fatigue and optimize performance ability across successive performances. The present study investigated the effect of whole body cryostimulation (WBC), contrast-water therapy (CWT), active (ACT) and passive (PAS) recovery protocols on parasympathetic reactivation and metabolic parameters of recovery between two full length competition ballets (B1 and B2). Methods: 11 elite synchronized swimmers performed all 4 trials in randomized order, one week apart. Peak oxygen consumption ( $\dot{V}O_{2peak}$  400) and blood lactate concentrations ([La]-b 400) were determined during a 400m swim time trial. Heart rate variability (HRV) was measured at rest (PreB1), 5min after B1 (PostB1), just before B2 (PreB2), and 5min after B2 (PostB2). Mean heart rate (HRmean), time-varying vagal-related indices (rMSSD and SD1), and power spectral density indices (HF, LF, LF/HF) were retained.  $\dot{V}O_{2peak}$  was measured at the end of B1 and B2, and [La]-b were obtained at PostB1, PreB2, and PostB2. Results: At the end of B1 and B2,  $\dot{V}O_{2peak}$  values were similar to  $\dot{V}O_{2peak}$  400, and [La]-b was higher than [La]-b 400. B1 and B2 caused significant decreases in rMSSD, SD1, HF and LF and increase in HRmean. At PreB2, all HRV indices had returned to PreB1 values with CWT, PAS, and ACT, while WBC yielded a 2 to 4-fold increase in vagal-related HRV indices compared to PreB1 (rMSSD,  $p = 0.01$ ; SD1,  $p = 0.01$ ; HF,  $p = 0.04$ ). [La]-b was significantly decreased during recovery with WBC and ACT compared to PAS ( $-9.2 \pm 2.2$ ,  $-8.8 \pm 1.7$ , and  $-8.0 \pm 1.4$  mmol.L<sup>-1</sup>, respectively). Further, WBC and ACT enabled a significant increase in  $\dot{V}O_{2peak}$  during B2, compared to B1 ( $+5.4\%$ ,  $p = 0.003$ , and  $+3.4\%$ ,  $p = 0.008$ ), while CWT led to no change, and PAS to a significant decrease ( $-3.6\%$ ,  $p = 0.003$ ). Conclusion: Even though each ballet required maximal aerobic energy production with large anaerobic contributions, elite swimmers displayed full parasympathetic reactivation 70 minutes postexercise, attesting to their highly trained status (Seiler et al. 2007). While cold water immersion techniques have been shown to accelerate postexercise parasympathetic reactivation after maximal exercise bouts (Buccheit et al. 2009, Stanley et al. 2011) WBC is the first method to show a large augmentation of vagal-related HRV indices beyond resting levels. WBC also results in similar effects as ACT on metabolic parameters of recovery and subsequent exercise capacity, and therefore appears as an effective recovery method in this context. Seiler S, Haugen O, Kuffel E. (2007) Med Sci Sports Exerc 39(8):1366-1373. Buchheit M, Peiffer JJ, Abbiss CR, Laursen PB (2009) Heart Circ. Physiol 296(2):H421-427. Stanley J, Buchheit M, Peake JM (2011) Eur J Appl Physiol (epub ahead of print)

### DAILY VARIATION AND EFFECTS OF FLUID INTAKE MODIFICATION ON SALIVA OSMOLALITY

Klein, A.1, Barnouin, R.2, Stewart, A.3, Metzger, D.2, Pross, N.2, Girard, N.2, Guelinckx, I.1, Demazieres, A.2, Perrier, E.1

*(1) Danone Research, Palaiseau, France; (2) FORENAP, Rouffach, France; (3) Cantimer Inc., Menlo Park, USA*

Purpose: There is no consensus on a marker of hydration that is minimally-invasive and quick to administer. Because it is easily sampled, saliva osmolality (Sosm) may be a good candidate to assess hydration in real life conditions, particularly in athletes where rapid, convenient results are important. Tracking daily hydration status is important for athletes, and is critical for those performing under stressful environmental conditions. However, saliva physiology is still unclear, even at rest. The purpose of this study was to evaluate daily variation in Sosm, as well as the use of Sosm as a marker of hydration status in adults with habitually low or high fluid intakes. Because convenient measurement is critical for widespread use, a secondary aim was to evaluate accuracy of a portable osmometer (PO) compared to a freezing point osmometer (FPO). Methods: 52 participants ( $24.8 \pm 3.1$  yrs;  $22.3 \pm 1.6$  kg/m<sup>2</sup>) were classified as Low ( $n = 29$ ) or High ( $n = 22$ ) drinkers based on habitual fluid intake assessed by a fluid journal. Both groups completed a 6-day inpatient crossover design trial with both low (1.0 L/day) and high (2.5 L/day) fluid intakes. During baseline (Days 1-2), participants followed the fluid regimen similar to their habitual intake. On Days 3-5, fluid intakes between groups were reversed. Sosm was analyzed concomitantly by FPO and PO at 13 predetermined time points each day. Results: A between-groups comparison of Sosm revealed no significant differences at baseline, but significantly higher values during Days 3-5 in the group consuming 1L/d compared to those consuming 2.5L/d ( $72.0$ , 95%CI [70.1 ; 73.8] vs.  $65.7$ , 95%CI [63.9 ; 67.5] mOsm/kg, respectively;  $p < 0.001$ ). Significant daily variation in Sosm was also observed: overall time-by-time comparisons revealed that Sosm values were significantly higher at 07h compared to all other time-points with the exception of 12h. Globally, values were highest after waking and lowest following meals. A Bland-Altman plot revealed good agreement for Sosm values less than 120mOsm/kg (96% of values) with an intraclass coefficient of 0.6. Conclusions: Results obtained in this study suggest that 1) Daily variation in Sosm is present but likely more attributable to meals than to circadian rhythm; 2) Sosm does not quantitatively differentiate habitually Low and High drinkers due to high inter-individual variation; 3) But, a change in fluid intake results in Sosm changes, particularly for a fluid intake increase; 4) A portable osmometer displays similar analytical performance to the reference methodology (FPO). This study was funded by Danone Research



**PHYSIOLOGICAL RESPONSES TO WORKING IN HOT ENVIRONMENT IN THE MORNING AND THE AFTERNOON**

Racinais, S., Fernandez, J., Farooq, A., Eikebu, A., Vimeshkumar, J., Gaoua, N.

*Aspetar, Qatar Orthopaedic and Sports Medicine Hospital; Qatar Aluminium Limited*

Background: Core temperature generally follows a circadian rhythm peaking in the late afternoon. We recently described that this circadian variation persists in shift-workers in hot environment, but with a higher average core temperature. This suggests that physiological (e.g., heart rate) and behavioural (e.g., activity) responses could be different during a morning and an afternoon work-shift in hot environment. Objectives: To characterize the physiological (e.g., temperature, heart rate) and behavioural (e.g., activity) responses to working in a hot environment and the impact on health parameters (e.g., heat fatigue symptoms, dehydration, sodium loss) during morning and afternoon work-shift. Methods: Twenty-two aluminium smelter workers volunteered to be screened during their usual morning (07:00-15:00h) and afternoon (15:00-23:00h) shift-work for: core temperature (ingestible pill), internal helmet temperature (adhesive patch), heart rate (chest strap), activity (tri-axial accelerometer), fluid consumption, body weight loss, hydration (urine specific gravity), sweat sodium concentration and questionnaire on heat fatigue symptoms. Results: The average temperature recorded from the helmet was  $34.3 \pm 5.5^\circ\text{C}$  in the morning and  $33.8 \pm 4.1^\circ\text{C}$  in the afternoon, with maximum values reaching  $\sim 50^\circ\text{C}$  during the two shifts. Given the constant work requirement, participants performed a similar amount of activity ( $836 \pm 332$  vs.  $880 \pm 338$  steps/h,  $n=10$ ) with a similar average ( $101 \pm 13$  vs.  $97 \pm 11$  bpm,  $n=12$ ) and maximal ( $149 \pm 17$  vs.  $155 \pm 16$  bpm) heart rate in the morning and afternoon, respectively. Participants rated the work-shifts of similar difficulty ( $5.0 \pm 1.2$  vs.  $5.3 \pm 1.3$  over 10,  $n=16$ ) and reported equivalent symptoms scores ( $5.7 \pm 7.3$  vs.  $5.7 \pm 8.5$  over 78) in the morning and afternoon. The average core temperature was similar during the two shifts ( $37.5 \pm 0.2$  vs.  $37.4 \pm 0.2^\circ\text{C}$ ,  $n=14$ ), but displayed a different pattern of evolution during the morning (significant increase,  $p=0.03$ ) and afternoon (no variation,  $p=0.55$ ) shifts. Participants displayed similar levels of urine specific gravity ( $1.018 \pm 0.006$  vs.  $1.018 \pm 0.007$ ,  $n=19$ ) and water consumption ( $2943 \pm 1388$  vs.  $2467 \pm 1046$  mL,  $n=20$ ) during the morning and afternoon shift. However, the sweat loss ( $3.8 \pm 2.2$  vs.  $2.7 \pm 1.5$  L) and sweat sodium concentration ( $55 \pm 44$  vs.  $41 \pm 20$  mmol/L,  $n=12$ ) tended to be higher in the morning than the afternoon ( $p < 0.10$ ), leading to a greater sodium loss in the morning ( $164 \pm 118$  vs.  $109 \pm 87$  mmol,  $p < 0.05$ ). Conclusions: Working in a hot environment induced similar adaptations regardless of shift time. However, the time-of-day did lead to differences in sodium loss and temperature kinetic, without affecting work tolerance.

# Friday, July 6th, 2012

08:00 - 09:30

## Invited symposia

### IS-PM13 Evidence Based Physiotherapy (Cardiac Rehabilitation) (\*)

#### DOES EXERCISE IMPROVE ARTERIAL FUNCTION?

Fernhall, B.

*University of Illinois at Chicago*

Arterial structure and function are related to cardiovascular outcome and mortality. Measures such as intima-media thickness (IMT), arterial stiffness, and endothelial function can be considered indices of subclinical atherosclerosis and a substantial amount of epidemiological evidence support their use in various populations. Traditional endurance exercise training improves measures of arterial stiffness and endothelial function in both general population and patients with atherosclerotic heart disease, particularly in those patients with poor arterial function at baseline. The mechanisms for these changes are thought to be a function of improved nitric oxide (NO) metabolism, potentially as a result of decreased inflammation and reduced oxidative stress. New information on high intensity interval training suggests that this form of exercise training may be more effective than traditional endurance training, not only in the general population but also in cardiac patients. The effect of endurance training on IMT is less clear, and few studies have shown IMT regression following training. However, it is possible that endurance training may reduce progression of IMT in patients with atherosclerotic heart disease. Resistance exercise training is now generally recommended as an integral part of cardiac rehabilitation. However, the effects of resistance exercise training on arterial function are mixed. In young, healthy individuals, acute resistance exercise typically increase arterial stiffness, and in some studies, resistance exercise training of various durations has also increased arterial stiffness. Most studies though, show no change in arterial stiffness following chronic resistance exercise training, including studies in cardiac patients. Similarly, in young healthy individuals, high intensity resistance exercise training may decrease endothelial function, whereas moderate intensity exercise training increases endothelial function. In patients with atherosclerotic heart disease, resistance exercise training appears to improve endothelial function, while having little effect on IMT. Thus, for patients with atherosclerotic heart disease, the type of exercise usually conducted in cardiac rehabilitation programs, appear to produce mostly beneficial effects on arterial function.

#### EXERCISE INTERVENTION IN ISCHEMIC HEART DISEASE PATIENTS: HOW CAN WE MAXIMIZE THE CLINICAL BENEFITS?

Hansen, D.

*Hasselt University*

In patients with ischemic heart disease, the implementation of rehabilitation programs have been shown to significantly reduce mortality, and improve cardiovascular disease risk factors, exercise capacity, and quality of life. Within these rehabilitation programs, exercise training is a cornerstone. During the last few decades, great progress has been made regarding the proper selection of training modalities to optimize the improvement in exercise capacity in these patients (which correlates with lowering of mortality risk). Moreover, within populations of obese subjects and type 2 diabetes patients, the understanding of how to select training modalities to maximize adipose tissue mass loss and increase glycemic control has increased considerably. These data can be used to optimize exercise interventions in ischemic heart disease patients with obesity and/or type 2 diabetes. It will be summarized what training modalities should be selected to maximize the clinical benefits (exercise capacity, adipose tissue mass, glycemic control) of exercise intervention in ischemic heart disease patients. However, the implementation of exercise intervention in ischemic heart disease patients is associated with some typical difficulties. The proper determination of exercise training intensity remains complex, many of the clinical benefits are lost on the long term, to mention a few examples. These difficulties will be highlighted to increase the awareness of the current limitations of exercise intervention in ischemic heart disease patients.

#### EXERCISE OPTIONS IN PATIENTS WITH HEART FAILURE

Halle, M.

*Technical University Munich*

Although an overall decline in the incidence of cardiovascular disease has been observed during the last decade, the prevalence of heart failure (HF) is steadily increasing in the civilized world. This can certainly in part be attributed to the demographic change, but also an increasing unhealthy life-style behaviour including low physical activity. Currently it is estimated that in Europe at least 10 million people suffer from systolic heart failure (Heart Failure with Reduced Ejection Fraction, HFrEF), and that about the same number has heart failure symptoms with normal ejection fraction but myocardial dysfunction (Heart Failure with Normal Ejection Fraction, HFNEF). Besides an optimal pharmacological therapy, exercise training has evolved as a core treatment strategy to improve morbidity and mortality in these patients. In HFNEF this has particularly been confirmed by a large randomized trial enrolling >2,000 patients monitoring clinical endpoints for up to four years (HF ACTION Trial). Data showed that training may significantly improve quality of life and hospitalisation in the patients. However, compliance to the exercise program and mode of intervention is still under debate. In HFNEF exercise over 3 months reduced myocardial stiffening and symptoms in a pilot study, a finding which is currently investigated in a large randomized trial (Ex-DHF Trial). In addition, recent studies have suggested that exercise training at relatively high intensity seems to equally or even more effective than most current programs, in which the level of exertion is either moderate or not clearly defined. In a small cohort interval training improves physical performance, quality of life and outcomes associated with survival, such as aerobic capacity, left ventricular dimensions, ejection fraction, and prognostic factors such as brain natriuretic peptide levels. In summary, exercise is a key component of current heart failure treatment. Ongoing research will focus on the mode of exercise to improve clinical outcomes.

**08:00 - 09:30****Oral presentations****OP-SH05 Experimental Psychology****PASSIVE HYPERTHERMIA INDUCES AN OVERLOAD LIMITING COMPLEX COGNITIVE TASKS.**

Gaoua, N., Herrera, C.P., Racinais, S., El-Massioui, F.

*ASPETAR, Qatar Orthopaedic and Sports Medicine Hospital*

Purpose: To investigate the changes in brain electrical activity (EEG) during cognitive tasks in a hot environment. We expected EEG recordings to determine the effect of both task complexity and passive hyperthermia. Methods: Ten male subjects were tested in a counter-balanced order on two separate occasions in normothermia [CON, core temperature of 37.0°C ( $\pm 0.2$ ), neutral environment (WBGT = 21.1  $\pm 0.4$ °C)] and hyperthermia [HOT, core temperature of 39.0°C ( $\pm 0.2$ ), hot environment (WBGT = 40.2  $\pm 0.6$ °C)]. Subjects performed a One Touch Stockings of Cambridge planning task with simple (OTS-4) and complex (OTS-6) levels of complexity. EEG was recorded over the frontal lobe and theta power (4-8 Hz) was analysed. Results and Discussion: EEG recordings showed that theta activity was significantly increased in HOT compared to CON (2.18  $\pm 0.18$  vs. 1.97  $\pm 0.09$ ,  $p = 0.04$ ). This difference was already present before task engagement, with higher values presenting in HOT than CON. The difference persisted during OTS-4 in parallel with the increase in theta activity from rest to OTS-4. There was no difference in performance between CON and HOT during OTS-4. However, the difference in theta power between CON and HOT disappeared during OTS-6. OTS-6 performance significantly decreased in HOT ( $p = 0.003$ ). Conclusion: Hot environments represent a load on working memory capacity even prior to task engagement. The absence of difference in theta power observed between conditions during OTS-6 suggests that a critical threshold had been reached, possibly explaining the decrements in cognitive performance in HOT. The results demonstrate that the additional cognitive resources required for complex cognitive tasks are unavailable, given the allostatic load imposed by passive hyperthermia, which leads to decreased performance.

**NEUROSTIMULATION FOR IMPROVEMENT OF POST-SLEEP MENTAL STATE IN ATHLETES**

Abeln, V.1, Anderten, M.2, Kleinert, J.2, Vogt, T.1, Schneider, S.1, Strüder, H.K.1

*German Sport University Cologne*

Introduction Sleep has consequences on physical and psychological performance as well as well being (Mah et al., 2011). Although one is aware of the fact that sleep is an important variable for athletes' performance, literature in sport science about how to improve athletes' sleep is rare. Because time for sleep is often limited due to the tight schedule of top athletes, the aim of this study was to improve the sleep quality by using a neurostimulator during sleep and to investigate its effect on post-sleep mental state (effect of neurostimulator on neurophysiological level has been proved before, unpublished results). Methods 15 soccer players of the U17 and U19 teams of a German Bundesliga club slept under the influence of a neurostimulator for 8 weeks. Using binaural, monaural and isochronous tones, the neurostimulator stimulates the brain with deep-sleep frequencies (2-6 Hz). The scale for perceived physical state (PEPS) and a short form of the 'Eigenzustandsskala' (EZ-scale) were used in order to measure changes in post-sleep physiological and psychological mental state evoked by the neurostimulator in comparison to the pre-intervention state. The self-assessment questionnaires for sleep and awakening quality (SSA) and the EBF-Sport have been applied for monitoring of changes in sleep behavior and quality and in the sport related stress-relaxation state during the study duration. Nonparametric variables have been analyzed using the Wilcoxon test, parametric variables by using ANOVA. Results In comparison to the pre-intervention state, athletes sleep quality increased ( $p < .05$ ), whereas ratings of feeling sleepy decreased in the course of the intervention period. In the intervention period, subjects stated to sleep deeper ( $p < .05$ ), to have a more regenerating sleep ( $p < .01$ ) and quoted to feel less unwell ( $p < .01$ ) and in a better physical state compared to pre-intervention state. Sleeping behavior or stress-relaxation state did not change. Discussion The post-sleep mental state of young elite soccer players could be improved by the application of a neurostimulator stimulating the brain with deep-sleep frequencies. Accordingly, neurostimulation does not only change neurophysiological parameters but also mental state and might therefore be an efficient tool for athletes. Correlating positive effects on cognitive and physical performance are assumed, and will be investigated in further studies. References Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The effects of sleep extension on the athletic performance of collegiate basketball players. *Sleep*, 34(7), 943-950.

**EFFECTS OF COMMERCIALLY AVAILABLE NEUROSCIENTIFIC METHODS ON PSYCHO-PHYSIOLOGICAL REGULATION AND COGNITIVE PERFORMANCE**

Finkenzeller, T., Amesberger, G.

*University of Salzburg*

Introduction The application of neuroscientific methods to improve sport performance in elite sports is getting more and more in vogue. However, many of the commercially available methods have not been evaluated empirically so far. Thus, two methods, the audio-visual perception enhancement method (AVWF@method) and the OGIRO@ modulation, have been selected for an empirical testing. Among other things, the AVWF@method claims to enhance autonomic balance and cognitive performance by listening to sound modulated music (Conrady, 2012). Similar effects are reported for the OGIRO@ modulation that influences brain activity by the use of transcranial magnet stimulation. Two studies should clarify if the two selected neuroscientific methods have a positive effect on autonomic balance and cognitive performance. Methods The sample of study 1 consisted of 57 male and female students (16 $\pm$ 8.6 years) of a college of physical education. Two experimental groups (group 1: AVWF@method,  $n = 25$ ; group 2: non-modulated music,  $n = 20$ ) participated in ten music intervention sessions over two weeks. A third group received no music intervention ( $n = 12$ ). In the pre-, post- and retention tests, an electrocardiogram for the determination of heart rate variability (HRV) parameters was recorded in a three minute resting condition (sitting, eyes closed). Cognitive performance was assessed via d2 attention endurance test (Brickenkamp, 2002), a stress tolerance and reaction time test (DT-S1; Schuhfried@; Neuwirth & Benesch, 2007), and a selective attention test (Krenn, 2008). In the second study, a randomized, double blind design was applied. A sample of 30 male sports students (24.7 $\pm$ 3.6 years) was divided into an intervention (OGIRO@ modulation) and a control group (dummy device). Over a period of 14 days, all of the subjects completed ten training sessions.

In a pre- and posttest, the same tests as in the first study were carried out. Results For all target variables, RM-ANOVAs were calculated with the factors group and time (study 1: 3x3; study 2: 2x2). No significant interactions were found in either HRV parameters or cognitive performance that would indicate intervention-related effects. Discussion Neither of the two studies could demonstrate a positive effect of neuroscientific methods on psycho-physiological regulation and cognitive performance in sports students. It seems doubtful that the two methods achieve the specified effects in high performance sports. The integration of empirical evidence into recommendations for practical use is discussed. References Brickenkamp R (2002). Göttingen: Hogrefe. Conrady U (2012). Retrieved February 17, 2012, from <http://www.avwf.de/de> Krenn B (2008). Unpublished Master Thesis: University of Vienna. Neuwirth W, Benesch M (2007). Mödling: Schuhfried, 1–48.

### ON THE PROBLEM OF THE TEMPORAL BODY

Hogenova, A.

*Charles University*

Keywords: pexis, internal perception of time, body schema, successivity, simultaneity, temporality Most people describe the body as a map, organ next to organ. We talk about their functions, structure, etc. But more important is the body that can generate many functions at once, at any one time. A dancing body is a very good example. Each body part is doing something different, legs and hands working independently of each other and yet the whole body of the dancer is like an effortless torrent. The body is able to create various movements at the same time and yet it is merely a focus of kinetic energy. Most bodily functions are explained successively, i.e. they are consecutive, but we are not interested in successiveness or simultaneity. We need to consider that during all of these movements man is able to think about what will be in the future, because he wants to prepare for that future. Here we show how causality, which focuses on changes in succession, is not able to describe or clearly explain everything in man. Aristotle defines time as the number of movement. It is perhaps the best known definition of time, which brings with it succession as the only possible interpretation of the movement of time. Everything happens consecutively, as cause and effect, creation and causal succession, by which science describes our common world. This is how the body is explained in physiology, anatomy, chemistry and physics. But the body's processes are diverse and happen suddenly. Thinking and motor skills emerge from the body as unique and elementary figures, they are not made up of several parts and they are not 'addition' because they are not a system: a system requires successivity as a condition for its onticity. Besides Aristotle's concept of time there is Martin Heidegger's so-called temporality. This is a totally different concept of time in which the past and future are concealed in the present. This is a totally different concept of time in which the past and future are concealed in the present. For the body, the physical flow of the present is only partially true.. Our temporal body is temporal in Heidegger's sense. It is not the temporality of Aristotle, where time is the number of movement and thus a line of past, present and future. It is not that simple. Of course, science is built on Aristotelian time as its basis, and therefore understands the body in this way. Temporality means that in present contains been-ness and the projective future. And Heidegger's temporality is the temporality we are most interested in. The basis of learning movement is the understanding of been-ness, which unconsciously lies "dormant" inside us and is the basis for teaching. Temporality of our bodies is important for learning any type of movement and for understanding human life in terms of presence (Dasein). This view of the body is not made use of and that is a shame. Therefore, we have devoted this paper to the topic. Literature: Heidegger, M. *Das Ereignis*. Frankfurt am Main: Vittorio Klostermann 2009.

### EFFECT OF SELF-DETERMINED MOTIVATION ON MORAL DISENGAGEMENT IN SPORT: THE MEDIATING ROLE OF RESISTIVE SELF-REGULATORY EFFICACY

Corrion, K., Canestrelli, C., d'Arripe-Longueville, F.

*Nice Sophia Antipolis University*

Introduction Several studies have shown that resistive self-regulatory efficacy was negatively related to moral disengagement in adolescents (e.g., d'Arripe-Longueville et al., 2010; Caprara et al., 2002). However the antecedents of self-regulatory efficacy variables are not well known. The motivational factors of moral disengagement in sport have been examined within achievement goal theory (e.g., Boardley & Kavussanu, 2010), and more recently within self-determination theory (Hodge & Lonsdale, 2011). In line with this study, the purpose of the present research was to examine the relationships between self-determined motivation and moral disengagement moral in sport, and to test the mediating role of resistive self-regulatory efficacy. It was expected that self-determined motivation would sustain resistive self-regulatory efficacy which in turn would affect moral disengagement. Methods Two hundred and ninety eight students voluntarily participated in the study. Participants were invited to complete three questionnaires: (a) the self-determination motivation scale for physical exercise (Vallerand, 1997); (b) the resistive self-regulatory efficacy in sport scale (Corrion et al., 2009); and (c) the moral disengagement in sport short scale (Corrion et al., 2010). Results The results indicated that resistive self-regulatory efficacy partially mediated the relationships between extrinsic/ intrinsic motivation and moral disengagement. The model showed (a) negative relationships between extrinsic motivation and resistive self-regulatory efficacy, resistive self-regulatory efficacy and moral disengagement; and (b) positive relationships between intrinsic motivation and resistive self-regulatory efficacy. Discussion These results confirm that self-determination would be a protective factor for moral disengagement (Hodge & Lonsdale, 2011) and highlight the mediating role of resistive self-regulatory efficacy in this relationship. Our findings also suggest that autonomy support might be encouraged to develop resistive self-regulatory efficacy in adolescents. Future studies could examine the role of self determined motivation on other self-regulatory efficacy variables (Bandura et al., 2001). References Arripe-Longueville F(d'), Corrion K, Scoffier S, Roussel P, Chalabaev A (2010). *J Sport Exerc Psychol*, 32, 595-618. Bandura A, Caprara GV, Barbanelli C, Pastorelli C, Regalia C (2001). *J Pers Soc Psychol*, 80, 125-135. Boardley I, Kavussanu M (2010). *J Sport Exerc Psychol*, 32, 176-192. Caprara GV, Regalia C, Bandura A (2002). *Euro Psychol*, 7, 63-69. Corrion K, Scoffier S, Gernigon C, Cury F, d'Arripe-Longueville F (2010). *L'Encéphale*, 36, 495-503. Hodge K, Lonsdale C (2011). *J Sport Exerc Psychol*, 33, 527-547. Vallerand (1997). Vol 29, 271-360. New York: Academic Press.

**08:00 - 09:30****Oral presentations****OP-PM25 Sport Science****THE RELATIONSHIP BETWEEN AEROBIC CAPACITY AND SENSITIVITY TO PRESSURE AND ISCHAEMIC NOXIOUS STIMULI**

Jones, M., Booth, J., Taylor, J., Barry, B.

*University of New South Wales*

THE RELATIONSHIP BETWEEN AEROBIC CAPACITY AND SENSITIVITY TO NOXIOUS PRESSURE AND ISCHAEMIC STIMULI Jones, M.1, Booth, J.1, Taylor, J.2 & Barry, B.1,2 1: UNSW School of Medical Sciences (Sydney, Australia) 2: Neuroscience Research Australia (Sydney, Australia)

Introduction Anecdotally endurance athletes are stoical, but there is limited evidence that tolerance of discomfort contributes to enhanced endurance. There is some evidence that aerobic exercise training reduces pain sensitivity (Anshel and Russell, 1994), however it is unclear whether enhanced tolerance of discomfort contributes to this adaptation. Studies on athletes and pain sensitivity have yielded equivocal findings (Scott and Gijssbers, 1981). Methods Ten males (24.2 yrs; BMI 23.7; VO<sub>2</sub>peak 44.5 ml/kg/min) and 6 females (25.3 yrs; BMI 21.7; VO<sub>2</sub>peak 42.3 ml/kg/min) participated in this study. Pressure pain threshold was measured at muscular sites on the upper and lower body using an algometer. Pain tolerance was assessed using a submaximal effort tourniquet test. Participants performed repetitive hand grip exercise (30 % maximum force; 4 s grip, 4 s rest) with upper arm occlusion for as long as tolerable or a maximum of 10 min. Pain tolerance was quantified by the number of seconds subjects were willing to continue exercise under the ischemic conditions as well as by subjective rating of pain on a visual analogue scale every 30 s. A maximal aerobic test was performed on a cycle ergometer to determine the subjects level of aerobic fitness. Results No correlation was observed between ischaemic pain tolerance and aerobic capacity for males (r-squared = 0.001, p = 0.92), females (r-squared = 0.05, p = 0.65) or for the normalised data set combining both sexes and accounting for subject age (r-squared <0.001, p = 0.99). For pressure pain, there was a significant inverse relation between normalized aerobic capacity of the male subjects and pressure pain thresholds of the upper (r-squared = 0.41, p < 0.05) and lower body (r-squared = 0.75, p < 0.05). Hence, male subjects with relatively higher aerobic capacity tended to have lower pressure pain thresholds. For female subjects, these associations were weaker and opposite (upper: 0.34, p = 0.22, lower: 0.09, p = 0.57). Discussion Ischaemic pain tolerance, arguably the more similar to pain experienced during an endurance task, did not correlate with aerobic capacity. The inverse relation between pressure pain threshold and aerobic capacity in males possibly arose from fitter males having lower subcutaneous adiposity (Finocchietti et al., 2011), though anthropometric data in the present study do not support this. A larger sample incorporating subjects from a broader range of aerobic capacities will extend and verify these findings. References Anshel, MH and Russell, KG. (1994). *J Sports Sci*, 12(6), 535-547. Finocchietti, S., Morch, CD., Arendt-Nielsen, L and Graven-Nielsen, T. (2011). *Clin J Pain*, 27, 735-745. Scott, V and Gijssbers, K. (1981). *BMJ*, 283, 91-93.

**A CRITICAL EXAMINATION OF "FAIRNESS" IN PARALYMPIC ELITE MULTI-CLASS COMPETITION**

Barnes, C.

*Australian Institute of Sport and University of Canberra*

Introduction In Paralympic field events, up to 30 classes contest what for able-bodied athletes is a single event (discus, javelin, shot etc.). If each class were to contest each event separately the competition would be overly long; also, the standard of competition may be lower than desirable. Consequently some classes are combined to reduce the number of separate events, and to ensure maintenance of appropriate standards. For intra-class comparison, it is necessary to define appropriate standards for each class. We show that for most classes valid comparisons are possible; but in some cases, they are not. We use this analysis to investigate the "fairness" of the current International Paralympic Committee standards, and show that some of the proposed multi-class combinations are inappropriate. Methods A table of event results (including all trials for preliminary, semi-final and final rounds) was constructed for Paralympic and World Championship events from 1998 to 2011. Mixed modelling regression was used to attempt to minimise the influence of known effects: gender, year; implement weight, class; and competition type, as well as second order interactions. Provided that selected performances are all sufficiently large, and that one particular condition is met, residuals are expected to follow the two-parameter extreme value (EV) distribution asymptotically. The critical condition is that the distribution of residuals so determined is stationary (invariant in time). Failure to meet this condition is indicated by failing to reproduce a straight line on a log-linear plot of ordered residuals versus magnitude. Given this condition, performances can be compared, even though they come from different classes (or even different events), via percentiles of their appropriate distributions, subject to the uncertainties in the slope and intercept of their respective linear ordered-residual plots. Results For most event/class combinations, the method proved to be valid, and useful when the total number of performances exceeded 150. However, for several classes (e.g. cerebral palsy classes below F37) it appears that the above analysis of performances does not lead to stationary distributions, and these classes cannot be justifiably combined. Discussion Reasons for the observed non-stationarity remain speculative at this stage; but it can be observed that significant improvements have been made recently by a small number of competitors in these classes. Relatively low numbers of reported results mean that such a competitor was able to significantly influence the distribution, resulting in non-stationarity. Similar results have been seen in able-bodied events where there is likely to have been a decline in the use of performance-enhancing substances (due to more stringent rules and enforcement). We conclude that the current International Paralympic Committee rules for combined class competition are unfair in a small number of cases; adoption of our methodology should lead to increasingly valid comparisons in all classes as more results accrue.

**BIO-ELECTRICAL CURRENT RESPONSE IS ASSOCIATED WITH PSYCHOMOTOR SPEED IN TOP LEVEL SOCCER PLAYERS**

Hautala, A.J.1, Roivainen, E.1, Kiviniemi, A.M.1, Tulppo, M.P.1

*Verve Research*

Introduction Psychomotor speed has been used to monitor athletes training load and it has been proposed that psychomotor slowness is an early marker of overtraining (Nederhof et al., 2007). However, non-invasive home-based tools to evaluate the training status and recovery of neuromuscular function are missing. Therefore, the purpose of the present study was to examine if a new method, based on

bio-electrical current response (BECR), measured at home is associated with psychomotor speed and endurance performance in top level soccer players. Methods Fourteen Finnish top level soccer players (team AC Oulu, age  $21 \pm 5$ , BMI  $24 \pm 1$  kg/m<sup>2</sup>) performed an endurance fitness test (20m Multistage Fitness Test: BEEP Test) in the field conditions. After the fitness test training load for the players was minimized for one week. During this week psychomotor speed tests (Vienna Test System, SCHUHFRIED GmbH, Austria) with visual warning signals were performed in the laboratory. The inspection and motor phases of reaction time to a visual signal were analyzed. BECR (FAM Sports, Finland) was recorded at same time at home on three separate mornings immediately after wake-up, three times at each measurement session, from left hand with low frequency stimulation. Altogether nine measurements of BECR were averaged for final analyses. Results The average running time in the BEEP test was  $16.6 \pm 1.4$  min (range 14.1-18.4). Inspection time to visual signal varied from 109 to 212 ms ( $144 \pm 27$ ), motor time from 79 to 223 ms ( $116 \pm 38$ ) and BECR from 3 to 17 mA ( $6 \pm 4$ ). BECR correlated positively with motor time ( $r = 0.73$ ,  $p = 0.003$ ) and showed a trend of association with inspection time ( $r = 0.49$ ,  $p = 0.076$ ), BEEP test ( $r = -0.46$ ,  $p = 0.102$ ) and age ( $r = 0.41$ ,  $p = 0.148$ ). There was no association between BECR and BMI ( $r = 0.07$ ,  $p = \text{ns}$ ). Discussion Bio-electrical current response measured at home is associated with psychomotor speed, particularly motor time to visual warning signal. If the response to electrical stimulus is delayed, motor time is slower. It appears that bio-electrical current response method is a promising tool to evaluate neuromuscular status of soccer players at home conditions during training and recovery. References Nederhof E, Lemmink K, Zwerver J, Mulder T (2007) The effect of high load training on psychomotor speed. *Int J Sports Med* 28: 595-601.

### TRACKING OF COMMUTING PHYSICAL ACTIVITY FROM YOUTH TO ADULTHOOD: THE YOUNG FINNS STUDY

Yang, X.1, Telama, R.2, Hirvensalo, M.2, Tammelin, T.1, Viikari, J.S.A.3, Raitakari, O.T.3

1: LIKES - RCHS (Jyväskylä, Finland), 2: UJ (Jyväskylä, Finland), 3: UT (Turku, Finland)

Introduction Research on the stability of commuting physical activity (CPA) from childhood to adulthood is scarce and there is a lack of prospective data that show such a relationship. The aim of the study was to evaluate the longitudinal changes and secular trends of CPA over 27 years from youth to early middle-age in the Cardiovascular Risk in Young Finns Study. Methods Participants were 2157 healthy adults (971 men and 1186 women), who participated in the follow-up measurements from youth (since 1980) to adulthood (aged 30 – 45 years in 2007) in the ongoing Cardiovascular Risk in Young Finns Study. The way and distance of commuting to school or work were asked by a questionnaire in 1980, 1983, 1986, 2001 and 2007 separately for summer and winter conditions. The commuting was categorized into four types: car, bus, walking and cycling. Commuting mode to school/work was also transformed to weekly metabolic equivalent values (MET hours/week) and then dichotomized into inactive ( $< 3$  MET hours/week) and active commuters ( $\geq 3$  MET hours/week). Results The prevalence of CPA declined sharply with increasing age, particularly in men. Active commuting was more prevalent in women than in men during young adulthood. There was a significant decreasing secular trend in CPA in youth between years 1980/1983 and 1986, particularly in boys and girls aged 18 and 21 ( $p < 0.05$ ). No secular change in CPA was observed in adulthood between years 2001 and 2007. Spearman's correlation coefficient for tracking of CPA was higher in young adulthood ( $r = 0.22-0.65$ ) than in youth ( $r = 0.20-0.45$ ). However, correlation from youth over a longer period into adulthood was a weak and non-significant. Persistently active commuters in youth had more than 1.6-fold likelihood of being active commuters in adulthood compared to their inactive counterparts. The adjusted odds ratios of being active commuter in adulthood were highest for active commuters in young adulthood in three age groups, varying between 7.5–15.0 in men and 3.4– 6.6 in women, respectively. Discussion Proportion of active commuters declines with age in both men and women. CPA in young adulthood tracks better into early middle-age adulthood than CPA in youth. Accumulating active commuting in youth and in young adulthood is related to being active commuter in early midlife for both genders. Maintaining active commuting to school or work is an essential component of overall physical activity and healthy lifestyle along the life course. Promotion of physically active commuting in youth and young adulthood seems to be important in order to enhance physically active lifestyle later in life.

### ATTITUDES TOWARDS DOPING IN PARTICIPANTS OF A POPULAR LONG-DISTANCE ROAD CYCLING EVENT ACCORDING TO THEIR DOPING BEHAVIOR: USERS VS NON-USERS.

Morente-Sánchez, J.1, Freire, C.1, Ramírez-Lechuga, J.2, Zabala, M.1,3

1 Faculty of Sport Sciences, University of Granada (Spain); 2 Faculty of Sport, University Pablo Olavide (Seville-Spain); 3 Spanish Cycling Federation, Madrid (Spain)

Introduction The purpose of this study was to know the attitudes towards doping of participants of a popular long-distance road cycling event taking into account if they had used doping substances or not in the past. Methods A sample of 2022 amateur cyclists ( $40.95 \pm 9.42$  years) who participated in a long-distance (205 km) Spanish road cyclist event called "Quebrantahuesos" (UCI Golden Bike), was divided into two groups: users of doping substances ( $G1=164$ ) and non-users ( $G2= 1858$ ). On the other hand, in order to contrast similar and balanced samples, data from users was also compared with an equivalent group of non-users ( $G3=157$ ). Descriptive design was carried out by means of a validated questionnaire (Petroczi & Aidman, 2009) of 17 questions using a Likert scale from 1 (Strongly Disagree) to 6 (Strongly Agree) for different statements that supported the use of doping in sport. Mean value  $\pm$  Standard Deviation was obtained for each item and Mann Whitney test for independent variables with Bonferroni post hoc was carried out. Results Mean score (1 to 6) and overall score (17 to 102) for different groups were, respectively:  $G1=2.88 \pm 0.94$ ,  $48.87 \pm 15.98$ ;  $G2=2.41 \pm 0.70$ ,  $40.98 \pm 11.95$ ;  $G3=2.30 \pm 0.66$ ,  $39.14 \pm 11.76$ , ( $G1$  vs  $G2$  &  $G3$ ,  $p < 0.001$ ). For users, the highest score was observed for the item "The media blows the doping issue out of proportion" ( $4.36 \pm 1.76$ ) and for non-users, "Athletes are pressured to take performance-enhancing drugs" ( $4.16 \pm 1.63$ ) -4=Slightly Agree; 5=Agree-. For almost all the items significant differences were observed between  $G1$  vs  $G2$  and  $G3$  ( $p < 0.05$ ), being higher in  $G1$  than in  $G2$  and  $G3$ . Between  $G1$  and  $G2$  only there were not significant differences for four items ("Athletes are pressured to take performance-enhancing drugs", "Athletes who take recreational drugs, use them because they help them in sport situations", "Athletes have no alternative career choices, but sport" and "Recreational drugs help to overcome boredom during training"). Between  $G1$  and  $G3$  there were not significant differences just for four items: "Recreational drugs give the motivation to train and compete at the highest level" "Athletes have no alternative career choices, but sport", "Athletes who take recreational drugs, use them because they help them in sport situations". Discussion Confessed doping users scored significantly higher on the scale compared with those who reported not to use of banned substances. Similar results were obtained by Uvacek et al. (2011) for users' overall score ( $46.8 \pm 13.32$ ) while that non-users' overall score was lower ( $34.43 \pm 8.74$ ). References 1. Uvacek, M Nepusz, T, Naughton, DP. Mazanov, J. Ranky, MZ, Petróczi, A. (2011). Self-admitted behavior and perceived use of performance-enhancing vs psychoactive drugs among competitive athletes. *Scandinavian Journal Medicien Science Sports*. 21: 224–234 2. Petroczi, A., Aidman, E. (2009). Measuring explicit attitude toward doping: Review of the psychometric properties of the Performance Enhancement Attitude Scale. *Psychology of Sport and Exercise*. 10: 390–396.

## TEN MINUTES OF DAILY SCHOOL-BASED SLACKLINE TRAINING ONLY IMPROVES TASK-SPECIFIC BALANCE PERFORMANCE IN 9-10 YEARS OLD CHILDREN

Donath, L., Roth, R., Ruegge, A., Groppa, M., Zahner, L., Faude, O.

*University of Basel*

Introduction School-based exercise interventions that improve balance, strength and endurance performance seem beneficial since adequate childhood exercise behavior more likely track into a healthier adult lifestyle. Slackline interventions were recently employed to promote postural control and strength performance in young adults (Granacher et al. 2010). Comparable studies in primary school children are lacking. Thus, the present study was performed to examine effects of daily school-based slackline-training bouts on static and dynamic balance and jump performance in children. Methods Two school classes of the 4th grade of the Swiss canton Basel (Intervention, n=21 vs. Control, n=13) (INT, age: 10.1 (SD 0.4) y, height: 1.39 (0.05) m, weight: 33.1 (4.5) kg, weekly sports club participation (SC): 2.4 (1.9) h; CON, age: 10.0 (0.4) y, height: 1.40 (0.06) m, weight: 34.7 (7.4) kg, SC: 1.8 (1.2) h) were included. The intervention was performed 5 times per week for 10 minutes each day within 6 weeks. INT comprised e.g. double and single limb standing, walking, turning and backwards walking. Both groups were encouraged to maintain their habitual physical activity. Before and after slackline training, balance and jump performances were assessed by (a) 30 seconds static and dynamic single limb stance on a force plate (path length displacement of the center of pressure (COP)), (b) backwards balancing on three different balance beams (3, 4.5 and 6 cm width), (c) upright standing as long as possible (single and double limb) on the slackline and (d) countermovement jumps (CMJ). Results Attendance was 27.4 (1.2) of 28 provided sessions (2 sessions were canceled). No significant group x time interactions for each leg (left and right) and conditions (static and dynamic) was observed for COP displacement ( $0.40 < p < 0.92$ ) as well as for backwards balancing on the three balance beams ( $0.08 < p < 0.77$ ) and CMJ height ( $p=0.28$ ). In contrast, high significant group x time interactions ( $0.006 < p < 0.02$ ) were found for slackline standing time with significant increases in INT (double limb: 5.1 (3.4) s to 17.2 (14.4) s; right leg: 8.2 (5.8) s to 38.3 (36.0) s; left leg: 10.6 (5.8) s to 49.0 (56.3) s and no significant changes in CON. Discussion Daily bouts of slackline training resulted in large slackline-specific improvements of postural control. A transfer to common static and dynamic single limb balance performance tasks, backwards balancing or jump performance was not observed. Thus, the benefit of slackline training with regard to general neuromuscular adaptations should not be overrated. References Granacher U, Iten N, Roth R, Gollhofer A. (2010). *Int J Sports Med*, 31, 717-723.

**08:00 - 09:30**

## Oral presentations

### OP-PM26 Sport Medicine: Experimental Interventions

#### LOCAL ADMINISTRATION OF INSULIN-LIKE GROWTH FACTOR-I STIMULATES TENDON COLLAGEN SYNTHESIS IN HUMANS

Hansen, M.1,2, Boesen, A.1, Holm, L.1, Flyvbjerg, A.2, Langberg, H.1, Kjaer, M.1

*(1) Institute of Sports Medicine, Dept. Orthopedic Surgery M81, Bispebjerg Hospital and Center for Healthy Aging, Faculty of Health Sciences, University of Copenhagen*

Introduction: Collagen is the predominant structural protein in tendons and ligaments, and can be controlled by hormonal changes. In animals, injections of insulin-like growth factor I (IGF-I) has been shown to increase collagen synthesis in tendons and ligaments and to improve structural tissue healing, but the effect of local injection of IGF-I on tendon collagen synthesis in human has not been studied. The purpose of this study was to study whether local injections of IGF-I have a stimulating effect on tendon collagen synthesis. Material and method: Twelve healthy non-smoking men participated: age  $62 \pm 1$  yrs (mean  $\pm$  SEM), BMI  $27 \pm 1$ . Two injections of either human recombinant (rh) IGF-I (0.1 ml Increlex®) or saline (control) into each patellar tendon were performed 24-hrs apart. Tendon collagen fractional synthesis rate (FSR) was measured by stable isotope technique in the hours after the second injection. Simultaneously, interstitial peritendinous IGF-I concentration and procollagen type I N-terminal propeptide (PINP) concentration, as a marker for type I collagen synthesis, were determined by microdialysis technique. Results: Tendon collagen FSR and PINP were significantly higher in the IGF-I leg compared to the control leg ( $P < 0.05$ ). Conclusion: local IGF-I administration can directly enhance tendon collagen synthesis both within and around the human tendon tissue.

#### FIVE REPEATED APNOEAS AFFECT THE HYPERCAPNIC VENTILATORY RESPONSE IN ELITE APNOEA DIVERS

Bourdass, D., Konstantopoulos, A., Tsakiris, T., Pavlakis, K., Triantafyllou, D., Geladas, N.

*University of Athens, Greece*

Introduction Apnoea divers appear to be CO<sub>2</sub> retainers (Florio et al., 1979) which is assumed to decrease CO<sub>2</sub> sensitivity (Lin et al., 1974) and may lead to altered hypercapnic ventilatory response (HCVR) as it is expressed by the slope of  $\alpha = VE/PETCO_2$ . The aim of this study was to test if HCVR is reduced by repeated breath hold maximal efforts (RBHE) and the possible contribution of this on duration of apnoea's easy going phase (EPH) in elite divers and no familiar with apnoea subjects. Methods Elite breath hold divers (EBH=11) & normal subjects (NBH=10) visited the laboratory in two different days. In the 1st day (BM) subjects performed a HCVR test using the Read rebreathing method (Read, 1967). In the 2nd day (PRE) subjects completed five RBHE with face immersion in cold water (12°C), separated by 2min intervals and 2 min upon manuvres' cessation they performed a HCVR test. Afterwards, only the NBH group trained every day on a five RBHE separated by 2min intervals. Two weeks later (POST), only the NBH repeated the 2nd day session. During apnoeas diaphragmatic activity was recorded continuously in order to determine the end of apnoea's EPH. Results The subjects' BHT range was 274.0-400.0, 57.1-166.5 and 90.1-260.9 sec for the EBH and NBH group in PRE and POST conditions, respectively. The slope  $\alpha$  in EBH showed significant difference between BM ( $1.8 \pm 0.2$ ) and PRE ( $1.4 \pm 0.2$ ) ( $p \leq 0.05$ ). In the NBH group, the slope of  $\alpha$  was  $2.4 \pm 0.3$ ,  $2.9 \pm 0.4$ ,  $2.8 \pm 0.5$  respectively to three conditions, BM, PRE and POST with no significant differences among them. Alpha ( $\alpha$ ) slope of EBH group in PRE compared with the PRE and POST conditions of the NBH group was significantly lower. EPH did not differ ( $p > 0.05$ ) between PRE and POST condition in NBH. EBH group had significantly higher averages of EPH for each repeated BH than NBH in PRE and POST conditions, and the  $\alpha$  slope

showed a strong correlation ( $r=0.61$ ,  $p\leq 0.05$ ) with the cumulative EPh of the five repeated apnoeas (CEPh) in PRE condition; nothing similar was observed in NBH. Discussion The EBH developed reduced HCVR two minutes after the end of the five repeated apnoeas, delaying the chemical stimuli of breathing and increasing the BHT (Chang & Lundgren, 1996) in contrast to NBH. Moreover, the correlation of a with CEPh only in EBH supports the hypothesis that any increase in BHT achieved after apnoea training in NBH cannot be explained by EPh duration changes or/and any HCVR changes. References Chang LP & Lundgren CE (1996). *Eur.JAppl.PhysiolOccup.Physiol*, 73,210-218. Florio JT, Morrison JB, Butt WS (1979). *J.Appl.Physiol*, 46,1076-1080. Lin YC, Lally DA, Moore TO, Hong SK (1974). *J.Appl.Physiol*, 37,291-296. Read DJ (1967). *Australas.Ann.Med*, 16,20-32.

### TRAINABILITY: A MATTER OF GENE VARIANTS?

Ring-Dimitriou, S.I, Kedenko, I.2, Humenberger, M.I, Feichtinger, R.3, Stangl, J.I, Andress, M.I, Steinbacher, P.4, Förster, H.5, Müller, E.I, Paulweber, B.2

1&4: University of Salzburg, 2&3: Paracelsus Medical University

Introduction Beside exercise prescription single-nucleotide polymorphism (SNP) in genes important for mitochondria function such as PPARGC1A and PPARD have been reported to affect the change in anaerobic threshold in a retrospective study (Stefan et al., 2007). Therefore we prospectively investigated a 10-wk training response of men with SNP in these genes. Methods Genotyping (TaqMan, ABI 7900HT) was performed in 838 sedentary males for SNP in PPARGC1A (rs8192678) and PPARD (rs2267668). After intervention (supervised 10 wks cycling, 3x 60 min, HR@70-90% VO2peak) n=28 remained for post tests (59±7 yrs, 27.6±4.1 kg/m<sup>2</sup> BMI, 36.3±6.9 ml/kg/min VO2peak). Subjects were assigned to wild type (WT=13), SNP1 (minor risk allele for PPARGC1A, WT for PPARD, n=6), and SNP2 (risk alleles for both genes, n=9). Trainability was determined as the relative change in work rate P@VT (point of optimal respiration), P@AT (anaerobic threshold), and P@RCP (respiratory compensation point) based on gas exchange analyses (ZAN680, nSpire Health, US) during incremental cycling (Ergoline, Schiller). Mean differences within and between groups were determined by ANOVA with  $p<0.05$ . The study was approved by the Salzburg Ethics Committee and funded by National Bank of Austria (J14156). Results Significant differences were found within WT in P@VT (99±21 vs. 122±19 W,  $p=.005$ ) and @RCP (155±25 vs. 185±29 W,  $p=.009$ ) only. P@RCP was significantly lowest in SNP1 compared to SNP2 and WT (% 3±9 vs. 12±5 vs. 20±15;  $F=4.6$ ,  $p=.02$ ). VO2@VT and @RCP were significantly lower in SNP1 and SNP2 compared to WT (% 2±10 vs. 4±13 vs. 18±15,  $F=3.6$ ,  $p=.04$ , and 0±8 vs. 6±5 vs. 17±16 vs.,  $F=4.8$ ,  $p=.02$ , respectively). Discussion In line with the findings of Stefan et al. (2007), we found a diminished exercise effect at sub maximal performance level of untrained males with SNPs. The short-term response at these levels of >15% in WT was sufficient compared to other reports (Skinner et al., 2001) and could probably serve as trainability markers regarding to Vollaard et al. (2009). Although the power of our study is limited due to sample size and sex selection, our data indicate that the trainability of aerobic performance could be affected by gene variants. References Skinner JS, Jaskolski A, Jaskolska A, Krasnoff J, Gagnon J, Leon AS, et al. (2001). *J Appl Physiol*, 90, 1770-1776. Stefan N, Thamer C, Staiger H, Machiacao F, Machann J, Schick F, et al. (2007). *J Clin Endocrinol Metab*, 92, 1827-1833. Vollaard NBJ, Constantin-Teodosiu D, Fredriksson K, Rooyackers O, Jansson E, Greenhaff PL, et al. (2009). *J Appl Physiol*, 106, 1479-1486.

### EFFECTS OF ONE-WEEK INTRANASAL LHRH APPLICATION ON THE HYPOTHALAMIC-PITUITARY-GONADAL AXIS IN HEALTHY YOUNG MEN

Krusche, T., Thomas, A., Schrader, Y., Thevis, M., Platen, P.

Ruhr-Universität Bochum

Effects of one-week intranasal LHRH application on the hypothalamic-pituitary-gonadal axis (HPGA) in healthy young men Krusche T.1, Thomas A.2, Schrader Y.2, Thevis M.2, Platen P.1 1Department of Sports Medicine and Sports Nutrition, Faculty of Sport Science, Ruhr-University Bochum 2Center for Preventive Doping Research and Institute of Biochemistry, German Sport University Cologne Introduction The misuse of intranasal LHRH in elite sports has frequently been reported during the last years. The aim of this project was to analyse hormones of the HPGA in healthy young men in order to develop a detection method for the misuse of LHRH in routine doping controls. Methods 10 healthy moderately trained students (22.8±1.7 yrs, 179.6±6.0 cm, 77.6±7.0 kg) were investigated 2 days before (d-2) a 7 day-period of intranasal LHRH application (every 1.5 hrs from 7am-10pm [in total 4.4 mg/day]), as well as during the 1st (d1) and 7th (d7) day of intranasal LHRH, and 2 days after cessation of LHRH application (d+2). On these days, we analysed serum concentrations of LH, FSH, total testosterone (T) and free testosterone (fT) at 9am. At 11am external stimulability of HPGA was tested with an intravenous LHRH stimulation test. Serum concentrations of LH, FSH, T and fT were analysed before and 60 min after intravenous LHRH. Results Basal LH increased from d-2 to d1 during the intranasal LHRH application period ( $p<0.05$ ), tended to remain elevated on d7 ( $p=0.09$ ), and declined below the pre-application level on d+2 ( $p<0.01$ ) (5.1±2.5, 19.2±11.5, 8.3±2.4, 1.4±1.0 mU/ml, respectively). FSH remained unchanged over time (5.1±7.0, 8.6±11.9, 4.4±4.5, 2.7±3.0 mU/ml, respectively). T increased from d-2 to d1 ( $p<0.05$ ), tended to remain elevated on d7 ( $p=0.08$ ), and declined below the pre-application level on d+2 ( $p<0.01$ ) (5.5±2.1, 7.4±2.5, 9.2±3.8, 4.2±4.2 ng/ml, respectively). fT remained unchanged on d1 compared to d-2, increased significantly on d7 ( $p=0.01$ ), and declined far below the pre-application level on d+2 ( $p<0.01$ ) (10.6±3.2, 14.1±6.8, 16.3±5.8, 4.2±1.7 pg/ml, respectively). LH increase 60 min after intravenous LHRH declined from d-2 to d1 and d7 ( $p<0.01$ ) and normalized again on d+2 ( $p<0.01$ ) (19.0±9.6, 5.4±6.2, 3.6±2.1, 12.7±4.5 mU/ml, respectively). FSH, T, and fT after intravenous LHRH remained unchanged over time. Discussion The study showed that 7-day intranasal LHRH application dramatically affected pituitary LH release and consequently increased peripheral testosterone concentrations in healthy young men. Spontaneous pituitary LH secretion and consequently T and fT concentrations were reduced at least up to 2 days after cessation of intranasal LHRH application. Simultaneously, external stimulability of the pituitary gland was reduced during intranasal LHRH application and became normal again 2 days later. This pattern of hormones might be used to test for LHRH application during doping control settings. This project has been carried out with the support of WADA.

### THE INFLUENCE OF VITAMIN-D SUPPLEMENTATION ON THE EFFECT OF 12-WEEKS RESISTANCE TRAINING IN HEALTHY UNTRAINED YOUNG AND ELDERLY MEN

Agergaard, J., Tørstrup, J., Uth, J., Vestergaard, J., Boesen, A., Schjerling, P., Langberg, H.

Bispebjerg Hospital

Introduction: Recently studies have shown that increased serum vitamin D levels improve skeletal muscle function in vitamin D insufficient elderly. The purpose of this study was to investigate whether there is an additive effect of vitamin D supplementation on skeletal muscle strength, mass and morphology during resistance training in young and elderly men. Material and Methods: The study was conducted



from December to April in Copenhagen, Denmark, where sunlight is not having an effect on serum 25(OH)D levels. Healthy untrained young (N=20, age 22.8 ± 2.0) and elderly (N=20, age 67.3 ± 4.3) men were randomized to daily supplementary intake of either 48 µg of vitamin D + 800 mg calcium (Vitamin D) or 800 mg calcium alone (Placebo) for 16 weeks. During the last 12 weeks the subjects underwent progressive resistance training 3 times/week of m. quadriceps femoris (leg extensions and leg press). Pre and post 12 weeks training hypertrophy were measured by cross sectional area (CSA) from MRI-scans and isometric strength of m. quadriceps femoris. Moreover, from muscle biopsies taken pre and post 12 weeks training muscle fiber type morphology were analyzed. Results: Due to 16 weeks of vitamin D supplementation serum 25(OH)D levels increased in the young and elderly vitamin D groups, and were elevated compared to the young and elderly placebo group respectively. Twelve weeks of resistance training increased CSA and isometric muscle strength of m. quadriceps femoris in both the young and elderly men. However, there was no evidence for an additive effect of vitamin D supplementation on muscle strength or hypertrophy. Nevertheless, the muscle fiber types in the young vitamin D group showed an increase in type IIa fiber percentage and percentage area compared to the placebo group. Discussion: Twelve weeks of resistance training gave an increase in CSA and strength of m. quadriceps in young and elderly healthy untrained men. However, during resistance training vitamin D supplementation did not have an additive effect on improvements in skeletal muscle function or mass. Only the muscle fiber type morphology in the young vitamin D group showed an improved training response. Studies showing an effect of vitamin D have looked at frail vitamin D insufficient elderly without any training intervention, whereas this study was performed on vitamin D sufficient healthy individuals with progressive resistance exercise applied. Hence, in the present study any possible effect of vitamin D may be overridden by the effective training protocol. Clearly it may also be speculated that only insufficient vitamin D levels may have a negative impact on optimal skeletal muscle function and response.

08:00 - 09:30

## Oral presentations

### OP-PM27 Physiotherapy and Sports Medicine

#### PLATELET-RICH PLASMA TO TREAT UPPER PATELLAR TENDINOPATHIES

Kaux, J., Croisier, J.L., Simoni, P., Brabant, G., Lapraille, S., Lonnew, V., Noel, D., Rodriguez de la Cruz, C., Colette, J., Le Goff, C., Gothot, A., Crielaard, J.M.

*University of Liège*

Introduction: Tendinopathies, especially upper patellar tendinopathy also known as jumper's knee, often remain rebel to conservative treatments. Several experimental studies have shown the healing properties of platelet and their growth factors. These factors have the potentiality to improve healing of different tissues: bones, muscles, tendons... Researches have specifically demonstrated the platelets action as mediator and/or enhancer of tissue healing. On the other hand, such treatment has been totally removed of list of doping treatments. The aim of our study was to investigate the effect of 1 injection of PRP in patients suffering from chronic jumper's knee. Methods: Patients performed imaging (US and MRI) and functional assessments, and a clinical examination using an algometer, before treatment and 6 weeks after PRP treatment. They were also invited to answer to questionnaire relative to pain and functional status. PRP was obtained from autologous blood using an apheresis system (COM.TEC, Fresenius). The injection of 6mL of PRP was realised without local anaesthesia into the proximal insertion of the patellar tendon. A 48h rest-time was recommended after infiltration. Afterwards, a submaximal eccentric reeducation was initiated 1 week after infiltration 3 times a week during 5 weeks. In case of pain, anti-inflammatory drugs were prohibited and patient were encouraged to take class I or II painbrakers. Our protocol was approved by Ethic Committee of University and University Hospital of Liège. Results: Twenty patients with jumper's knee were included in our study. Pre-injection tests revealed pain of the upper part of the patellar tendon just below the patella, associated with loss of function. Imaging exams confirmed diagnosis. Six weeks post-injection, the clinical status was improved for the majority of the patients, with a significant decrease of algo-functional scores. The pain reported during functional assessments was decreased (in particular for the eccentric actions), yet no significant improvement of physical performances was observed. We found no significant differences between imaging exams before and 6 weeks after PRP injection. Conclusion: One in situ injection of PRP clinically improved patients with jumper's knee 6 weeks after treatment. Most patients reported a decrease of pain during day-life and through physical activities. However nor functional performances neither imaging were improved. A followup at 3 months is actually in process to evaluate more long term efficacy of PRP treatment.

#### EFFECT OF KINAESTHETIC TAPES ON PLANTARFLEXOR MUSCLE PERFORMANCE

Csapo, R., Herceg, M., Alegre, L., Crevenna, R., Pieber, K.

*Carinthia University of Applied Sciences*

Introduction Kinaesthetic tapes (KT) are frequently used in physiotherapy and sports medicine to improve circulation of blood and lymph flow, relieve pain through neurological suppression, or enhance proprioception by cutaneous stimulation of peripheral afferent nerves. In addition to these therapeutic objectives, it has been suggested that KT-application may enhance motoneuron activity, purportedly facilitating contraction and increasing muscle strength (Hammer, 2006). However, studies performed to validate the proposed performance-enhancing effects have yielded controversial results (Vithoulka et al., 2010; Fu et al., 2008). The purpose of this study was to examine the effects of application of KT on plantarflexor muscle performance in different motor tasks. We hypothesised that taping of the triceps surae muscle would improve isometric plantarflexor strength and muscular endurance with no significant effect on drop jump performance. Methods Using a repeated-measures design, all performance measures were obtained in 12 male (age: 24.9±4.0 yrs; height: 1.80±0.06 m; mass: 74.0±6.2 kg) and 12 female (age: 24.0±3.6 yrs; height: 1.67±0.04 m; mass: 61.1±5.9 kg) participants on two separate occasions: without tapes (NT) and after application of KT over the triceps surae muscle. Isometric plantarflexor strength was measured by Biodex dynamometry. During strength tests, integrated electromyographic activity (iEMG) was obtained from both heads of the gastrocnemius muscle. To determine muscular endurance, participants completed an isokinetic fatigue test (30 consecutive contractions at 180°/s). Drop jump performance (jump heights and ground contact times) was assessed in a series of jumps from different drop heights (20, 40 and 60 cm), analysing the vertical components of ground reaction forces. Results The KT-intervention was associated with a general increase in

gastrocnemius iEMG activity. However, significant increases in isometric strength were only found at fully dorsiflexed ankle positions (KT:  $155.2 \pm 42.0$  Nm vs NT:  $140.5 \pm 51.5$  Nm,  $p = 0.037$ ). Strength gains were negatively correlated to baseline strength ( $r = -0.58$ ,  $p = 0.003$ ). In the isokinetic fatigue and drop jump tests, no significant differences were observed between NT- and KT-conditions. Discussion The application of KT over the triceps surae muscle promotes an increase in isometric strength and gastrocnemius iEMG activity. Our data suggest that these effects are joint-angle dependent and more prominent in weaker individuals. By contrast, the KT-intervention does neither improve drop jump performance nor muscular endurance. References Fu, T., Wong, A., Pei, Y. et al. (2008). *J Sci Med Sport*, 11(2), 198-201. Hammer, W. (2006). *Functional soft-tissue examination and treatment by manual methods*. Jones and Bartlett, Boston. Vithoulka, I., Beneka, A., Malliou, P. et al. (2010). *Isokinet Exerc Sci*, 18(1), 1-6.

### THE EFFECT OF BLOOD-BORNE FACTORS ON HUMAN TENDON CELLS: COUNTERACTING TENDON HEALING?

Bayer, M.L., Schjerling, P., Heinemeier, K.M., Herchenhan, A., Krosgaard, M., Kjaer, M.

*Institute of Sports Medicine Copenhagen and Center for Healthy Aging*

**Introduction** The use of platelet-rich plasma (PRP) as treatment following tendon injuries has received substantial attention in the last few years, both due to frequent use and due to lack of scientific evidence for an effect on tendon regeneration (de Jonge et al., 2011; Paoloni et al., 2011). Both PRP and serum contain a high amount of several growth factors, especially transforming growth factor-beta1 (TGF-beta1), and we aimed to study the effect of serum supplementation and the isolated effect of TGF-beta1 on the expression of key tendon matrix genes by human tendon cells. **Methods** Cell cultures were established from mature human semitendinosus and gracilis tendon, and studied in both monolayer (2D) cultures and engineered 3D tendon-like tissue. Tendon cells were subjected to culture medium with or without serum supplementation ( $n=5$ ). The effect of TGF-beta1 was tested by adding the growth factor to the medium (25ng/ml,  $n=5$ ). Subsequently, mRNA expression was analyzed by quantitative real-time PCR. **Results** Serum supplementation caused a decrease in mRNA expression of collagen type III, XII, XIV and fibronectin (FN) ( $p<0.05$ ). Addition of TGF-beta1 to human tendon cells had a marked negative effect on the expression of collagen type XIV and decorin mRNA ( $p<0.01$ ), whereas it caused an upregulation of collagen V, FN and fibromodulin. Collagen I expression was not affected by either serum supplementation or TGF-beta1. **Discussion** The results suggest that a high concentration of blood-borne growth factors and of TGF-beta1 specifically, impairs the expression of several key tendon genes, among which the decreased expression of collagen type III, XII, XIV and decorin are prominent. As these molecules are important early regulators of collagen fibrillogenesis (Banos et al., 2008), the lack of any of these molecules leads to structurally and functionally inferior tissue (Ansoerge et al., 2009). These findings upon human tendon cells *in vitro* raise the possibility that PRP, which has a composition comparable to serum, could have a detrimental effect upon collagen fibrillogenesis associated with tendon healing. **References** Ansoerge HL, Meng X, Zhang G, Veit G, Sun M, Klement JF, Beason DP, Soslowky LJ, Koch M, Birk DE. (2009). *J Biol. Chem*, 27;284(13):8427-38. Banos CC, Thomas AH, Kuo CK. (2008). *Birth Defects Res C Embryo Today*, 84(3):228-44. de Jonge S, de Vos RJ, Weir A, van Schie HT, Bierma-Zeinstra SM, Verhaar JA, Weinans H, Tol JL. (2011). *Am J Sports Med*, 39(8):1623-9. Paoloni J, De Vos RJ, Hamilton B, Murrell GA, Orchard J. (2011). *Clin J Sport Med*, 21(1):37-45.

### MULTIMODAL PHYSIOTHERAPY IMPROVES OUTCOME BEYOND PLACEBO INJECTION BUT DOES NOT ALTER EFFECTS OF CORTICOSTEROID INJECTION FOR LATERAL EPICONDYLALGIA.

Coombes, B., Bisset, L., Brooks, P., Vicenzino, B.

*University of Queensland*

**Introduction** The short-term benefits of corticosteroid injection for treating lateral epicondylalgia (tennis elbow) must be weighed against evidence of poorer long-term success (Coombes, Bisset et al. 2009) and higher recurrence compared to wait and see or physiotherapy treatment using elbow manipulation and exercise (Bisset, Beller et al. 2006). Clinically, practitioners frequently emphasise the importance of an active rehabilitation program, with recent evidence suggesting that mechanical loading may counteract the potentially deleterious effect of corticosteroid treatment on fibroblasts (Chen, Marymont et al. 2007). We aimed to investigate if the lower long-term success and greater recurrence of corticosteroid injection (1) can be ameliorated by addition of a multimodal physiotherapy program of manipulation and exercise and (2) are not placebo in nature. **Methods** 165 patients with unilateral lateral epicondylalgia participated in an injection-blinded placebo controlled trial, randomly assigned to one of four groups: corticosteroid injection ( $n=43$ ), placebo injection ( $n=41$ ), corticosteroid injection plus physiotherapy ( $n=40$ ) or placebo injection plus physiotherapy ( $n=41$ ). Multimodal-physiotherapy involved eight sessions of elbow mobilisation, progressive resistance and sensorimotor exercise, supplemented with a home program. Evaluation of the addition of multimodal physiotherapy, as well as the placebo effect of injection on success and recurrence 12 months after treatment were analysed on an intention to treat basis ( $p<0.01$ ). Number needed to treat (NNT) and 99% CI were calculated as a clinically meaningful measure of effect size. **Results** Compared to placebo injection, injection supplemented with manipulation and exercise improved all outcomes in the short-term (Success: 4weeks NNT 3 (2 to 21); 8 weeks NNT 3 (2 to 17)). Addition of manipulation and exercise did not improve the long-term success of injection, nor improve the recurrence of injection, which was 42% higher with corticosteroid injection than placebo (NNT -2 (-4 to -4)). **Discussion** Addition of eight weeks of exercise and manipulation to corticosteroid injection does not ameliorate the medication-induced delayed recovery in patients with lateral epicondylalgia. Patients ought to be made aware that for every two patients that have a corticosteroid injection, one will experience a recurrence within 12 months, regardless of whether they receive physiotherapy. **References** Bisset, L., E. Beller, et al. (2006). *BMJ* 333(7575): 939. Chen, C. H., J. V. Marymont, et al. (2007). *Connect Tissue Res* 48(2): 65-9. Coombes, B. K., L. Bisset, et al. (2009). *J Sci Med Sport* 12(6): e79.

### AN AUDIT OF ROUTINE PRELIMINARY MEDICAL EVALUATION IN ATHLETES ATTENDING FOR LABORATORY BASED MAXIMAL EXERCISE TESTING

Mahony, N., Bailey, D.

*Trinity College Dublin*

**Introduction** Athletes attend the exercise laboratory to gauge fitness, individualise training prescription and monitor training effectiveness. Pre-exercise medical scrutiny based on standard guidelines (ACSM, 2002) is routinely performed in our laboratory despite uncertainty in the literature with regard to effectiveness and benefits of the process and outcomes (Wingfield et al., 2004). The aim of this study was to review medical findings, exclusions, restrictions, and recommendations made in preliminary medical evaluation procedures, in order to assess the value of the process and fulfil Irish Medical Council (IMC, 2011) requirement for audit of clinical practice **Methods** Preliminary medical questionnaire and examination results of athletes who attended the exercise laboratory between June 2010 and June 2011 are

currently being reviewed. Questionnaire consisted of; training, family, past medical, medications, menstrual, and immunisation history sections and systems review checklist. Examination consisted of resting pulse and blood pressure (Omron, Japan), head, neck, cardio-respiratory examination, and problems highlighted in the questionnaire. Further ancillary tests; pulmonary function (Micro-medical, UK) and full blood count (Coulter Electronics, UK) were performed to out-rule; airway limitation; and sub-clinical anaemia, dehydration, and infection. Anonymous medical findings and ancillary test data were recorded on a spread sheet for qualitative analysis. Results To date 132/210 records, (19F/113M) have undergone preliminary scrutiny and 20/210 records detailed analysis of ancillary pulmonary function and haematological data. Sports represented were; cycling, triathlon, running, rowing, sailing, and Gaelic games. Athletes were excluded from testing due to minor illness (4), athletic fatigue (2) and history of exercise related syncope (1); a further 6 athletes were restricted to sub-maximal testing due to age (>45yr), elevated DBP (102mmHg), family history of SADS and a previously undiscovered heart murmur. Main recommendations included; urgent cardiology opinion (1), routine ECG/Echocardiogram (8), iron studies (3), dietary analysis and iron supplementation (3), GP follow-up for minor illnesses (6), further rehabilitation of minor injuries (2), and DXA scan (1). No abnormal findings were found in menstrual history, physical examination and no previously unknown respiratory limitations were detected. In analysis of full blood count data 7 athletes had borderline low WCC, one athlete had iron deficiency anaemia and several had low MCH values. Discussion This study has shown that an abbreviated 10 minute pre-participation medical procedure can detect significant medical conditions relevant to both performance and health of the athlete; and in one case revealed episodes of exercise related syncope in a young tri-athlete that led to diagnosis of a serious cardiac conduction defect. References Wingfield et al. (2004) Clin J Sport Med 14, 109-122. Pre-participation Physical Examination, American College of Sports Medicine. 2002

**08:00 - 09:30**

## Invited symposia

### IS-SH06 Psychological and Sociological Perspectives on Prevention and Rehabilitation of Sport Injuries

#### METHODOLOGICAL CHALLENGES IN THE PREVENTION AND REHABILITATION OF SPORTS INJURY: A BEHAVIORAL PERSPECTIVE

Johnson, U.

*Halmstad University*

This presentation will discuss methodological challenges in the prevention and rehabilitation research of sports injury focusing on especially the psychological domain. During the last 30 years several scholastic studies have been published in the sport injury field using contemporary research designs and theoretical frameworks. Frequently used designs typically consist of cross-sectional studies based on one or two questionnaires and using samples of university (male) athletes. However, many important research variables need further recognition for the advancement of the field. For example, there is a need for strong and integrated research design, maybe stimulated by Bahr & Krosshaug (2005) "Model of injury causation", a need for prediction of overuse injuries, a need for controlled and experimental studies as well as studies of the stress response in relation to pre- and post-injuries. Moreover, the use of standardized measures and proper statistics as well as recognition of expectancy effects in intervention studies is challenging methodological concerns in order to advance the field (Johnson, 2007). One particularly challenging concern is to integrate latent growth curve modeling (LGCM) in both pre- and post-injury research. Using LGCM, in contrast to more traditional analyses when examining change and dynamic relationships across time, entails several advantages, such as increased power of tests of mean differences and the possibility to model change in latent factors and flexibility to study how the latent factors of level and change may predict other outcomes (Duncan et al., 2006). Further research examining prevention and rehabilitation of sports injury aiming at athlete is warranted. References: Bahr R., & Krosshaug, T. (2005). Understanding injury mechanisms: a key component of preventing injuries in sport. *British Journal of Sports and Medicine*, 39, 324-329. Duncan, T.E., Duncan, S.C., & Strycker, L.A. (2006). An Introduction to Latent Variable Growth Curve Modeling: Concepts, Issues, and Applications. Mahwah, NJ: Lawrence Erlbaum. Johnson, U. (2007). Psychosocial antecedents to sport injury, prevention and intervention: An overview on theoretical approaches and empirical findings. *International Journal of Sport and Exercise Psychology*, 5, 352-369.

#### ATHLETES RETURN TO SPORT FOLLOWING INJURY REHABILITATION: A PSYCHOSOCIAL PERSPECTIVE

Podlog, L.

*University of Utah*

This presentation will highlight sociological and psychological research examining athlete experiences in returning to sport following injury rehabilitation. In particular, the traditional wisdom that physical and psychological readiness to return-to-sport following injury are synonymous will be challenged by examining the key psychosocial issues facing returning athletes (Arden et al., 2011). In elucidating these issues, it will be suggested that a range of competence, autonomy, and relatedness based factors may exert a profound influence on athletes' return-to-sport outcomes (Podlog et al., 2011). Among the most commonly reported competence issues are re-injury anxieties, diminished confidence in return to play abilities, fitness concerns, and worries that one may not be skilled enough to maintain a position/role on the team. Internal and external pressures to return to sport indicate that autonomy issues may also be apparent (Charlesworth & Young, 2004). Finally, relatedness issues (i.e., connection to others) in terms of isolation from coaches, teammates, and training partners may occur as recovering athletes become removed from their usual training and competition venues and spend more time in rehabilitation settings. A lost sense of social identity and questions about one's value as a person without competitive involvement may also lead to feelings of disengagement from one's sport. Moreover, a lack of social support from coaches, teammates and significant others may heighten perceptions of a lack of relatedness with significant sporting others (Bianco, 2001). Collectively, these findings suggest that rehabilitation specialists, coaches, and teammates should address competence, autonomy, and relatedness issues in an attempt to enhance athlete return-to-sport outcomes. Further research examining the efficacy of interventions targeting athlete issues during the return-to-sport transition is warranted. References Arden, C.L., Webster, K. E., Taylor, N. F., & Feller, J.A. (2011). Return to sport following anterior cruciate ligament reconstruction surgery: A systematic review and meta-analysis of the state of play. *British Journal of Sports Medicine*, doi:10.1136/bjsm.2010.076364 Bianco, T. (2001). Social support and recovery from sport injury: elite skiers share their experiences. *Research Quarterly for Exercise and Sport*, 72, 376-388. Charlesworth, H., & Young, K. (2004). Why English female

university athletes play with pain: motivations and rationalizations. In K. Young (Ed.), *Sporting bodies, damaged selves: Sociological studies of sports-related injury* (pp. 163-180). Oxford, UK: Elsevier. Podlog, L., Dimmock, J., & Miller, J. (2011). A review of return to sport concerns following injury rehabilitation: Practitioner strategies for enhancing recovery outcomes. *Physical Therapy in Sport*, 12, 43-48.

### **SPORTS INJURY PREVENTION: A PSYCHOLOGICAL INTERVENTION PROGRAM FOCUSING FLOORBALL**

Tranaeus, U., Johnson, U.

*Karolinska Institute/Halmstad university*

Sports injury prevention: a psychological intervention program focusing floorball. Tranaeus, U., 1, 2, Johnson, U., 2. 1: Karolinska Institutet (Stockholm, Sweden), 2: Halmstad University (Halmstad, Sweden). Sports injuries are an obstacle in most athletes' strive to achieve their goals. It is of importance to develop rehabilitation programmes and safe return to sport; also preventive intervention programmes are required. The aetiology of sports injuries shows multi-facetted natures. The results of psychological studies shows evidence that psychosocial factors affect the injury-risk exist (e.g. Johnson, 2011). One theoretical framework to intervention programme is Williams and Andersen's stress-injury model (1998). The model provides psychosocial factors which are activated by the athletes' cognitive and somatic stress-response. Over the years, psychological preventive intervention programmes have been evaluated, aiming to reduce the number of injuries through stress- management (e.g. Johnson et al., 2005). In our recently conducted study, the overall aim was to reduce the stress-response through a psycho-educational intervention and consequently lower the number of injuries. Out of the 22 participating Swedish elite male and female floorball teams, 10 teams were randomized to a preventive intervention programme. This programme was implemented during the first half of the season and consisted of six hour-long sessions with one whole team at a time, based on goal-setting, stress management, concentration, relaxation, self-confidence and emotions. The program was constructed to meet the cognitive and somatic reactions of stress. All sustained injuries were recorded at the start of the study and registered as they occurred during the eight months season's. The intervention-group sustained less injuries compared to the control-group. Reports of past and present research will be given at the seminar. References Johnson, U., Ekengren, J., & Andersen, M., B. (2005). Injury prevention in Sweden. Helping soccer players at risk. *Journal of Sport & Exercise Psychology*, 27, 32- 38. Johnson, U. (2011). Athletes' experiences of psychosocial risk factors preceding injury, *Qualitative Research in Sport, Exercise and Health*, 3, 99-115. Williams, J. M., & Andersen, M. B. (1998). Psychosocial antecedents of sport injury: Review and critique of the stress and injury model. *Journal of Applied Sport Psychology*, 10, 5-25.

**08:00 - 09:30**

### **Invited symposia**

#### **IS-BN10 Tendon Plasticity: Neuromechanics and Motor Output**

---

##### **EFFECTS OF AGE AND TRAINING ON TENDON STIFFNESS AND FAST FORCE PRODUCTION**

Blazevich, A.

*Edith Cowan University*

Tendons are elastic elements that transfer muscular forces to bones. As intermediaries between muscles and bones, their mechanical characteristics significantly impact on movement performance. In addition to promoting energy savings during tasks such as locomotion, tendon mechanical properties, in particular tendon stiffness, influence the rate at which forces are transferred from muscles to bones (i.e. electromechanical delay and rate of force development). This is because energy transferred by a muscle must travel in a wave-like manner through the tendon to reach the bone, and the rate of wave propagation is influenced by tendon stiffness, amongst other parameters. Tendon stiffness must therefore influence fast force production during athletic tasks as well as during postural stabilisation and balance tasks. There is considerable evidence that tendon stiffness is highly changeable. Chronic changes in both loading and unloading (i.e. changes in physical activity patterns) influence tendon stiffness, and tendon stiffness has been shown to increase through the lifespan from childhood to adulthood and then decrease in later life. What is not clear is whether age-related changes in tendon stiffness reflect a true aging response or are a result of age-related changes in loading patterns (i.e. exercise). Recent research hints that both may be factors in the development of tendon stiffness from childhood to adulthood, as indicated by both changes in tendon cross-sectional area and Young's modulus and by moderate correlations between tendon stiffness and age, body mass and peak muscle force. Although modelling studies suggest that changes in tendon stiffness should have a dramatic impact on movement performance, empirical testing has rarely been done to ascertain whether changes in tendon stiffness of the magnitude that occur with aging or physical activity (or inactivity) are sufficient to have a noticeable functional impact. In particular it is not clear whether such changes have a meaningful effect on the rate of force transfer from muscle to bone. Recent evidence from studies in children suggests that the impact is noticeable, but small. Specifically, the data suggest that changes in tendon stiffness from early childhood through to adulthood have a notable impact on rate of force development and electromechanical delay. However, significant (>30%) increases in tendon stiffness resulting from strength training probably has only a minor effect. Whether these small effects influence complex movement performance is still unclear.

##### **TENDON ADAPTATIONS TO OVERLOADING AS MEASURED IN VIVO: WHERE DOES THE DISCREPANCY COME FROM?**

Seynnes, O.R.

*Norwegian School of Sport Sciences*

Tendons' essential role during locomotion and movement relates to the tradeoff between enabling accurate positioning of the limb and the storage and restitution of elastic energy. The study of this role and how it might be affected with increased loading largely relies on i) precise methods to estimate tendon mechanical properties and ii) a comprehensive understanding of the adaptation process. Currently these properties can be estimated non invasively, in vivo, by obtaining the force-elongation relationship with combined ultrasonography and dynamometry. Using this technique, training studies generally indicate an increase in tendon tensile stiffness (1). Yet, partly owing to

methodological aspects, large differences between studies can be found in the magnitude of changes, ranging 15% to over 60%. Furthermore, increases in modulus or cross-sectional area (CSA) underlying tendon stiffening have not been consistently observed, preventing a clear understanding of this type of adaptation. The increase in tendon stiffness in response to overloading is usually ascribed to an increase in collagen content and in cross-linking of collagen molecules. These metabolic responses would in turn cause an increase in tendon Young's modulus and CSA. Intriguingly, animal studies suggest that tendon modulus is relatively independent from function, species or body mass, whereas damage resistance to prolonged stress correlates well with habitual stress (2, 3). In view of these observations, some authors have proposed the safety factor (ratio of failure stress to habitual stress), rather than modulus, as the essential property driving tendon adaptation and 'self-repair' as a central feature of this process (2). Although the precise mechanisms underlying tendon adaptation remain elusive, it seems that, in conditions of long term adaptations, adjustments in tensile stiffness are mostly achieved by changes in tendon dimensions, contrasting with reports of increased tensile modulus in human tendons subjected to overloading. Here we will propose a review of the technical considerations influencing in vivo measurements of tendon structural and mechanical changes to overloading. In a second part, current concepts of tendon adaptations and a possible model will be discussed. 1. Heinemeier KM, Kjaer M. Journal of musculoskeletal & neuronal interactions 11: 115-23, 2011. 2. Ker RF, Wang XT, Pike AV. The Journal of experimental biology 203: 1317-1327, 2000. 3. Pollock CM, Shadwick RE. The American journal of physiology 266: R1016-21, 1994.

## TENDON PLASTICITY IN NORMAL, EXERCISED AND PATHOLOGICAL TENDON

Legerlotz, K., Screen, H.R.C., Riley, G.P.

*University of East Anglia*

**Introduction** Biological materials such as tendons must adapt their mechanical properties and matrix composition in order to remain functional. While loading is known to be required for tendon tissue homeostasis, overloading has been implicated as a contributing factor in the initiation of tendinopathies. The aim of our study was to investigate how defined loading or overloading regimes influence mechanical properties and gene expression in normal tendon fascicles from different tendons, and to analyse gene expression in pathological tendon tissue, with a particular focus on the inflammatory cytokine Interleukin 6 (IL6). **Methods** Tendon fascicles were isolated from 3 tendons: bovine foot flexor and extensor, or human hamstrings tendons. Fascicles were secured in custom made loading chambers (1) and subjected to a variety of different loading conditions, from no load to heavy loading, with different durations of static and cyclic strain. Loading was followed by either mechanical testing or gene expression analysis by qRT-PCR. Also, gene expression in human tendon samples from normal, ruptured or painful tendinopathic Achilles tendon (AT) and normal or painful tendinopathic posterior tibialis tendon (PTT) were analysed by qRT-PCR. **Results** IL6 gene expression was induced with loading in both bovine and human tendon tissue. Although the mechanical properties of bovine flexor and extensor tendons were different, with the extensor tendon failing at higher strain levels, there was no difference in the gene expression response to cyclic loading. In human hamstrings fascicles, the IL6 loading response was induced early, peaking at 3h of static strain. Only very low levels of strain were needed to induce IL6 expression relative to levels in freshly dissected tissue. Unloading also induced IL6 expression and to a greater extent than loading. Compared to normal tendon IL6 expression was upregulated in ruptured and painful AT (180- and 6.3-fold), but not in painful PTT. **Discussion** We have shown that IL6 gene expression is upregulated in different tendons with loading, and that only low levels of strain are needed to induce this response. Since IL6 is known to stimulate the synthesis of collagen, the main component of tendon matrix, IL6 might play an important role in tendon adaptation to exercise. However, we found IL6 also to be upregulated with unloading and pathological conditions of the AT also, suggesting that IL6 could also be involved in either the development of tendinopathies or the healing response. It remains to be established whether the difference in gene expression between pathological AT and PTT is due to differences in loading, tendon structure or composition or reflects a difference in the type, progression or healing of tendinopathy. **References** (1) Legerlotz et al. (2011). Scand J Med Sci Sports [Epub]

**08:00 - 09:30**

## Oral presentations

### OP-BN06 Biomechanics

#### THE INFLUENCE OF HIP ANGLE ON DORSIFLEXION RANGE OF MOTION, PASSIVE ANKLE MOMENT AND NEUROMUSCULAR REFLEX ACTIVITY OF THE TRICEPS SURAE

Kay, A.D., Warren, L.A., Hammond, L.E.

*The University of Northampton*

**Introduction** Adopting a slumped position in the spine stretches the neuromeningeal tract, which is a common method to identify signs of neural tension including a pain response and limited range of motion (ROM) at the hip and knee (Boland & Adams, 2000). However, this phenomenon has not been examined at the ankle; therefore, the aims of the present study were to examine whether hip position, likely to illicit neural tension, would influence ankle dorsiflexion ROM, passive moment and electromyographic muscle activity of the triceps surae. **Methods** Eighteen recreationally active participants (10 men and 8 women: mean  $\pm$  SD age = 28.6  $\pm$  6.3 yr, mass = 73.3  $\pm$  12.9 kg, height = 1.7  $\pm$  0.1 m) volunteered for the study after giving written, informed consent, with ethical approval from the University of Northampton. Passive dorsiflexion ROM trials were performed on an isokinetic dynamometer across three hip positions (supine = 10°; semi-reclined = 55°; upright = 85°). Dynamometry data measuring dorsiflexion ROM and passive ankle moment were recorded during the trials with electromyographic (EMG) activity of the triceps surae also recorded; simultaneous 3D motion analysis also measured ROM. Separate repeated measures ANOVA's with post-hoc analysis determined the location of any significant differences between conditions; significance accepted at  $p < 0.05$ . **Results** Significant differences were detected in dorsiflexion ROM ( $p < 0.01$ ), passive moment ( $p < 0.05$ ) and EMG (Sol, GM) ( $p < 0.01$ ) between hip flexion conditions. Post-hoc analyses revealed no difference between supine and semi-reclined hip positions in any measure, while the upright position had significantly lower dorsiflexion ROM, significantly lower passive moment but significantly higher EMG activity at peak ROM than both supine and semi-reclined conditions. Paired analyses between dynamometry and motion analysis ROM data revealed dynamometry significantly ( $p < 0.01$ ) overestimated ROM in each condition although this did not explain the differences across hip conditions. **Discussion** Despite the reduction in dorsiflexion ROM in the upright position there was a

significant increase in EMG activity. As ROM was reduced it is unlikely that this was a stretch-reflex response from type Ia muscle afferents but may be the result of type IV nociceptors. The reduction in dorsiflexion ROM clearly has implications for dynamometry testing protocols and subject positioning when examining ankle kinematics and mechanics. Similarly, the motion analysis data also revealed that dynamometry analysis overestimated ROM, with significantly greater overestimation in the two reclined positions due to increased heel displacement from the dynamometer footplate. References Boland R, Adams R. (2000). *Aust J Physiother*, 46, 191-200.

### THE RATE OF FASCICLE STRETCH DURING ECCENTRIC EXERCISE AFFECT THE LONGITUDINAL ADAPTATION OF THE VASTUS LATERALIS MUSCLE

Sharifnezhad, A., Marzilger, R., Arampatzis, A.  
*Humboldt Universität zu Berlin*

**Introduction:** The longitudinal plasticity of muscle is a well-known phenomenon in the literature (Williams & Goldspink 1978). Butterfield & Herzog (2006) reported that the best predictors for a longitudinal adaptation in rabbit tibialis anterior muscle were the maximal moment and the amount of fiber strain. In humans there is little information about the effect of controlled eccentric loading on the longitudinal adaptation of muscles. The purpose of this study was to investigate the effect of magnitude and velocity of the applied eccentric stimulus on the longitudinal adaptation of the vastus lateralis muscle. **Methods:** We applied four different eccentric exercise protocols on two experimental groups. The first group (n=10) exercised the knee extensors of one leg (protocol 1) at 65% of the maximum voluntary contraction (MVC) and the second leg (protocol 2) at 100% MVC on a dynamometer. The angular velocity of the eccentric contractions was 90°/s and the range of motion from 25° to 100° knee angle in both protocols. The second group (n=10) exercised one leg at 100% MVC, 90°/s angular velocity and a range of motion between 25° and 65° (protocol 3). The other leg exercised at 100% MVC, 240°/s angular velocity and range of motion between 25° and 100° (protocol 4). The control group included 11 participants. In the pre-post measurements we examined the fascicle length of the vastus lateralis from 20° to 90° knee angle and the moment-angle relationship of the knee extensors. **Results:** We found an increase ( $p < 0.05$ ) in fascicle length of vastus lateralis compared to the control group only in the leg trained with the protocol 4. The increase in fascicle length was similar (~14%) for the whole range of the knee angle. During the training in protocol 4 the rate of fascicle strain of the vastus lateralis were ~3.3 times higher compared to the other three protocols. Furthermore the high strain velocity of the fascicles has been located in the phase where the moment decreased. The moment-angle relationship of the knee extensors has been improved in all protocols with a superior improvement in protocol 2. **Discussion:** Exercise protocol 4 was the only one that showed clear longitudinal changes in fascicle length. The findings give evidence that (a) not every eccentric exercise causes an increase in fascicle length and (b) the velocity of fascicle stretch seems to be important for the longitudinal adaptation. A rapid decrease of moment during the eccentric exercise may affect the rate and probably the magnitude of fascicle strain, due to the catapult effect of the tendon. **References:** Butterfield & Herzog (2006). *Pflügers Arch Eur J Phys*, 451, 688-700. Williams & Goldspink (1978). *J. Anat.* 127, 459-468.

### MUSCLE AND TENDON CROSS-SECTIONAL AREA AND VERTICAL STIFFNESS IN HOPPING

Eriksrud, O., Ekeberg, M., Federolf, P., Bojsen-Møller, J., Cabri, J., Raastad, T.  
*Norwegian School of Sport Sciences*

**Introduction** The vertical stiffness of the locomotor system during running or hopping is regulated by the tension in the muscle-tendon systems crossing the ankle, knee and hip joints. This tension is controlled by neuromuscular activation, however, it may also be influenced by the mechanical properties of the muscles or tendons. This study investigated if muscle and tendon cross-sectional area contribute to the bilateral or unilateral vertical stiffness in hopping. **Methods** Seventeen athletes from different disciplines (8 power lifters, 7 distance runners, 3 high jumpers) were tested in bilateral and unilateral hopping for 15 seconds on a floor-mounted force plate (AMTI). The average vertical stiffness of 10 consecutive hopping cycles was determined according to Morin et al. (2005). The cross-sectional area of anterior and posterior thigh and leg muscles and of the patellar and Achilles tendon were obtained from MRI images. **Results** Bilateral stiffness ( $20.7 \pm 4.5 \text{ kN}\cdot\text{m}^{-1}$ ) was significantly greater than unilateral vertical stiffness ( $12.9 \pm 4.0$  and  $12.1 \pm 2.6 \text{ kN}\cdot\text{m}^{-1}$ ,  $p < 0.05$ ). The dominant leg was 6.6% stiffer than the non-dominant leg, however, this difference was not significant ( $p > 0.05$ ). No significant correlations were found between bilateral and unilateral stiffness and cross-sectional area of the thigh and leg muscles or patellar and Achilles tendon. **Discussion** The vertical stiffness measure in hopping reflects the overall function of the musculoskeletal system of the lower extremity where ankle (Farley and Morgenroth, 1999) and knee joint stiffness (Hobara H et al., 2009) have been found to be important. Cross-sectional area of muscles and tendons crossing these joints reflect force generation capacity, however this was not found to be correlated to vertical stiffness in this study. **References** Morin JB et al. (2005). *J Appl Biomech*, 21, 167-180. Farley CT, Morgenroth DC (1999). *J Biomech*, 32, 267-273. Hobara H et al. (2009). *J Biomech*, 42, 1768-1771.

### POSTURAL LEANING DIRECTION CHALLENGES THE MANIFESTATION OF THE TONIC VIBRATION REFLEX RESPONSE

Amiridis, I., Kanakis, I., Arvanitaki, C., Patikas, D., Hatzitaki, V.  
*Aristotle University of Thessaloniki*

**Introduction** The application of Tendon Vibration (TV) during standing leads to a postural shift in the direction of the applied vibration (Kavounoudias et al., 1999). Nevertheless, the vibration induced muscle tension regulation cannot fully account for the observed postural changes suggesting that the processing of proprioceptive input depends on the degree of instability of a particular task (Radhakrishnan et al., 2011). In this study, we hypothesized that the effect of TV on body posture and ankle muscle activation is dependent on a) the direction of instability induced by leaning and b) the active state-loading of the muscle. **Methods** Twenty young adults stood over the midline of two adjacent force platforms (Bertec, USA) in a) bipedal stance distributing Body Weight (BW) equally (50%) between the two platforms, b) forward and backward leaning by transferring 80% of BW in the front and back platform respectively. To maintain the required leaning position for 60s, subjects received on-line visual feedback of BW distribution matched to a target line into a large screen projector (Barco NV, Belgium). In each position, tendon vibration (frequency 80Hz, amplitude 1.5-1.8 mm, Technoconcept, France) was carefully applied during the middle 20 s over the Achilles Tendon (AT), the Tibialis Anterior Tendon (TAT) or both tendons (BOTH). **Results** TV resulted in a significant postural shift (deviation from the target) towards the vibration side and an increase of the Standard Deviation (SD) of the resultant BW distribution during as well as in the post vibration period. A significant Vibration x Inclination interaction indicates that these effects were diminished during forward leaning but were greater during backward leaning. The AT vibration resulted in a significant increase of MGAS and SOL EMG activity that was greater during mid stance and backward leaning but lesser during forward leaning. Similarly, TAT

vibration increased TAis EMG only in the backward leaning position, while this reflex response was attenuated in the mid stance and forward leaning positions. Discussion The greater postural fluctuations during TV application are due to an increase in reflex activity at the ankle. The effect of TV is modulated by the direction of postural leaning being inhibited during forward and facilitated during backward leaning. On the other hand this does not seem to be dependent on the degree of active state-loading of the muscle. The present results favor the hypothesis of higher order processing of proprioceptive signals arising from the ankle muscles. References Kavounoudias A, Gilhodes JC, Roll R, Roll JP (1999). *Exp Brain Res*, 124, 80-88. Radhakrishnan SM, Hatzitaki V, Patikas D, Amiridis IG (2011). *Exp Brain Res*, 213, 423-433.

## LOWER LIMB INTERNAL KINETICS AND EMG IN INTERNATIONAL RACE WALKERS

Hanley, B., Bissas, A.

*Leeds Metropolitan University*

Introduction Race walking is an Olympic event with rules which state that no visible loss of contact should occur and that the knee must be straightened from initial contact until the vertical upright position. Little research has been carried out on lower limb muscle activity in race walking despite such information being potentially useful to coaches and athletes. The aim of this study was to analyse lower limb joint moments, powers and electromyography patterns in elite race walking. Methods Twenty international race walkers performed multiple trials at their season's best pace in a laboratory setting. The group consisted of ten men (stature: 1.79 m ( $\pm$  0.06); mass: 67.0 kg ( $\pm$  9.4)) and ten women (stature: 1.69 m ( $\pm$  0.05); mass: 53.9 kg ( $\pm$  5.6)). Ground reaction forces (Kistler, Winterthur) were recorded of the contact phases of both legs (1000 Hz). Recordings of these kinetic data were synchronised with both 2D high-speed videography (100 Hz) (RedLake, San Diego) and electromyography of seven lower limb muscles (1000 Hz) (DelSys, Boston). The video data were digitised (SIMI, Munich) and de Leva's (1996) body segment parameter model was applied. Joint moments and powers were calculated from the force and video data using a link segment rigid body model (Winter, 2005). Results The ankle plantarflexors were one of the main contributors to forward momentum. This was due to an eccentric contraction of the triceps surae during midstance which aided a large concentric contraction during late stance in developing forward propulsion. The other main contributors were the hip extensors (gluteus maximum and biceps femoris) during late swing and early stance. The knee joint was hyperextended for 66% ( $\pm$  14) of the stance phase which resulted in predominantly eccentric or isometric contractions in the muscles surrounding the knee during stance. The knee muscles also underwent eccentric contractions during both early and late swing phases, with a particularly large magnitude of negative power in the knee flexors prior to initial contact ( $6.3 \pm 1.0$  W/kg). Discussion During stance, the hip forcefully extended at initial contact and the ankle powerfully plantarflexed prior to toe-off to maintain and generate forward momentum. The race walking rule which requires the knee to be extended during the first half of stance meant the knee muscles underwent little energy absorption or generation during stance. Rather, the leg functioned as a rigid lever which increased the importance of the hip and ankle joints. Because of the restricted motion of the stance knee the importance of the swing leg was increased. Training regimens which develop the strength of the key muscle groups are recommended. References De Leva P. (1996). *J Biomech*, 29(9), 1223-1230. Winter DA. (2005). *Biomechanics and Motor Control of Human Movement*, 86-96. John Wiley & Sons, Hoboken.

**08:00 - 09:30**

## Oral presentations

### OP-PM28 Training and Testing: Elite Athletes

#### SWIM START PERFORMANCES AT THE TURKISH NATIONAL CHAMPIONSHIPS

GUMUS, M., AKALIN, T.C.

*Zonguldak Karaelmas University*

Introduction The start in swimming, together with the other elements of the race, is very important for achieving better results in championships. Start times were shown to consist of between 0.8% and 26.1% of the overall race time depending on the event. Getting a good (lucky)-start, or psyching your opponents out of a quick-start, can make all the difference it takes to get a world record or Olympic medal. The purpose of our study was to evaluate of starting reaction time of Turkish swimmers participated to 2011 Turkish National Championships. Methods In this study, 1738 official competition times of 313 swimmers (157 female, 156 male) who participated in 2011 Turkish National Championships. Competition was performed in 50 m indoor swimming pool by permission of Turkish Swimming Federation and the data of starting reaction time -the duration between the starting signal and when the feet leave the block- measurements were obtained by SWISS TIMING (OMEGA) that is official partner of FINA. Data were evaluated by using SPSS for Windows 16.0 software and mean values were represented as "arithmetic mean $\pm$ standard deviation". ANOVA test, student t test, posthoc bonferroni test and pearson correlation analysis were used for the comparisons between the measurements. Results of analysis were evaluated with 95% confidence interval. Results Participation in the competition all the swimmers an average starting reaction time (SRT) was  $0.78 \pm 0.09$ s. SRT was  $0.80 \pm 0.09$ s for female,  $0.76 \pm 0.08$ s for male and there was a significant difference between groups ( $p=0.001$ ). SRT was  $0.80 \pm 0.09$ s for youth,  $0.77 \pm 0.09$ s for junior,  $0.76 \pm 0.07$ s for senior and there was a negative and significantly correlation between SRT and age groups ( $r=-0.217$ ,  $p=0.001$ ). There was a positive and significantly correlation between SRT and race distance (short distance:  $0.76 \pm 0.08$ , long distance:  $0.81 \pm 0.09$ ) ( $r=0.186$ ,  $p=0.001$ ). In championship, there was a significantly difference between semi-final categories by SRT ( $p=0.001$ ) and SRT was  $0.79 \pm 0.09$ s for elimination races,  $0.77 \pm 0.09$ s for semi-finals and  $0.79 \pm 0.09$ s for finals. There was a positive and significantly correlation between SRT and rankings, the first three best placed athletes  $0.76 \pm 0.09$  and the others  $0.78 \pm 0.09$ s. Discussion In the men's 50 m freestyle final in the Sydney Olympic Games, there was only 0.05s separating 1st and 3rd places and in the same event at the 2003 World Championships, 0.52s separated 1st and 8th place. In 50 and 100 m swimming races, performance has been strongly linked to start performance. These values are laid down on the Turkish population in the coming years, and the races are very important in order to allow comparison. References Lytle, A. & Benjanuvatra, N. (2004). Access on 01.03.2012 under [http://coachesinfo.com/index.php?option=com\\_content&view=article&id=89:swimming-start-style&catid=49:swimming-coaching&Itemid=86](http://coachesinfo.com/index.php?option=com_content&view=article&id=89:swimming-start-style&catid=49:swimming-coaching&Itemid=86).

**ALTERATIONS OF PHYSICAL PERFORMANCE IN ELITE MALE HANDBALL PLAYERS DURING A SEASON**

Póvoas, S.1,2, Ascensao, A.3,5, Magalhaes, J.3,5, Seabra, A.4,5, Oliveira, E.2, Soares, J.4,5, Rebelo, A.4,5

*Maia Institute of Higher Education; Faculty of Sport, University of Porto*

ALTERATIONS OF PHYSICAL PERFORMANCE IN ELITE MALE HANDBALL PLAYERS DURING A SEASON Póvoas, S.1,2, Ascensão, A.3,5, Magalhães, J.3,5, Seabra, A.4,5, Oliveira, E.2, Soares, J.4,5, Rebelo, A.4,5 1: Research Center in Sports, Health Sciences and Human Development, 2: Maia Institute of Higher Education (Maia, Portugal), 3: Research Centre in Physical Activity, Health and Leisure, 4: Centre of Research, Education, Innovation and Intervention in Sport, 5: Faculty of Sport, University of Porto (Porto, Portugal) Introduction Handball is an intermittent sport that implies specific endurance and high-intensity physical performance demands (Póvoas et al., 2012). To cope with these demands during an entire competitive season, handball players are submitted to training and competition sets, which may induce variations in physical performance levels. We therefore aimed to analyse the effects of training and competition during an entire season on elite male handball players' anthropometric and physical profile. Methods Sixty-three players from six teams of the Portuguese Handball Professional Male League were evaluated three time points throughout the season (pre-season (T0), pre-competitive period (T1) and competitive period (T2)). The players performed the Yo-Yo Intermittent Endurance Test-level 2 (YYIE2), the countermovement (CMJ) and squat jumps, a straight sprint test (5 and 20 m), a sprint test with changes of direction (COD), and the running-based anaerobic sprint test (RAST) (for ref.'s see Póvoas et al., 2012). Results Significant increases were observed in YYIE2 and jump performance from T0 to T1 time points, although CMJ height decreased in T2 ( $p \leq 0.05$ ). There were no significant changes in the anthropometric profile as well as in straight sprint performance throughout the season. Nevertheless, COD performance increased in T2 and also in T1 when compared to T0 ( $p \leq 0.05$ ). RAST-related fatigue index decreased in T2 when compared to T0 ( $p < 0.05$ ). Discussion Our results show that training and competition induced alterations in physical capacities evaluated during a season, which is in accordance with other studies (Gorostiaga et al., 2006; Hakkinen, 1988). Training sessions and competitive matches favourably modulated specific endurance, repeated sprint and power-related abilities throughout the season, with the exception of CMJ. The specific pattern of handball movements and actions require particular neuromuscular demands also targeting positive influences on COD throughout the season, an agility-related test closely related to the ability to perform acceleration-deceleration movements, which in turn are associated to eccentric muscle contractions. References Gorostiaga, E. et al. (2006). *Med Sci Sports Exerc.* 38(2), 357-366. Hakkinen, K. (1988). *J Human Movement Studies*, 15, 119-128. Póvoas, S. et al. (2012). *Strength Cond Res*, doi: 10.1519/JSC.0b013e318248aeae.

**PHYSICAL DEMANDS IN ELITE TEAM HANDBALL: COMPARISONS BETWEEN MALE AND FEMALE PLAYERS**

Michalsik, L.B.1, Aagaard, P.2, Madsen, K.1

*1: Aarhus University, Aarhus, Denmark 2: University of Southern Denmark, Odense, Denmark*

Introduction In elite Team Handball, the physical capacity of the players has a crucial influence on playing performance. The central areas of physical training seem in general to be the same for male and female players, however physical demands may yet vary among the sexes. Therefore, the present study examined possible differences in physical demands between male and female elite TH players, which were closely monitored over a six and five season time span, respectively. Methods Each player was evaluated during match-play using video recording and subsequent computerized locomotive and technical match analysis. Further, physiological measurements during match-play, physical testing and anthropometric measurements were also carried out. Results Women ( $n=83$ ) performed a longer mean total distance covered (TDC) per match ( $4002 \pm 551$  m) (group means  $\pm$  SD) compared to men ( $n=83$ ) ( $3627 \pm 568$  m,  $p < 0.05$ ) despite less mean total effective playing time (TPT) ( $50.70 \pm 5.83$  min vs.  $53.85 \pm 5.87$  min). Women spent substantial less time standing still ( $10.8 \pm 3.8$  % of TPT per match) compared to men ( $36.9 \pm 8.6$  %,  $p < 0.001$ ) and worked with a greater mean relative physical load (RWL,  $79.4 \pm 6.4$  % of  $VO_2$ -max) than men ( $70.9 \pm 6.0$  % of  $VO_2$ -max,  $p < 0.05$ ). Women performed less amount of high-intensity running per match ( $2.6 \pm 1.8$  % of TDC) compared to men ( $7.9 \pm 4.9$  %,  $p < 0.01$ ) and also had markedly fewer number of activity changes ( $663.6 \pm 100.1$ ) than men ( $1482.4 \pm 312.6$ ,  $p < 0.001$ ). Men performed a higher number of high-intense playing actions per match ( $36.9 \pm 13.1$ ) than women ( $28.3 \pm 11.0$ ,  $p < 0.05$ ). In offence, men received more tackles ( $34.5 \pm 11.2$ ) and gave more tackles ( $29.9 \pm 8.2$ ) while in defence compared to women ( $14.6 \pm 5.7$ ,  $20.7 \pm 6.1$ ,  $p < 0.05$ ). Mean body height and body mass in the Danish Premier Team Handball League was significantly higher for men ( $189.6 \pm 5.8$  cm,  $91.7 \pm 7.5$  kg) compared to women ( $175.4 \pm 6.1$  cm,  $69.5 \pm 6.5$  kg,  $p < 0.001$ ). Identical positional differences in the physical demands were demonstrated irrespectively of gender, with wing players performing more high-intensity running and less physical confrontations than backcourt players and pivots ( $p < 0.01$ ). Conclusions In conclusion, substantial gender-specific differences in the physical demands were observed, where male elite TH players performed more high intense, strength-related actions and more high-intensity running than female elite TH players. Conversely, female players covered a greater total distance and worked with a higher RWL than their male counterparts. Consequently, female players should therefore focus relative more on aerobic training and relative less on anaerobic training and strength training. In both genders, wing players performed more high-intensity running and less physical confrontations than all other players. The planning of the physical training in both sexes should be directed at the specific playing position and the players' individual physical capacity.

**REPETITIVE SPRINT ABILITY IN ELITE ICE HOCKEY PLAYERS**

Tschopp, M.

*Swiss Federal Institute of Sports Magglingen*

Repetitive sprint ability in elite ice hockey players Tschopp, M1, Zryd, A2, Gassmann, N2, Bolszak, S2, Reinhard, A1 1: Swiss Federal Institute of Sports (Magglingen, Switzerland); 2: Swiss Ice Hockey Association (Zürich, Switzerland) Introduction: The repetitive sprint ability (RSA) is an important physical factor for ice hockey players (Noonan, 2010). However, there exists no validated test analyzing RSA in ice hockey players that mimics the actual work to recovery ratio of the game. The aim of the present study was twofold: 1) to explore whether an on-ice repetitive sprint test with a hockey-specific work to recovery ratio is able to discriminate between hockey players of different performance levels; and 2) to evaluate the relationship between the hockey-specific RSA, and aerobic and anaerobic fitness. Methods: 12 professional elite ice hockey players (PROF;  $25.4 \pm 2.4$  J.;  $90.1 \pm 5.9$  kg;  $184.6 \pm 4.1$  cm), and 15 non-professional elite ice hockey players (N-PROF;  $23.9 \pm 4.4$  J.;  $84.4 \pm 8.5$  kg;  $181.1 \pm 5.5$  cm) completed a repetitive shuttle sprint test (RISST) with full equipment on ice. The test includes 3 series of 4 all-out sprints with a  $180^\circ$  turn ( $2 \times 15$  m). Every 20 seconds, the players would begin the next sprint. Between the series, there was a 4 minute recovery period of 3 minutes. Within 3-7 days after the RISST the participants performed a  $VO_2$ max-test on a cycle ergometer, a Wingate-Test (WINGATE) and a jump test on a force plate (JUMP) in the laboratory. For statistical analysis, Cohen's effect size (ES), unpaired t-Test and Pearson's correlation coefficient were used ( $p < 0.05$ , \*). Results: Significant differences between PROF and N-PROF



were found for total sprint time (PROF 43.98±1.19 vs. N-PROF 44.99±1.08sec; ES 0.89, p=0.03), and for the sprint time of the second (ES 1.09, p=0.01) and third RISS series (ES 0.78, p=0.05). No relevant difference was found for the best RISS sprint time (3.40±0.11 vs. 3.43±0.10sec, ES 0.29). Only moderate to small ES were obtained in the laboratory tests with the smallest difference between PROF and N-PROF in VO2max (57.8±4.2 vs. 56.7±6.4ml/ kg min; ES 0.21; WINGATE Mean Power: ES 0.66; JUMP Peak Power: ES 0.73). Total RISS sprint time moderately correlated with WINGATE Mean Power (r=0.54\*) and JUMP Peak Power (r=0.55\*). VO2max significantly correlated with the decrement of the sprint time between series (r= - 0.50\*) but not with RISS total sprint time (r=0.38). Discussion: The RSA measured with a repeated shuttle sprint test on-ice with a hockey-specific work to recovery ratio is able to discriminate between ice hockey players of different performance levels to a greater extent than a single shuttle sprint or classic laboratory fitness tests. The hockey-specific RSA shows associations with anaerobic performance and anaerobic capacity. VO2max seems to have its importance in the ability to recover between series. References: 1. Noonan, B. (2010). *J Strength Cond*, 24(9), 2290–2295.

## QUANTIFICATION OF TACKLING DEMANDS IN ELITE AUSTRALIAN FOOTBALL USING INTEGRATED WEARABLE ATHLETE TECHNOLOGY

Gastin, P.1, Breed, R.2, McLean, O.1, Spittle, M.1

*Deakin University*

Introduction Australian football (AF) allows considerable physical contact between players and tackling is considered an important performance indicator in the sport. Despite increases in the speed of the game (Wisbey et al., 2010), the frequency of collisions and the number of shoulder and soft tissue injuries in AF (Orchard & Seward, 2010), no data is available to describe the nature and impact forces associated with tackling. This study categorised tackles into low, medium and high intensity using video technology as a criterion measure and then described and compared speed and accelerometer data between tackle groups. Methods Data was collected from twenty professional AF players during four in-season games. All tackles made by the player and those against the player were coded and time stamped at the point of contact (Sportscode v8.4, Sportstec, Australia) and then categorised into low, medium and high intensity impact groups based on defined criteria before further analysis of the data. Peak and mean GPS and accelerometer data (MinimaxX S4, Catapult Innovations, Australia) were collected at the point of contact and during a 3 s tackle zone (from 1 s before to 2 s after impact), respectively. Two-way analysis of variance was used to assess differences (p < 0.05) between tackle type (made and against) and tackle intensity. Results A total of 173 tackles made (low = 68, medium = 100, high = 5) and 179 tackles against (low = 47, medium = 118, high = 14) were recorded, with an average of 88 tackles per game and 7 tackles per player per game. No significant differences were observed between tackles made and against. Significant differences were found between all tackle intensity groups for peak and mean accelerometer g force (forwards, sideways, upwards and their resultant [3D load]) and velocity data. Peak velocity was significantly greater in high (mean ± SD; 18.2 ± 4.8 km/h) compared to medium (13.9 ± 5.3 km/h) and low intensity (10.1 ± 3.3 km/h) tackles. Peak 3D load was significantly greater in high (7.8 ± 1.3 g) compared to medium (4.9 ± 1.4 g) and low intensity (4.1 ± 1.3 g) tackles. Discussion High intensity tackles, although less frequent in AF, are significantly greater in speed of movement at contact and in the force of impact compared to tackles of lower intensity. Differences in accelerometer forces between tackles observed to be progressively greater in intensity suggest a level of environmental validity and provide preliminary support for the use of accelerometers to assess player load in field team sports. References Orchard A, Seward D. (2011). 2010 Injury Report - Australian Football League, 1-25. Wisbey B. et al. (2010) *J Sci Med Sport* 13(5): p. 531-536.

08:00 - 09:30

## Oral presentations

### OP-PM29 Molecular Physiology

#### EFFECT OF RUNNING INTENSITY ON EXPRESSION OF MICRORNA-124 AND NRSF/REST IN THE HIPPOCAMPUS OF ADULT MALE RATS

Mojtahedi, Sh.1, Kordi, M.2, Soleimani, M.3, Hosseini, S.4, Fallah Omran, S.5, Shabkhiz, F.6

*Faculty of Physical Education and Sport Sciences, University of Tehran.1,2,5,6. Faculty of Medical Science, Tarbiat Modares University.3, The Islamic Azad University - Sabzevar Branch.4*

Introduction Sets of combinatorially expressed Transcription factors (TFs) and microRNAs precisely delineate individual cell types (Conaco et al., 2006). Recently has been shown that these elements play a crucial role in major cellular processes such as development and differentiation through post-transcriptional regulation. There is some evidence that miR-124 and NRSF/REST are involved in regulation of the transition from progenitor to mature neuron (Cheng et al., 2009). Our goal was examine the effect of the intensity of treadmill running on expression of miR-124 and REST in the hippocampus of adult male rat. Methods 18 adult male vistar rats following 1 week of familiarization with treadmill were randomly divided into three groups of control(n=6) and runner(n=6). In low intensity group (n=6), animals daily, were allowed to run on treadmill at a speed of 11 m/mni for 30 minutes, for 2 weeks. In high intensity group(n=6) the subjects were ran in the same conditions but at a speed of 25m/min. After 24 hours of the last session of exercise, the animals were sacrificed and the hippocampus of both side of hemisphere rapidly dissected out on ice cold PBS and flash frozen in -70 °C until processing for RNA purification. Changes in expression analyzed using the quantitative RT-PCR technique(Livak and Schmittgen., 2001 ). Results One way analysis of variance (ANOVA) and least significant difference (LSD) post hoc tests showed significant differences for expression of miR-124 between low intensity group and high intensity group related to control group (p≤0.05 ) so expression of miR-124was elevated in both of groups.Also observed significant reduced for expression of REST between low intensity group and high intensity group related to control group (p≤0.05)The elevation and reduction in high intensity group were more vigorous than the low intensity group. Discussion Expression of miR-124 and REST, in the hippocampus of adult rats, is associated with exercise intensity and running in higher intensity in comparison with lower intensity, leads to robust changes in some mechanisms that involve in exercise- induced neurogenesis. References Cheng L, Pastrana E, Tavazoie M, Doetsch D, (2009). miR-124 regulates adult neurogenesis in the subventricular zone stem cell niche. *Nature neuroscience*, 12(4):399-408. Conaco, C., Otto, S., Han, J. J., & Mandel, G, (2006). Reciprocal actions of REST and a microRNA

promote neuronal identity. Proceedings of the National Academy of Sciences of the United States of America, 103, 2422–2427. Livak KJ, Schmittgen TD. Analysis of relative gene expression data using real-time quantitative PCR and the  $2^{-\Delta\Delta Ct}$  method. Methods 2001; 25:402–408.

### CAPN2 MEDIATED BREAKDOWN AND DISASSEMBLY OF MYOFIBRIL-CYTOSKELETAL PROTEIN COMPLEXES WITH EXERCISE

Belcastro, A.

*York University*

Angelo N. Belcastro<sup>1,2</sup>, Chad G. Ball<sup>1</sup> and Tracie Albisser<sup>1</sup>. School of Human Kinetics<sup>1</sup>, University of British Columbia, Vancouver, B.C., Canada, V6T 2B5 and School of Kinesiology and Health Science<sup>2</sup> and Muscle Health Research Centre, York University, Toronto, On, Canada, M3J 1P3. Introduction Several reports associating skeletal muscle exercise damage with increased calcium and calpain (CAPN2) activity exist; however evidence quantifying protein modifications and subsequent release from myofibril-cytoskeletal (MY-CY) complexes at rest and following exercise are scarce. The purpose of this study was to test the hypothesis that exercise will increase the rate of breakdown and release (i.e., disassembly mediated by CAPN2) of selected MY-CY proteins (i.e., desmin,  $\alpha$ -actinin, tropomyosin (TM) and myosin-binding protein C (MyBP-c)). Methods Rats were assigned to a control (n=8) and run exercise (n=8) group (25m/min; -160 grade). Following exercise purified MY-CY complexes (plantaris muscles) were subjected to proteolysis with purified CAPN2 (1.5U/40ug). The amount of protein remaining (% of total) was quantified at 30, 60, 300, 900 and 1800 seconds of proteolysis for desmin,  $\alpha$ -actinin, TM and MyBP-c normalized to actin. As well estimates of first order exponential rate constants (k) were measured. All parameters were tested using student t-test and/or ANOVA (SPSS) at a p=0.05. Results Rats ran for 45±4 minutes with a 2-fold increase in plasma creatine kinase activity (p<0.05) and 50-70% reduction in muscle glycogen (p<0.05). MY-CY protein yield was lower after exercise (65±5 vs 59±6 mg/g); as were the relative amounts of desmin (↓81%),  $\alpha$ -actinin (↓33%), TM (↓7%) and MyBP-c (↓13%). Following 30 minutes of CAPN2 digest the amount of desmin,  $\alpha$ -actinin, TM and MyBP-c remaining in MY-CY from control were 0%, 51%, 14% and 38%, respectively; the amount of protein remaining in exercise samples for each protein were 0%, 46%, 11% and 32% (p>0.05). Exponential rate constants (k) estimated for control and exercise showed that desmin (fastest) > TM > MyBP-c >  $\alpha$ -actinin (slowest) (p<0.05). Exercise was associated with an increase in k for  $\alpha$ -actinin (0.35 vs 0.52) and MyBP-c (0.97 vs 1.41) (p<0.05), with minimal differences for desmin and TM (p>0.05). Discussion The results support the hypothesis that there are selective proteolytic rates (k) and an order sequence of MY-CY protein breakdown. That a constant amount of CAPN2 activity is associated with different rates of proteolysis during exercise, points to the need to assess factors contributing to the heterogeneity of protein breakdown. Susceptibility of MY-CY proteins to CAPN2 degradation (k values) revealed that spatial arrangements and/or protein modifications, but not protein size, are implicated with exercise response. Supported by NSERC Canada

### AEROBIC TRAINING IN URBAN AND RURAL ENVIRONMENT: EFFECTS ON BRAIN-DERIVED NEUROTROPHIC FACTOR, INFLAMMATORY MARKERS AND COGNITION.

Bos, I.1,2, Vanparijs, J.1, De Boever, P.2,3, Pattyn, N.4, Int Panis, L.2,5, Meeusen, R.1

1, 4: *Vrije Universiteit Brussel (Brussels, Belgium)*; 2: *Flemish Institute for Technological Research (VITO) (Mol, Belgium)*; 3, 5: *Hasselt University (Diepenbeek, Belgium)*

Introduction: Particulate Matter (PM) exposure is linked to inflammation and cognitive decline (Calderón-Garcidueñas et al., 2011), while aerobic training improves cognition (Masley et al., 2009). It was found that Brain-Derived Neurotrophic Factor (BDNF) is a key mediator of the mechanism (Vaynman et al., 2004). Previously, the exercise-induced increase in BDNF serum level was not present after cycling near a busy road (Bos et al., 2011). The aim is to investigate effects of PM exposure during aerobic training on inflammatory biomarkers, BDNF in serum and cognitive performance. Methods: Two groups of inactive volunteers completed an aerobic training program of 12 weeks, 3 sessions/week, one group (n = 15) in an urban, another group (n = 9) in a rural environment. Ultrafine Particle (UFP) concentrations were measured during each training session. Before and after the program fitness levels (Cooper test), BDNF serum levels, blood leukocyte count, exhaled NO (eNO) and cognitive performance (Stroop task, Operation Span, Psychomotor Vigilance Task) were analyzed. Results: UFP concentrations were significantly higher in urban compared to rural environment (p = 0.003). Fitness levels improved (p < 0.0001) in both groups equally (p = 0.16). Leukocyte count (p = 0.022), and eNO (p = 0.003) increased after training in the urban group, whereas eNO (p = 0.85) and leukocyte count (p = 0.47) did not differ in the rural group. Reaction times in the Stroop task improved after training in a rural environment (p = 0.001), but not after training in urban environment (p = 0.58). No effects were found on BDNF levels, Operation Span and Psychomotor Vigilance test performances. Discussion: Aerobic training in urban environment with high traffic - related air pollution increased inflammatory biomarkers and, in contrast to aerobic training in rural environment, cognition did not improve. References Calderón-Garcidueñas L, Engle R, Mora-Tiscareño A, Styner M, Gómez-Garza G, Zhu H, Jewells V, Torres-Jardón R, Romero L, Monroy-Acosta ME, Bryant C, González-González LO, Medina-Cortina H, D'Angiulli A. (2011). Brain Cogn, 77(3), 345-355. Masley S, Roetzheim R, Gualtieri T. (2009). J Clin Psychol Med Settings 16(2), 186-193. Vaynman S, Ying Z, Gomez-Pinilla F. (2004). Eur J Neurosci, 20(10), 2580-2590.

### FLOOD-PRIMED CONTINUOUS TRACER INFUSION ALLOWS APPLICATION OF A SINGLE BIOPSY APPROACH FOR DETERMINATION OF MUSCLE PROTEIN FRACTIONAL SYNTHESIS RATE

Reitelseder, S., Dideriksen, K.J., Nielsen, R.H., Holm, L.

*Institute of Sports Medicine Copenhagen*

Introduction Muscle protein fractional synthesis rates (FSR) are measured by administering an amino acid stable isotope tracer as a primed continuous intravenous infusion. The prime serves to immediately obtain the target enrichment in the circulating pool of free tracee. Followed by a continuous infusion, time (e.g. 90 min) has to elapse for enrichment equilibration between circulating and intracellular compartments. Calculations of FSR rely on collection of muscle proteins at two distinct time points during the infusion period. Delta abundance of incorporated tracer is divided by an appropriate precursor's enrichment and the incorporation time. To shorten the time for tracer equilibration in all free tracee pools, the flooding approach has been introduced and validated. However, the flooding protocol allows only a limited tracer incorporation time. The single-biopsy protocol has also been introduced with the primed continuous infusion protocol, which, however, challenges some assumptions underlying the FSR calculations. Unsatisfied with these protocols, we aimed to create a flood-primed continuous tracer infusion protocol that allowed use of a single-biopsy approach and a prolonged incorporation

time. Methods Protocol I: 7 young males were given flood-primed (8.96 mmol, enriched 12.5% tracer/tracee ratio (TTR)) continuous (8  $\mu\text{mol}\cdot\text{kg LBM}^{-1}\cdot\text{h}^{-1}$ ) infusions of L-[ring- $^{13}\text{C}_6$ ]PHE, and muscle biopsies were obtained after 10, 30, 60, 120, and 360 min. Protocol II: To investigate if the PHE flood-prime affected the FSR, 5 other young males were given primed (9  $\mu\text{mol/kg LBM}$ ) continuous (9  $\mu\text{mol}\cdot\text{kg LBM}^{-1}\cdot\text{h}^{-1}$ ) infusions of L-[1,2- $^{13}\text{C}_2$ ]LEU from 0 to 480 min. After 120 and 300 min muscle biopsies were obtained to determine FSR. Hereafter, PHE flood-primed of 9.09 mmol, enriched 7% TTR with L-[15N]PHE was given followed by continuous infusions (8  $\mu\text{mol}\cdot\text{kg LBM}^{-1}\cdot\text{h}^{-1}$ ) of unlabeled PHE to mimic protocol I. A third muscle biopsy was obtained at 480 min to determine FSR during 3 h following the flood-prime. Results Protocol I: At 10, 30, 60, 120, and 360 min muscle free PHE enrichment were  $6.98\pm 0.70\%$ ,  $6.87\pm 0.71\%$ ,  $6.42\pm 0.58\%$ ,  $6.58\pm 0.70\%$ , and  $6.23\pm 0.81\%$  TTR, respectively. Protocol II: Myofibrillar FSR was  $0.079\pm 0.006\%$  /h and was unaffected by the PHE flood-primed continuous infusion ( $0.068\pm 0.009\%$  /h,  $p>0.05$ ). Discussion The flood-prime quickly introduced the PHE tracer into the intramuscular pools and secured the essential assumptions for the application of the single-biopsy approach in combination with the use of the continuous infusion approach, and, importantly, PHE administration did not affect muscle FSR.

### THE EFFECTS OF DIET RESTRICTION AND TREADMILL RUNNING EXERCISE ON EXPRESSION OF MCP-1 AND OXIDATIVE STRESS MRNA OF EPIDIDYMAL ADIPOSE TISSUE IN OBESE MICE

Ahn, N.

*Keimyung University*

THE EFFECTS OF DIET RESTRICTION AND TREADMILL RUNNING EXERCISE ON EXPRESSION OF MCP-1 AND OXIDATIVE STRESS mRNA OF EPIDIDYMAL ADIPOSE TISSUE IN OBESE MICE Ahn, N.1, Kim, K.1, Ko, J.1, Byun, J.1, Park, K.1, Kim, H.2, Chang, I.3 1: KMU (Daegu, Korea), 2: KMC (Daegu, Korea), 3: CUD (Daegu, Korea) Introduction Monocyte chemoattractant protein (MCP)-1 chemotactically recruits monocytes to sites of inflammation. This protein is traditionally thought to be expressed mainly by endothelial cells and macrophages (Zhu et al., 2008). However, it has recently been shown to be primarily expressed by adipose tissues. Therefore, this study analyzed the expression of MCP-1, HIF-1 $\alpha$ , NOX2, ERK1&2, and Mn-SOD mRNA of WAT induced high-fat diet obese mice. Methods Subjects were 44 four-week-old C57BL/6 mice. Obesity is induced using a high-fat diet (45% fat) for five weeks. And this study examined the effects of diet restriction and treadmill running exercise for eight weeks on the changes of MCP-1 and oxidative stress mRNA in epididymal adipose tissue. Results A high-fat diet for 13 weeks, HFD-DR group showed a significant higher ( $p<0.001$ ) expression MCP-1 mRNA than ND group and HFD group. After treadmill exercise and diet restriction, HFD-DR group showed a significant higher ( $p<0.01$ ) expression MCP-1 mRNA than Non-EX group and Ex group. And Ex group showed a significant lower ( $p<0.05$ ) expression HIF-1 $\alpha$  mRNA than Non-Ex group. Also, Non-Ex-HFD-DR group showed a significant lower ( $p<0.05$ ) expression NOX mRNA than Non-Ex-HFD group. And Ex-HFD-DR group showed a significant lower ( $p<0.01$ ) expression ERK2 mRNA than Non-Ex-HFD-DR group. Discussion This study shows that treated by exercise have a significant decrease in HIF-1 $\alpha$  and ERK2 mRNA. Especially, MCP-1 mRNA showed a significant decrease in exercise and diet restriction. Antioxidant effects and improvement of hypoxia through exercise can significantly reduce the expression of MCP-1 in WAT (Sakurai et al., 2009). It could be suggested the positive effects of exercise training on obesity by the changes of MCP-1 mRNA expression and oxidative stress. References Sakurai T, Izawa T, Kizaki T, Ogasawara J, Shirato K, Imaizumi K, et al. (2009). *Biochem Biophys Res Commun*, 379(2), 605-609. Zhu J, Yong W, Wu X, Yu Y, lv J, Liu C, et al. (2008). *Biochem and Biophys Res Commun*, 369, 471-477.

09:50 - 11:20

## Invited symposia

### IS-PM03 Sports Nutrition Symposium: Sports Nutrition offered by Mother Earth sponsored by GSSI

#### BERRIES AND CHERRIES

Bowtell, J.

*Exeter University*

Cherries and berries and other fruits and vegetables are rich in a variety of phytochemicals such as flavonoids and anthocyanins. These biologically active compounds may underpin the reductions in clinical condition and mortality risk associated with fruit and vegetable consumption that is evident from epidemiological studies. For instance, the health benefits associated with consumption of the Mediterranean diet may at least in part rely upon the flavonoid content of dietary components such as olive oil, red wine, and tomatoes. Many of the phytochemicals including flavonoids and flavonols are vasoactive inducing vasodilatation via a nitric oxide dependent mechanism, and epidemiological evidence suggests that high dietary anthocyanin intakes reduce the relative risk for hypertension. Cherries, in particular sour or montmorency cherries, which are rich in anthocyanins also possess antioxidant and anti-inflammatory properties. Consumption of montmorency cherry juice prior to and following intensive exercise has consistently been shown to enhance the acute recovery of muscle function most likely through reduced oxidative damage and inflammation. Similar evidence is also emerging for other fruits and berries such as blueberries and pomegranate. The usefulness of chronic supplementation to support training adaptation, however, remains uncertain; although evidence from rodent studies is tantalisingly positive. Phytochemicals provided by Mother Earth offer great potential as key nutraceuticals of the future.

#### GREEN TEA

Hodgson, A.

*University of Birmingham*

Green tea (GT) is made from the leaves of the *Camellia sinensis* L plant which is rich in polyphenol catechins and caffeine. For some time now there has been an increasing interest in the capacity of GT to oxidise fats and promote weight loss which in turn may improve body composition, health and exercise performance. As a result, GT has become a popular dietary supplement on the sports nutrition market, especially as a fat burner and weight loss tool. Long term GT intake, in some but not all cases, has been shown to promote weight loss. It is believed that the anti-obesity effects of GTE intake may be attributed to elevated fat oxidation and total energy expenditure. In support

of this, it has been shown that in a number of cases, GT intake (short term and long term) at rest and during exercise may increase energy expenditure and fat oxidation. Although several studies have observed positive effects the literature is inconclusive. The precise dose, duration of intake, and population that elicit maximal effects are currently unknown. In addition the bioavailability of GT catechins in vivo and the subsequent bioactivity is less well understood. In humans, the bioavailability of GT following intake determines the bioactivity. GT catechins (parent compounds) are extensively metabolised (conjugated compounds) in the gut and liver, poorly absorbed and are found in low concentrations in vivo. The emergence of -omic technology is a new technique that can identify the interaction between the metabolic effects of GT and the association to the specific GT catechins following ingestion in vivo. This firstly will advance our understanding of GT bioavailability and bioactivity, but also provide support and comparison to the putative in vitro mechanisms. At present the precise mechanisms of GT and site of action are unclear. However the mechanisms behind the effects of long term GT may be different than those that explain the short term effects of GT. Short term intake of GT is thought to inhibit catechol-O-methyltransferase (COMT) in vitro, while caffeine is thought to inhibit phosphodiesterase (PDE) in vitro. Both of these mechanisms may act synergistically to increase lipolysis. Alternatively long term GT intake may involve changes in expression of specific fat metabolism genes, which have been supported only by animal data. Both mechanisms lack the use of GT catechin compounds and concentrations similar to what is observed in vivo as well as supporting human studies. Therefore the mechanisms of GT remain speculative. While GT may offer promising benefits to body composition, health and exercise performance, the lack of consistent evidence means that practical application of GT intake is currently not possible. Despite this, GT supplements are frequently used.

## BEETROOT AND OTHER SOURCES OF NITRATE

Jones, A.

*Exeter University*

Recent studies have addressed the influence of dietary nitrate supplementation on the physiological responses to exercise. We have shown that enhancing nitric oxide (NO) bioavailability through supplementation of the diet with nitrate-rich beetroot juice reduces resting blood pressure and the O<sub>2</sub> cost of exercise and improves exercise performance. Specifically, we found that 4-6 days of nitrate supplementation (0.5 L of beetroot juice per day containing ~ 6 mmol nitrate) reduced the steady-state O<sub>2</sub> cost of sub-maximal cycle exercise by 5% and extended the time-to-exhaustion during high-intensity cycling by 16%. These effects were highly surprising given that the O<sub>2</sub> cost of sub-maximal exercise has been considered to be essentially fixed. We and others have subsequently confirmed these findings in other populations and with different exercise modalities. The positive effects of nitrate supplementation on the O<sub>2</sub> cost of sub-maximal exercise can be manifest acutely (i.e. 2.5 h following ingestion) and this effect can be maintained for at least 15 days if supplementation is continued. Because beetroot juice contains compounds other than nitrate that might also be bioactive, we have developed a nitrate-depleted beetroot juice as a placebo. We found that nitrate-depleted juice had no physiological effects relative to a control condition whereas nitrate-rich beetroot juice reduced the O<sub>2</sub> cost of both walking and running and extended the time-to-exhaustion by 15%. These results confirm that nitrate is the key bioactive component of beetroot juice, though it cannot be discounted that other components (such as antioxidants and polyphenols) facilitate the bioconversion of nitrate to NO. Most recently, we and others have investigated the influence of acute dietary nitrate supplementation on time trial (TT) performance in competitive cyclists. These studies have shown a 1-2% reduction in the time to complete TT distances between 4 and 16 km. The dose of nitrate that has been shown to improve exercise efficiency can readily be achieved through the consumption of 0.5 L of beetroot juice (or an equivalent high-nitrate foodstuff). Following a 5-6 mmol bolus of nitrate, plasma [nitrite] typically peaks within 2-3 h and remains elevated for a further 6-9 h before declining towards baseline. Therefore, it is recommended that nitrate is consumed approximately 3 h prior to competition or training. A daily dose of a high-nitrate supplement is required if plasma [nitrite] is to remain elevated. It is presently unclear how sustained dietary nitrate supplementation might impact upon adaptations to training. There is the possibility that uncontrolled high doses of nitrate salts might be harmful to health. In contrast, natural sources of nitrate are likely to promote health. For this reason, it is recommended that athletes wishing to explore possible ergogenic effects of nitrate supplementation employ a natural, rather than pharmacological, approach.

**09:50 - 11:20**

## Oral presentations

### OP-SH06 Sociology

#### HEALTHY AGING: THE IMPORTANCE OF PLACE AND SPACE

Volkwein-Caplan, K.

*West Chester University of Pennsylvania*

In this presentation the relationship between culture and successful aging will be explored. Theories of aging have proposed that there is a dynamic relationship between the physical and social environment and the quality of the aging experience. The average life expectancy in Western societies is currently 76; one hundred years ago it was 49. One of the most serious economic considerations facing the world in the 21st century is how to cover the cost of health care for an increasing older adult population. Aging is not only a biological phenomena, it is also socially and culturally constructed. Age norms and expectations influence the ways in which later life is lived. Social integration and physical activity are two of the most important factors determining health and well being in later adulthood. Older adults who are able to stay active and maintain their sense of connection with their community have been shown to experience fewer chronic illnesses, experience less unhappiness, dissatisfaction, isolation, anxiety, and depression. Physical activity not only improves and heals the body, but it also influences psychological well-being in later life. Despite the strength of this relationship, only a small percentage of older adults engage in regular exercise. Clearly there are ethnic, social class, and gender differences in physical activity. As the number of older men and women continues to grow, it becomes increasingly important to address health related behaviors such as physical activity and to focus on life styles factors which affect older adults' health and happiness. Drawing from extensive cross-cultural studies conducted in Germany and the USA, the ways in which the social and physical environment can enhance well being and happiness for older men and women will be discussed.

### UNDERSTANDING INTER-INDIVIDUAL PROCESSES IN LOW THRESHOLD 'COMMUNITY' SPORTING CONTEXTS. AN ANALYSIS OF FLEMISH INITIATIVES

Schaillée, H., Theeboom, M.

*Vrije Universiteit Brussel*

Introduction At present, adolescents can engage in a number of sporting contexts, such as: traditional sports clubs, low threshold 'community' contexts (De Knop et al., 1996) and specific 'sport-plus' contexts (Coalter, 2010). It has been indicated that mere participation in sports does not automatically produce developmental experiences, as this largely will depend on how sports programs are delivered (Petitpas et al., 2005). It has been argued that inter-individual processes would directly influence how individuals experience a specific setting, and is therefore critical in order to improve setting outcomes (e.g., developmental experiences, social-psychological outcomes) (Tseng & Seidman, 2007). A study was set up to gain a better understanding of inter-individual processes within several Flemish low-threshold 'community' sporting contexts. Methods A qualitative methodological approach was used for the analysis of three broad dimensions (sport type, relationships, norms), hypothesized to influence inter-individual processes. The three dimensions evolved from several reflections in a number of social sciences. In order to examine these broad dimensions within several Flemish low-threshold 'community' sporting contexts, various setting level-features such as: aims, approaches, and personal experiences of both teachers and co-ordinators were analyzed. Results The analysis allowed more insight with regard to inter-individual processes in several Flemish low thresholds 'community' sporting contexts. Furthermore, results revealed different profiles for the three broad dimensions (sport type, relationships, and norms), which might facilitate different developmental experiences among the youth involved. Discussion The findings have helped to identify key areas for further investigation and intervention, and have contributed to the growing and much needed body of research with regard to inter-individual processes within sporting contexts. We assume that several dimensions might be in a dynamic transition with each other, resulting in specific developmental experiences among the individuals involved. Further research should focus on the impact of inter-individual processes on their sport participants. References Coalter, F. (2007). A wider social role for sport: Who's keeping the score? London: Routledge. De Knop P, Engstrom L, Skirstad B, Weiss M (1996). Worldwide trends in youth sport. Champaign, IL: Human Kinetics. Petitpas A, Cornelius A, Van Raalte J, Jones T (2005). The Sport Psychol. 19, 63-80. Tseng V, Seidman E (2007). Am J Community Psychol, 39, 217-228.

### LOVE & HATE. CONSTRUCTING A NARRATIVE

Aage, R.

*Malmö University*

The purpose of this article is to interpret and analyse the concept of football hooliganism as presented in print media and digital media. As a case study I have used an event that occurred during a football match between two men's football teams in the Swedish Allsvenskan. I have analysed the coverage of this event in order to problematise the issue of who is allowed to distinguish between good football culture and hooliganism. Previous studies of old media coverage of hooliganism shows that journalism stigmatises the perpetrators, creates an atmosphere of panic and simplifies the underlying causes. One issue explored in this article is possible differences between descriptions of the event in the old and new media. Some researchers claim that the media landscape has been totally transformed by the new media, and that society is moving into a new, digital age. Others disagree, arguing that the term "new media" is inaccurate, since "new media" are still governed by the same financial, political and cultural forces as the "old media". In order to analyse the media narratives around the event I have used different theoretical approaches. Key words: Sportsmedia, hooliganism, oldmedia, newmedia, masculinity.

### LOST IN THE DESERT WITHOUT A COMPASS: METHODOLOGICAL CHALLENGES OF A NON-MUSLIM/NON-ARAB 'DOING' PHYSICAL ACTIVITY RESEARCH IN THE MIDDLE EAST

Knez, K.

*ASPETAR-Qatar Orthopaedic and Sports Medicine Hospital*

The last decade has seen a resurgence of literature focusing on sport, ethnicity and race, with a small yet growing number of researchers focusing specifically on the intersections of culture and religion. At the same time, there has been an increased focus on the importance of reflexive practice within the social sciences, with a call for researchers to question and deconstruct the authority of the 'author' and power differences within interviews and fieldwork. The anticipated outcome of this reflexive practice is that hidden agendas, values and power differences will be brought to the foreground, allowing the researcher to account for that which shapes the research process. The current author has previously 'engaged' in reflexive practice when conducting research among minority groups within a western context, however it was not until working as a minority in both a foreign country and foreign culture that the real complexity behind reflexive research became salient. This was particularly evident when questions arose surrounding different ways of knowing and ways of living, especially when these did not always align with dominant western belief systems surrounding gender, physical activity and to a lesser extent, social theory. Although anthropologists and ethnographers have been negotiating the challenges of working within different cultures for some time, it is only recently that this has been addressed within the field of sport and physical activity/education (see for example Dowling & Flintoff, 2011). The current paper will therefore provide a critique of reflexive practice as it has been conducted within the physical activity/education and sport literature to date, and re-position this critique within the context of Doha, Qatar. In doing so, the practical challenges of conducting qualitative physical activity research in a country and culture that is vastly different to the researcher's will be explored, and possible solutions or 'ways forward' highlighted. Dowling F, Flintoff A (2011). Qualitative Research in Sport, Exercise and Health, 3(1) 63-79.

### THE PERCEPTION OF MAGHRIBIAN IMMIGRANT ASSOCIATIONS IN CATALONIA ON THE PARTICIPATION OF THE MUSLIM MAGHRIBIAN WOMAN IN PHYSICAL ACTIVITIES

Nasri, K., Soler, S.

*Inefc - Barcelona*

Catalonia is one of the Spanish communities that welcomes more Maghribian population. According to IdesCat data (2010), more than 243,109 Maghribians (Morocco, Algeria and Tunisia) are living in Catalonia, and the 41.72 % are women. In spite of this, among other immigrant women, Muslim Maghribian women (MMW) in Catalonia are characterized by the limited participation within the society

(Cuentas & Vera, 2011). Following Nash (2005), despite the feminization of migration flows, these women remain in silence and invisible. In the field of sports, many studies highlight the low participation of MMW in formal physical activities (PA). However, various experiences and studies show that there are MMW doing sport and interested in it, but mainly in immigrant associations and other entities focused on supporting immigrants (Soler, Gaztelu, & Serra, 2010; Balibrea et al, 2002). Both types of entities are the main destination of immigrant women and their first information point, specially for MMW (Moreras, 2004). These places also offer a range of activities (workshops, language courses...), and become an important point to build and strengthen the bond between the catalonian society and the Maghribian immigrants. This contribution is an attempt to analyze what is the role of these entities in the field of sport and collect the perception of their leaders about MMW participation in sport. References: • Balibrea, E., Santos, A., & Lerma, I. (2002). Actividad física, deporte e inserción social: un estudio exploratorio sobre los jóvenes en barrios desfavorecidos. *Apuntes. Educación física y deportes*, 69, 106-111. • Cuentas, S., & Vera, P. (2011). Migración, género y desarrollo: Mujeres transnacionales actoras del cambio social. Barcelona: *intered*. • Kennett, Chris; Sagarzazu, Itxasne & Cerezuela, Berta (2007). El multiculturalisme en les polítiques esportives: anàlisi de l'adequació de les polítiques locals a Catalunya a les actuacions promogudes per la Unió Europea. Centre d'Estudis Olímpics. Disponible en: <http://olympicstudies.uab.es/imm07/down/abril07.pdf> [Consulta: Septiembre, 2010]. • Moreras, J. (2004). Marroquíes en Cataluña. In *Atlas de la inmigración marroquí en España* (pp. 305-313). Madrid: Observatorio de la inmigración marroquí en España. • Nash, M. (2001). Diversidad, multiculturalismos e identidad; perspectivas de género In M. Nash & D. Marre (Eds.), *Multiculturalismos y género* (pp. 21-47). Barcelona: edicions bellaterra. • Nasri, K., Soler, S., Serra, P., & Gaztelu, M. (2010). La invisibilidad de la mujer magrebi musulmana en el deporte: causas y perspectivas de cambio. *AEISAD*, Vol: 11, • Soler, S., Gaztelu, M., & Serra, P. (2010). Disseny, implementació i avaluació d'un programa d'activitat física per a la inclusió femenina a L'Hospitalet de Llobregat. Disponible en: <http://inefcgiseafe.wordpress.com/recerques/proyectos/proyectos-memories/>

**09:50 - 11:20**

## Oral presentations

### OP-PM30 Health and Fitness: Female population

#### THE EFFICACY OF PUBLICLY AVAILABLE WEBSITES FOR PHYSICAL ACTIVITY PROMOTION AMONG UNIVERSITY STUDENTS

Leung, F., Wong, H.S., Huang, J.

*The Chinese University of Hong Kong*

Purpose: Despite the numerous health benefits associated with regular physical activity (PA), an obvious decline in PA during the transition from secondary school to university has been reported (Bray & Born, 2004). The purpose of this study was to examine the effectiveness of the public access Internet for promoting PA among university students. Methods: One hundred and sixty-one Hong Kong university students were randomly assigned to one of the three groups, i.e. the public access Internet group (PAI), stage-targeted Internet group (STI), and control group (C). Participants of the PAI group received 5 links of publicly available websites relating to PA. Participants of the STI group received an on-line stage-targeted behaviour change programme entitled "Active Living Every Day (ALED)" (Blair et al., 2001). Group C did not receive any intervention treatment. The assessments of PA level, stage of change and self-efficacy for engaging in PA were conducted at baseline, 3rd month and 6th month after the commencement of the intervention. Three focus group interviews were conducted, a total of 15 participants were interviewed, and qualitative data were collected. Results: Increased PA was found in the STI group at the 3rd month assessment compared with baseline (PA score in MET•minutes/week:  $915.2 \pm 549.5$  Vs  $1359.6 \pm 918.8$ ,  $p < 0.05$ ). Improvements in stage of change ( $P < 0.05$ ) were found in the STI group at the 3rd and 6th month assessments and in the PAI group at the 6th month assessment. Decreased self-efficacy score ( $P < 0.05$ ) was found in the PAI group at the 3rd and 6th month assessments. Qualitative data were also collected. The contents of the public access websites could not arouse the PAI group participants' interest to read through the details and hence did not help in increasing their PA levels and stages of exercise change. The ALED course contents facilitated the STI group participants to increase their PA levels by leading them to set their own exercise goals and by emphasizing the importance and health benefits of regular PA. The ALED course contents had positive influences on stages of exercise changes of the STI group participants. The participants in the PAI and the STI groups did not perceive any positive influences from the intervention contents on their exercise self-efficacy. Conclusion: The results suggested that participants in the PAI group did not demonstrate improvement in PA to the same extent as their counterparts in the STI group. The public access websites were not effective for PA promotion among university students. References: Bray, S. R. & Born, H. A. (2004). Transition to university and vigorous physical activity: Implications for health and psychological well-being. *Journal of American College Health*, 52(4), 181-188. Blair, S. N., Dunn, A. L., Marcus, B. H., Carpenter, R. A., & Jaret, P. (2001). Active living every day: get active with a 20-step program. *Human Kinetics*, Champaign, IL.

#### UNDERSTANDING PHYSICAL ACTIVITY ACROSS THE LIFESPAN IN WOMEN: FINDINGS FROM THE AUSTRALIAN LONGITUDINAL STUDY ON WOMEN'S HEALTH

Brown, W.J., Hockey, R., Uijtdewilligen, L.

*University of Queensland, Brisbane, Australia and VU University Medical Center, Amsterdam, NL*

Introduction It is well accepted that, at the population level, physical activity levels decline during adulthood. For example data from the US suggest that, for men and women combined, younger people are more likely to be active than older people, with the prevalence of those meeting recommendations declining from 60% of 18 - 24 year olds to 39% of those 65 years and older (1). The largest decline is when people are in their twenties. Methods Data were from women in the three cohorts (born 1973-78 [N=9436]; 1946-51 [N=10,694]; and 1921-26 [N=9050]) of the Australian Longitudinal Study on Women's Health who completed four surveys over a 9 year period when they were aged 22-27 to 31-36, 50-55 to 59-64 and 73-78 to 82-87 years. Activity status was assessed using adapted Active Australia questionnaire items about time spent walking and in moderate and vigorous activity, with a summary score in MET.minutes/week used to define meeting recommendations ( $\geq 600$  MET.mins/week = 'active'). Results In the younger and older cohorts, the proportions meeting guidelines declined from 55% (age 22-27) to 47% (age 31-36) and from 37% (age 73-78) to 24% (age 82-87) respectively. However, in the

middle cohort, the proportion of active women increased from 45% (age 50-55) to 56% (59-64). Importantly, of those who answered every survey, only 12% of each cohort was 'active' at every survey, across all cohorts. In contrast, while only 8-10% of the younger and mid-age women were consistently inactive, more than one quarter of the older women were consistently inactive. The complex changing activity patterns will be illustrated using mosaic plots. Changing activity status was associated with changes in factors that impact on free time, such as marital status and childbirth in the younger women, and retirement, widowhood and birth of grandchildren in the mid-age women. Among the older women decreasing activity was associated with declining health and moving into an aged care institution. Discussion In this large representative cohort, changes in physical activity did not follow the expected decline with age. While there was a trend for activity to decline when the women were in their 20s, as their family responsibilities increased, the data show a clear increase in activity in mid-age. This is a time when women have more free time, as their work and family responsibilities are reduced. Activity levels do however decline quite markedly from the mid-seventies into older old age. Reference Haskell WL et al. Physical Activity and Public Health: Updated recommendation for adults from ACSM and the American Heart Association. *Circulation* 2007;116:1081-1093

## PHYSICAL ACTIVITY AS BEHAVIOR IN CONTROLLING WEIGHT

Bezerra, P., Venancio, C.

*Viana do Castelo Polytechnic Institute (IPVC); Research Centre in Sports Sciences, Health Sciences and Human Development (CIDESD)*

Introduction In recent years, the concerns with the body image, size and shape have promoted different behaviors that may contribute in the development of eating disorders. The physical activity performed in an excessive and intensive manner has been identified as one of the most relevant behaviors in controlling weight, in patients suffering eating disorders. This is particularly common in female adolescents where the practice of intense physical activity has been associated to body dissatisfaction. The aim of this study was to investigate the relationship between the body-image distortion, the body mass index (BMI) and the excessive practice of physical activity as behavior to lose weight, in female adolescents. Methods Two hundred and seventy nine female adolescents ( $16.6 \pm 1.2$  yrs,  $59.0 \pm 11.8$  Kg,  $1.63 \pm 0.06$  m,  $BMI = 22.4 \pm 4.1$ ) were recruited from Viana do Castelo. The subjects were asked to fulfill a questionnaire (Dixie, 2002) to collect information about the body-image distortion and behaviors to lose weight. The cross-tabs technique and Spearman coefficient of correlation were used to assess the relationship between BMI and behaviors to lose weight and the body-image distortion. The significance was set at  $p < 0.05$ . The Human Research Ethics Committee of the Institute approved testing procedures and the written informed consent was obtained from the subjects. Results Moderate to high risk of body-image distortion was found in 2.2% of the subjects. The female adolescents at moderate to high risk of developing eating disorders showed a  $BMI < 20$ . Furthermore, 50% of these subjects had reported the practice of intense physical activity as behavior in controlling weight. This behavior was also shown in 48% of the subjects in which 15% presented  $BMI < 10$  and 16% presented  $BMI > 25$ . Significant but moderate correlations were found between BMI and both the body-image distortion ( $r=0.33$ ,  $p<0.01$ ) and the practice of intense physical activity ( $r=0.20$ ,  $p<0.01$ ). Discussion Results showed that few subjects demonstrated deep body image distortion. Also, the physical activity as behavior to lose weight was the most common behavior among the subjects. BMI showed significant correlations with both body image distortion and physical activity as behavior to lose weight. However, no correlation was found between body image distortion and physical activity as a behavior to lose weight. It appears that rather than body image perception, the subject's BMI value is the main factor in promoting the physical activity as behavior to lose weight. References Dixie, M. A. (2007). Prevalência das doenças do comportamento Alimentar. *Análise Psicológica*, 4 (XXV): 559-569

## THE EFFECTS OF HIGH AND LOW LOAD UPPER BODY RESISTANCE TRAINING ON LIMB STRENGTH AND FLEXIBILITY IN WOMEN WITH BREAST CANCER RELATED LYMPHOEDEMA

Pumpa, K., Cormie, P., Rattray, B., Spry, N., Galvao, D.A., Newton, R.U.

*University of Canberra*

The Effects of High and Low Load Upper Body Resistance Training on Limb Strength and Flexibility in Women with Breast Cancer Related Lymphoedema Pumpa, K.L.1, Cormie, P.2, Rattray, B.1, Spry, N.3, Galvão, D.A.2, Newton, R.U.2 1: University of Canberra, AUSTRALIA; 2: Edith Cowan University, AUSTRALIA; 3: Sir Charles Gairdner Hospital, AUSTRALIA. Introduction Upper limb impairments such as decreased range of motion (ROM) and strength are evident in women after treatment for breast cancer. These differences are greater in women with lymphoedema (Smoot et al., 2010). Improvements in shoulder ROM without lymphoedema exacerbation have been identified in women with breast cancer after gentle strength and flexibility exercises (Kilbreath et al., 2012). This research compared the effects of high and low load resistance exercise on upper body ROM and strength in women with breast cancer related lymphoedema (BCRL). Methods Seventy women with a clinical diagnosis of BCRL participated in this investigation (age:  $57 \pm 9$  y, weight:  $77 \pm 15$  kg, bioimpedance spectroscopy [BIS] score:  $15 \pm 18$ , time since lymphoedema diagnosis:  $5 \pm 6$  y). Participants were stratified for age and lymphoedema status and then randomised into three groups; high load resistance exercise (HIGH  $n=24$ ), low load resistance exercise (LOW  $n=23$ ) or usual care (UC  $n=23$ ). Participants in the HIGH and LOW groups completed progressive resistance training twice weekly for 12 weeks, while participants in the UC group maintained their normal lifestyle. Training sessions involved 1-4 sets per exercise at loads equivalent to 6-10 repetition maximum (RM) for HIGH (~75-85% 1RM) and 15-20 RM for LOW (~55-65% 1RM). Assessments were conducted pre and post intervention using standard measurement techniques for physical function on both affected and non-affected limbs (grip strength; wrist, elbow and shoulder ROM; 1RM in chest press and seated row; and RM test in chest press and seated row at 70% 1RM). Standard descriptive statistics, two way (group x limb) analysis of variance and intention to treat analyses were utilised. Results Exercise was effective with no differences between the HIGH and LOW groups for any parameter or limb. Improvements in wrist flexion were evident in the HIGH ( $P \leq 0.004$ ) and LOW ( $P \leq 0.016$ ) groups; elbow extension and shoulder flexion improved in the LOW group ( $P = 0.001$ ; and  $P = 0.015$  respectively); improvements were identified in both the RM chest press and seated row in both HIGH and LOW groups ( $P \leq 0.021$ ); and increases in grip strength were evident in both HIGH and LOW groups ( $P \leq 0.015$ ) when compared to UC. Discussion Upper body resistance training involving high and/or low loads is effective for improving physical function in the upper bodies of women with BCRL. References Kilbreath S, Refshauge K, Beith J, Ward L, Lee M, Simpson J, Hansen R. (2012). Breast Cancer Res Treat, Epub ahead of print Jan 29. Smoot B, Wong J, Cooper B, Wanek L, Topp K, Byl N, Dodd M. (2010). *J Cancer Surviv*, 4(2),167-178.

09:50 - 11:20

## Oral presentations

### OP-PM31 Training and Testing 4

#### EFFECT OF CONCURRENT EXPLOSIVE STRENGTH AND ENDURANCE TRAINING ON SPRINT PERFORMANCE BEFORE AND AFTER A 5-MIN TIME TRIAL

Müller, B.1,2, Steiner, T.1, Wehrli, J.P.1

1: Federal Office of Sports (Magglingen, Switzerland), 2: Swiss Cycling Federation (Bern, Switzerland)

**Introduction** A fast starting phase can be crucial to overall performance in MTB Cross Country competition whereas in road cycling it is the final sprint which can determine whether someone is successful or not. This variable competition intensity with many needed accelerations creates high demands in muscular strength (Yamamoto et al., 2010). The purpose of this study was to examine the effect of explosive strength training on a 10 s sprint performance at rest and after a 5-min time trial (TT). **Methods** Eighteen male adolescent cyclists (age  $15.0 \pm 0.5$  yr) were matched to pairs and assigned either a combined strength and endurance group (S&E;  $n = 9$ ;  $VO_{2peak}$   $64.0 \pm 5.1$  ml/kg/min) or an endurance group (E;  $n = 9$ ;  $VO_{2peak}$   $64.7 \pm 1.8$  ml/kg/min). One-third of the training sessions in the S&E group consisted of explosive strength training. During the 6-week intervention the training load and duration as well as the intensity distribution were the same for both S&E and E groups. The following parameters were measured before and after the training intervention: Sprint performance for 10 s at rest and after a 5-min TT recording Peak power (Ppeak) and mean power for 10 s (P10s), power during the 5-min TT,  $VO_{2peak}$ , and squat jump (SJ) performance. **Results** Results after the intervention showed no significant differences within the groups for Ppeak (S&E  $+1.3 \pm 5.8\%$ ; E  $-3.0 \pm 5.9\%$ ) or within the E group alone for P10s ( $-1.5 \pm 5.2\%$ ). The S&E group showed  $+3.8 \pm 4.4\%$  higher P10s at rest. After the TT, the E group improved Ppeak ( $+15.7 \pm 20.4\%$ ) and P10s ( $+16.1 \pm 20.7\%$ ), whereas in the S&E group only P10s improved ( $+16.5 \pm 16.1\%$ ) significantly. Both groups improved their TT performance (S&E  $+11.5 \pm 5.4\%$ ; E  $+8.0 \pm 7.0\%$ ). The S&E group improved  $VO_{2peak}$  ( $+6.0 \pm 3.6\%$ ) and SJ performance ( $+7.8 \pm 5.2\%$ ). No changes were seen in the E group in these parameters ( $VO_{2peak}$   $+2.2 \pm 3.2\%$ ; SJ  $+1.9 \pm 5.8\%$ ). The development of  $VO_{2peak}$  and SJ performance before and after the intervention was different between the two groups. **Discussion** Concurrent explosive strength and endurance training showed an improvement in total sprint performance during 10 s at rest without compromising TT performance. In addition, the S&E group improved their explosive strength ability as well as  $VO_{2peak}$ . Accordingly, in bike disciplines where a high intensity start phase is crucial to performance, combined strength and endurance training can be recommended as part of the yearly training plan. Furthermore, negative effects of strength training on endurance performance in this age group are not to be expected. **References** Yamamoto, L.M., Klau, J.F., Douglas, C., Kraemer, W.J., Armstrong, L.E. & Maresh, C.M. (2010). *J. Strength Cond. Res.*, 24(2), 560-566.

#### EFFECT OF HIGH-SPEED POWER TRAINING ON IMPROVING MUSCULAR AND FUNCTIONAL PERFORMANCE IN OLDER WOMEN

Pereira, A., Silva, A., Costa, A., Monteiro, A.M., Marques, M.

UNIVERSIDADE DE TRAS OS MONTES

**Introduction** In older populations, maintenance of muscle power output is a key factor in everyday task performance, such as climbing stairs, rising from a chair and walking, as well as in decreasing the likelihood of falls, especially in women (Häkkinen et al., 1998; Izquierdo et al., 2001). The purpose of the study was to examine the effects of 12 weeks high-speed power training on maximal strength (1RM) and functional tasks of the arm and leg muscles (sit-to-stand and get-up and go) (Pereira et al., 2012). **Methods** Twenty-four women were assigned randomly to a control group (CG) ( $n=12$ ,  $63.3 \pm 5.9$ ) and an experimental (EG) ( $n=12$ ,  $60.3 \pm 9.3$ ). The experimental group was subjected to three sessions /week of strength training for 12 weeks). The control group did not do any physical activity. Data collection were in the pretest (T1) and post-test (T12). The evaluation consisted of strength exercises: 1-repetition maximum bench press (1RMBP), 1-repetition maximum in leg extension (1RMLE) and tests that evaluated the functional fitness: sit and stand up - 30 sec. (ST) and 'go up and go' (GUG), both the battery of tests Rikly & Jones (1999). The training plan consisted of bench press exercise (BP) and bilateral leg extension (LE) with progressive loads (40% -75%) and performing abdominal (3x12) and lumbar (3x10). **Results** During 12-weeks of high-speed power training, CG showed significant decreases in the test ST ( $-12.2\%$ ,  $p = 0.029$ ). For the EG, improvements were observed in the tests 1RMBP (38.6%,  $p = 0.001$ ), 1RMLE (24.6%  $p = 0.00$ ) and ST (17.1%,  $p = 0.003$ ). Although GUG test decrease in execution time of the course, but this was not significant ( $-4.3\%$ ,  $p = 0.259$ ). **Discussion** A program of strength training with maximum speed during the concentric phase allows significant gains in increased levels of strength in upper and lower limbs. Moreover, this approach contributes to the increased mobility and functional autonomy, as well as increasing neuromuscular coordination and power, which in old age seem to contribute significantly to reducing the risk of falls and consequently to increase functional independence and quality of life. **Conclusion** These data indicate that high-speed power training is an effective exercise approach leading to large gains in upper and lower extremity muscle performance and function capacity. **References** Häkkinen, K., Kallinen, M., Izquierdo, M., Jokelainen, K., Lassila, H., Malkia, E., Kraemer W.J., Newton, R.U., Alen, M., 1998. Changes in agonist-antagonist EMG, muscle CSA, and force during strength training in middle-aged and older people. *J. Appl. Physiol.* 84, 1341-1349. Izquierdo, M., Häkkinen, K., Ibanez, J., Garrues, M., Anton, A., Zuniga, A., Larrion, J.L., Gorostiaga, E.M., 2001. Effects of strength training on muscle power and serum hormones in middle-aged and older men. *J. Appl. Physiol.* 90, 1497-1507. Pereira A, Izquierdo M, Silva AJ, et al. (2012). Effects of high-speed power training on functional capacity and muscle performance in older women. *Exp Gerontol.*

#### EFFECT OF DIFFERENT INCLINES ON SPRINTING, BOUNDING, AND ONE-LEG HOPPING PERFORMANCE IN ENDURANCE TRAINED ATHLETES

Sjövist, J., Sandbakk, Ø., Willis, S., Andersson, E., Holmberg, H.C.

Swedish Winter Sports Centre

Effect of Different Inclines on Sprinting, Bounding, and One-Leg Hopping Performance in Endurance Trained Athletes Sjövist, J(1), Sandbakk, Ø(2), Willis, S(1), Andersson, E(1), Holmberg, H.-C.(1) (1)Swedish Winter Sports Research Centre, Department of Health Sciences,



Mid Sweden University, Östersund, Sweden. (2)Department of Human Movement Science, Norwegian University of Science and Technology, Trondheim, Norway Introduction In cross-country skiing, uphill sprinting, bounding, and one-leg hopping is a common dry-land training method to improve skiing performance. However, the impact of different inclines on performance in sprinting, bounding and hopping in this population has not been investigated. Therefore, the aim of the study was to analyze the kinematics of sprinting, bounding, and hopping, and the effects of strength, power, and individual ranking on performance in three different inclines. Methods 14 male elite cross-country skiers performed 15 m sprinting (SPR), five-step bounding (5SB), and five one-leg hops (5OLH) on 0, 7.5, and 15° inclines. Moreover, a mid-thigh pull was used to measure maximal isometric strength and squat jumps (SQJ) and double and single-leg countermovement jumps (CMJ) for power. For kinematics, total cycle time, frequency, contact time, flight time, stride length during sprinting, bounding and hopping were analyzed. FIS-points were used to rank skiers. Results As expected, incline negatively affected performance in SPR, 5SB, and 5OLH ( $p < 0.05$ ). At 7.5 and 15° incline, contact time increased in SPR, 5SB, and 5OLH ( $p < 0.05$ ) and flight time decreased in 5SB and 5OLH ( $p < 0.05$ ) while remaining unaffected in SPR. Stride length decreased by 25-30% from 0 to 15° in SPR, 5SB, and 5OLH. Strength was correlated to 5SB and 5OLH at 7.5 and 15° ( $r = 0.60-0.83$ ) while power correlated to SPR at 0 and 15° ( $r = -0.56-0.63$ ), 5SB at 0 and 7.5° ( $r = 0.55-0.64$ ), and 5OLH at all inclines on the non-dominant leg ( $r = 0.58-0.72$ ). Higher ranked skiers' 5SB were longer at 7.5 and 15° and 5OLH were longer at 15° on the non-dominant leg. Discussion As incline increases, slower sprint times may be contributed to shorter stride length and increased contact times while shorter bounding and hopping distances to shorter stride lengths and flight times. Maximal strength positively affects bounding and one-leg hopping and power affect sprinting, bounding, and one-leg hopping performance at steeper inclines. Uphill bounding and one-leg hopping could be useful training methods for cross-country skiers. References Cronin JB, Hansen KT. (2005) Strength and power predictors of sports speed. *J Strength Cond Res.* 19, 349-357. Hunter JP, Marshall RN, McNair PJ. (2004) Interaction of step length and step rate during sprint running. *Med Sci Sports Exerc.* 36, 261-271. Paradise GP, Cooke CB. (2006) The effects of sprint running training on sloping surfaces. *J Strength Cond Res.* 20, 767-777.

### IMPROVING REPEATED SPRINT ABILITY BY A SHORT PERIOD OF VERY HIGH INTENSITY INTERMITTENT EXERCISES TRAINING IN YOUNG SOCCER PLAYERS

Durand, T., Dellal, A., Pialoux, V., Hautier, C.  
*Sport Science Université de Claude Bernard*

Improving Repeated Sprint Ability by a short period of very high intensity intermittent exercises training in young soccer players DURAND T. (1), DELLAL A. (2), PIALOUX V. (1), HAUTIER C. (1) (1) Sport Science University of Claude Bernard, Lyon, France ; (2) Olympique Lyonnais FC (soccer) Introduction The Repeated Sprint Ability (RSA) is often considered as one of the most important skill to develop the physical performance of elite players. However, there is still a lack of study concerning others methods allowing the improvement of the RSA. Therefore, the aim of the present study was to examine the effect of 5-25 and 5-15 intermittent exercises with and without footwork exercises on the RSA performance but also on the maximal speed and an intermittent aerobic test. Methods Sixteen U19 soccer players (height: 178.0±6.0 m; body mass: 66.6±5.3 kg; body fat: 7.3 ±3.1%) took part in this experimentation. All players performed a 4 week-training period including 5-15-sec and 5-25-sec intermittent exercises with and without footwork exercises. The 5-25-sec and 5-15-sec consisted in 5-sec of work at maximal intensity followed by 25 or 15-sec of passive recovery during 2 blocks of 6 minutes and 4 minutes, respectively. Players performed each intermittent exercise once with specific footwork (consisting in lateral footwork, jumps with ground reaction, skipping, frequency, exercises with hoops) and another time in traditional conditions without specific footwork. Prior and after this 4 week-training period, each player performed a RSA Test (10 x 30-m interspaced by 30-sec of active recovery), an intermittent fitness test (30-15 IFT) and a 10-m and 30-m sprint performance test. Heart rate (HR) and rating of perceived exertion (RPE) were monitored during and after each test and intermittent exercises training. Results The 4-week training period of very high-intensity intermittent exercise induced a significant increase of the 30-15 IFT and RSA performances ( $p < 0.05$ ), whereas the 10-m and 30-m sprint performance was unchanged. Complementary, the 5-25 intermittent exercise without footwork exercises allows to reach similar HR and RPE values than during RSA. On the contrary, for the intermittent exercises with footwork exercise, the HR and RPE are less important than during the tests. Discussion According to these results, it appears that the short intermittent exercises at very high-intensity (combination of 5-25-sec and 5-15-sec) seems to be appropriate for the development of both the repetition of high intensity actions (RSA) and intermittent fitness performance (30-15 IFT). It should be suggested to alternate between very high-intensity intermittent exercises and RSA training in order to develop the physical performance in youth players. Furthermore, it could be interesting that future study will examine if a period of small-sided games training induce similar effects than RSA or short duration of intermittent exercises.

### ACUTE EFFECTS OF A CONVENTIONAL HIGH-INTENSITY STRENGTH TRAINING SESSION UNDER SIMULATED ORTHOSTASIS ON A NEW ROBOTIC LEG PRESS

Kümmel, J., Rosenberger, A., Mester, J., Gruber, M., Zange, J.  
*German Aerospace Center*

ACUTE EFFECTS OF A CONVENTIONAL HIGH-INTENSITY STRENGTH TRAINING SESSION UNDER SIMULATED ORTHOSTASIS (LBNP) ON A NEW ROBOTIC LEG PRESS Kümmel, J. (1,4), Rosenberger, A.(1,2), Mester, J.(2), Gruber, M.(4), Zange, J.(1,3) 1: German Aerospace Center (Cologne, Germany), 2: German Sport University Cologne (Cologne, Germany), 3: University of Cologne (Cologne, Germany), 4: University of Konstanz (Konstanz, Germany) Introduction Lower body negative pressure (LBNP) is a gravity independent method to simulate orthostasis. Due to the muscle pump function in exercising leg muscles, an increase in hydrostatic pressure by gravity or LBNP increases the arterio-venous pressure difference and in consequence muscle perfusion (Egaña et al., 2010). This study is the first application of combining a robotic leg press (RBL) that allows free modelled profiles of force and velocity with a LBNP chamber. We tested the hypotheses that LBNP during simulated high-intensity leg press exercise i) increases total hemoglobin content (tHb) and oxygen saturation (SmO<sub>2</sub>) for m. vastus lateralis, and ii) reduces the increase in systolic blood pressure (sBP) and cardiac output (CO). Methods Nine healthy male subjects (age: 28±4yrs) participated in this study. In a cross-over design, all subjects performed 3 sets of knee extensions in a supine position at 0 (CON), -20, and -40mmHg LBNP. The RBL produced a constant force at 80% of the individual 1RM. SmO<sub>2</sub> and ΔtHb were continuously measured by near-infrared spectroscopy. SBP and CO were determined from measurements of continuous finger blood pressure, thorax impedance, and electrocardiogram. Results After the first exercise set, ΔtHb increased in all three conditions indicating a reactive hyperemia. With LBNP, ΔtHb was higher when compared to CON (0mmHg: 3.5±0.9μmol/L, -20mmHg: 8.2±0.9μmol/L, -40mmHg: 12.7±0.9μmol/L,  $P < 0.05$ ) during LBNP baseline. Average ΔtHb did not significantly change during exercise sets in comparison to corresponding intervals of rest. During rest, no differences to baseline values in SmO<sub>2</sub> and sBP between LBNP and CON were observed, whereas CO was significantly lower with LBNP (0mmHg: 3.8±1.3L/min, -20mmHg: 2.2±1.5L/min, -40mmHg: 2.1±1.8L/min,  $P = 0.04$ ). Dur-

ing exercise, no differences in SmO<sub>2</sub>, sBP, and CO were found between CON and LBNP. Discussion The increase in  $\Delta$ tHb with LBNP indicates capillary blood pooling in the vastus muscle. However,  $\Delta$ tHb increase with LBNP did not affect the time course of SmO<sub>2</sub> during the entire test protocol. Moreover, only at rest but not during exercise, sBP showed the known modulations of the cardiovascular system to orthostasis. This indicates that the participants of the study were not able to profit from improved muscle perfusion using muscle pump and hydrostatic pressure during LBNP with the specific time course of force used in the present leg press training. References Egaña M, Ryan K, Warming SA & Green S (2010). *Eur J Appl Physiol* 108, 649-656.

09:50 – 11:20

## Oral presentations

### OP-PM32 Neuromuscular Physiology: Fatigue

#### CHANGES IN CORTICAL ACTIVATION AND EXCITABILITY DURING PROLONGED CYCLING EXERCISE

Jubeau, M.1,2,3, Rupp, T.1, Perrey, S.4, Temesi, J.3, Wuyam, B.1, Verges, S.1, Millet, G.Y.1,3

1. HP2 (Grenoble, France), 2. MIP (Nantes, France), 3. LPE (Saint-Etienne, France), 4. M2H (Montpellier, France)

**Introduction** It has been previously demonstrated that prolonged cycling exercise induces muscle fatigue, i.e. decrease of maximal voluntary contraction (MVC) force, due to alterations of both peripheral mechanisms (contractile properties and action potential propagation) and central drive (1). However, it remains unknown whether a supraspinal deficit occurs throughout prolonged exercise. Therefore, the purpose of this study was to evaluate cortical excitability and cortical activation before, during and after a 4-h cycling exercise. **Methods** Ten healthy subjects performed three 80-min bouts on an ergocycle at 45% of their maximal aerobic power separated by 25 min bouts of neuromuscular function (NMF) testing. Before exercise and immediately after each bout, NMF was evaluated on the right quadriceps femoris under isometric conditions. Transcranial magnetic stimulation was used to assess cortical voluntary activation (VA, as proposed by 2), cortical excitability via motor evoked potential (MEP) and intracortical inhibition by cortical silent period (CSP). Electrical stimulation of the femoral nerve (single and paired stimuli) was used to measure peripheral VA and muscle properties. Mechanical and electromyographic (vastus lateralis, vastus medialis and rectus femoris) data were recorded during all NMF testing procedures. Results MVC was significantly reduced after the first bout ( $P < 0.01$ ) and was further decreased (-25%,  $P < 0.001$ ) at the end of exercise. As expected, single twitch and doublet peak torque were depressed after the first bout and remained so throughout the protocol ( $P < 0.001$ ). M-wave amplitudes were also reduced for the three studied muscles ( $P < 0.01$ ). In contrast, CSP and raw MEP amplitude remained unchanged throughout the protocol. However, MEP normalized to maximal M-wave significantly increased after the first cycling bout and remained elevated. Finally, a significant decrease in both cortical and peripheral VA was observed at the end of exercise (~ -7%,  $P < 0.01$ ) but these changes were not correlated. **Discussion** Alterations of both central drive and muscle function explain the large strength loss after prolonged cycling exercise. The main findings of this study are that reductions in peripheral VA measured here and in previous fatigue studies in cycling are partly explained by a deficit at the corticospinal level despite increased corticospinal excitability and similar intracortical inhibition. **References** 1. Lepers R, Maffiuletti NA, Rochette L, Bruignon J, Millet GY, 2002, *J Appl Physiol* 92: 1487-1494. 2. Goodall S, Romer LM, Ross EZ, 2009, *Exp Physiol* 94: 995-1004

#### EFFECT OF 30-H SLEEP DEPRIVATION ON CYCLING PERFORMANCE AND CENTRAL FATIGUE

Temesi, J.1, Arnal, P.J.1, Verges, S.2, Millet, G.Y.1

1. Université de Lyon, F-42023, Saint-Etienne, France 2. HP2 Laboratory (INSERM U1042), Université Joseph Fourier, F-38000, Grenoble, France

**Introduction** Deterioration in endurance performance with sleep deprivation (SD) has been observed anecdotally and in previous studies (Martin, 1981). Numerous hypotheses have been proposed, including that SD increases perception of effort (RPE). Another effect of SD is the potential for alterations to central motor command during exercise. Although effects on maximal force with SD have not been found, effects of SD on central fatigue are unknown. The aim of this study was to test the hypothesis that increased supraspinal fatigue contributes to impaired exercise performance with SD. **Methods** 9 active males with normal sleep patterns performed 2 randomized and counterbalanced 2-day sessions. On day 1 (J1), subjects performed neuromuscular tests comprising maximal (MVC) and submaximal voluntary contractions of knee extensors with peripheral nerve (PNS) and transcranial magnetic stimulation. On day 2 (J2), after a night of complete SD or normal sleep (CO), subjects performed tests as per J1 before, after cycling 40 min at 65% maximal aerobic power (MAP) and then after cycling to exhaustion (65% MAP; + 5% MAP every 5 min). MVC, voluntary activation (VA), maximal M-wave at rest (Mmax) and during MVC (Msup), motor evoked potential (MEP) and potentiated twitch (TwPot) amplitudes, RPE and performance time were analyzed by repeated-measures ANOVA or t-test with significance at 0.05. **Results** No differences were observed between SD and CO or between J1 and J2 before cycling ( $p > 0.05$ ). On J2, RPE increased and MVC decreased with cycling time (both  $p < 0.001$ ). This was paralleled by the appearance of low-frequency fatigue ( $p < 0.001$ ) and decreasing TwPot ( $p < 0.001$ ) and %VA PNS ( $p = 0.04$ ). Vastus lateralis (VL) MEP/Mmax at 50, 75 and 100% MVC increased in amplitude with time on J2 ( $P < 0.05$ ). There were no differences in MEP/Mmax amplitudes in Rectus femoris or Vastus medialis, nor for MEP/Msup in any quadriceps muscle. Both Mmax and Msup amplitudes decreased in all quadriceps muscles with time on J2 ( $p < 0.05$ ). **Discussion** The results of this study showed no change in neuromuscular measures with SD. Endurance cycling to exhaustion produced a decrease in maximal force associated with low frequency fatigue and some central fatigue. At fatigue, cortical excitability was elevated in VL. These effects were not, however, accentuated with SD. Although exercise time to exhaustion with SD was 3.5% shorter than CO, this difference was not significant. Evidence of increased RPE and central fatigue, especially increased supraspinal fatigue, with SD were not observed, perhaps explaining the lack of performance difference between the two conditions. **References** Martin BJ. (1981). *Eur J Appl Physiol Occup Physiol*, 47, 345-354.

## NEUROMUSCULAR FATIGUE INDUCED BY WHOLE-BODY VIBRATION EXERCISE PERFORMED WITH MODERATE ADDITIONAL LOAD

Maffiuletti, N.A.1, Saugy, J.2, Cardinale, M.3, Place, N.2

(1) *Schulthess Clinic* (2) *University of Geneva* (3) *British Olympic Association*

**Introduction** Despite the fact that acute and chronic effects of whole-body vibration (WBV) exercise have received considerable attention in the last few years (see Rittweger, 2010), the mechanisms underlying the reduction in maximal voluntary contraction (MVC) strength induced by one WBV session are poorly known. The aim of this study was to investigate the origin and the extent of neuromuscular fatigue induced by half-squat static WBV exercise, and to compare it to a non-WBV condition. **Methods** Nine healthy adult volunteers completed two fatiguing protocols (WBV and non-WBV, randomly presented) separated by 48 hours. The fatiguing protocols consisted of five 1-min repetitions of static half squat with a load of 50% of individual body mass. The WBV was administered on a linear platform with a frequency of 30 Hz and an amplitude of 4-6 mm. Neuromuscular fatigue of knee and ankle muscles was investigated with a series of assessments completed before and immediately after each fatiguing protocol. The main outcomes were MVC torque, voluntary activation (twitch interpolation), M-wave amplitude and doublet peak torque. **Results** Knee extensor MVC torque decreased significantly and to the same extent after WBV (-23%) and non-WBV (-25%), while knee flexor, plantar flexor and dorsiflexor MVC torque did not decrease significantly. Quadriceps and triceps surae voluntary activation were unaffected by the two fatiguing protocols, and similarly vastus lateralis and soleus M-wave amplitude did not show any significant alteration. Doublet peak torque decreased significantly and to a similar extent following WBV and non-WBV exercise, for both knee extensors (-25%) and plantar flexors (-7%). **Discussion** The main finding of this study was the lack of difference between the extent and the origin of neuromuscular fatigue induced by WBV and non-WBV static half-squat exercise performed with additional loads. Both protocols undoubtedly induced muscle fatigue in knee extensors (but not in the other main muscles of the lower limb), as witnessed by considerable MVC torque losses. Knee extensor muscle fatigue was not due to activation failure (central fatigue) but rather to peripheral muscle contractile failure, which, again, did not differ between WBV and non-WBV conditions. Adding WBV to isometric resistance exercise with moderate loads does not induce additional neuromuscular effects compared to static exercise alone (see also Hannah et al., 2011). **References** Hannah R, Minshull C, Folland JP. (2011) *Scand J Med Sci Sports*, DOI: 10.1111/j.1600-0838.2011.01361.x Rittweger J. (2010). *Eur J Appl Physiol*, 108, 877-904.

## FATIGUE AND NEUROMUSCULAR STRATEGIES IN SUBMAXIMAL ISOMETRIC CONTRACTIONS IN CHILDREN WITH CEREBRAL PALSY

Doix, A.C., Gulliksen, A., Braendvik, S.M., Roeleveld, K.

*Norwegian University of Science and Technology*

**INTRODUCTION** It has been recently suggested that lower limb muscles would be more fatigue resistant in cerebral palsy (CP) children than in healthy control (HC) peers (Moreau et al., 2008). Voluntary activation in CP is shown to be impaired during fatiguing contractions and leads to lower force production and incomplete activation of the muscles, reflected in hampered motor unit (MU) recruitment (Stackhouse et al., 2005). Yet, up to 25% of maximal voluntary contraction (MVC), MU recruitment seems to be similar in CP and HC (Rose and McGill, 2005). The aim of this study was to investigate whether CP children would recruit additional MUs as HC would to compensate for muscle fatigue during a sustained contraction at a low force level. **METHODS** Twelve children with CP and seventeen healthy-controls (HC) of similar age participated in this study. Participants performed isometric MVCs in elbow flexion and extension, and a submaximal isometric contraction until exhaustion at about 20% MVC. Surface electromyography (EMG) of biceps brachii (BB), triceps longus (MTB) and triceps lateralis (LTB) were collected. Data from accelerometer were recorded to measure vertical variations of accelerations of the elbow flexion/extension. **RESULTS** The average flexion and extension peak torques during the MVCs were lower in the CP group than the HC group. Time to exhaustion in the endurance task was similar in both groups. The CP group experienced less acceleration fluctuations and a lower increase in this variable from start to end than the control group ( $p=0.007$ ). The change of EMG amplitude of BB ( $p=0.017$ ), MTB ( $p=0.001$ ) and LTB ( $p=0.021$ ) was significantly greater during the task in the HC group than in the CP group. The median frequency of the MTB had a larger decrease from start to end in the HC group ( $p=0.002$ ). **DISCUSSION** The lack of EMG amplitude increase in CP subjects shows that even at a contraction level as low as 20 % MVC, CP subjects were not able to recruit additional motor units to compensate for muscle fatigue throughout the task. The similar endurance time in CP can be explained by the fact that the external load was determined as a percentage of MVC, which is a relatively lower load of their maximal muscle capacity (Rose and McGill, 2005), also supported by the lower amount of acceleration fluctuations at the start of the contraction. Therefore CP participants would stop their task at a lower level of muscle fatigue, indicated by the lower change in median frequency EMG and acceleration fluctuations from start to exhaustion. **REFERENCES** Moreau NG, Li L, Geaghan JP, Damiano DL. (2008). *Arch Phys Med Rehabil*. 89(10), 2011-2016 Stackhouse SK, Binder-MacLeod SA, Lee SCK. (2005). *Muscle Nerve*. 31(5), 594-601. Rose J and McGill KC (2005) *Dev Med Child Neurol*. 47,329-336

## ANALYSIS OF AUTONOMIC FUNCTION AND SELF-REPORTED FATIGUE IN PATIENTS WITH CHRONIC FATIGUE STATES UNDERTAKING AEROBIC EXERCISE.

Keech, A., Vollmer-Conna, U., Barry, P., Lloyd, A.

*University of New South Wales*

**Objective:** Chronic fatigue syndrome (CFS) is a debilitating illness with unknown pathophysiology and characterised by pathological fatigue and related symptoms. Autonomic dysfunction is associated with worsened symptoms and poor sleep in patients with CFS (Burton, Rahman et al. 2010). Although evidence is inconsistent, autonomic dysfunction may act to perpetuate fatigue across a range of functional somatic syndromes (Tak, Riese et al. 2009). We examined a role for autonomic dysfunction in post-exertional exacerbation of symptoms in CFS following sustained, moderate-intensity aerobic exercise. **Methods:** The study included a well-characterised sample of patients with CFS (N=10) and healthy control subjects (N=11). Self-report of fatigue (using an 11-pt scale designed to measure multi-dimensional characteristics in real-time), physical function and sleep quality were obtained twice at baseline and immediately, 1hr, 4hrs, 24hrs and 72hrs after 25 minutes of cycling exercise at 70% of age-predicted maximum heart rate. Heart rate was recorded continually via electrocardiogram for a 24 hr baseline period and the first 24hrs of recovery following exercise. Heart rate variability (as %HF power) was determined as an index for parasympathetic (vagal) activity. **Results:** CFS was associated with substantial fatigue, functional impairment and poor sleep (all  $p<0.02$ ) at baseline. The exercise trial immediately exacerbated fatigue in patients, which briefly subsided but then returned and peaked 24hrs after exercise. No significant differences in autonomic parameters were apparent from analyses of group differences. Results from preliminary multiple regression modelling suggest that post-exertional fatigue at 24 hrs was best

predicted by the condition of CFS ( $p=0.002$ ), the workload performed during the exercise ( $p=0.02$ ), fatigue ratings ( $p=0.003$ ) and higher HRV ( $p=0.002$ ) immediately after the exercise, and low HRV ( $p=0.03$ ) as well as high HR ( $p<0.001$ ) around the time of falling asleep during that night. Conclusions: As expected patients reported exacerbated fatigue, functional impairment and poor sleep following the exercise. More research with larger sample size is needed to draw definitive conclusions regarding the role of autonomic dysfunction in post-exertional fatigue. Given the variance in physiological data, it is clear that statistical approaches based on individual differences will provide better insights into these complex relationships than group comparisons.

### COMPARATIVE ANALYSIS OF METABOLIC AND FUNCTIONAL CHANGES RESULTING FROM VOLUNTARY AND ELECTRICALLY-EVOKED CONTRACTIONS OF THE KNEE EXTENSORS

GONDIN, J.1, JUBEAU, M.1,2, LE FUR, Y.1, VILMEN, C.1, COZZONE, P.J.1, DUHAMEL, G.1, BENDAHAN, D.1

1: Aix Marseille Université, 2: Université de Nantes

**Introduction :** It has been previously suggested that neuromuscular electrical stimulation (NMES) was related to a greater metabolic demand, i.e. a larger phosphocreatine (PCr) depletion and acidosis as compared to voluntary contractions (VOL). Given that the corresponding metabolic changes were not accurately localized, one could expect that they were sampled from a mixture of activated and non-activated muscle areas. In addition, one could also expect additional biases since NMES is linked to a preferential activation of muscle fibers close to the stimulating electrodes<sup>2</sup>. On that basis, localized metabolic (<sup>31</sup>P chemical shift imaging: CSI) and magnetic resonance transverse relaxation time (T<sub>2</sub>) changes were compared between VOL and NMES contractions. **Methods:** Sixteen healthy subjects completed both NMES and VOL protocols inside a 3T MR scanner (Siemens) for two testing sessions and were asked to perform 232 isometric contractions (750-ms on-off ratio) of the knee extensors (~30% of MVC force). The NMES protocol (frequency: 30Hz) was performed with similar characteristics while electrodes were placed over the vastus lateralis (VL) and vastus medialis muscles. During the first session, metabolic changes (i.e., PCr consumption and acidosis) were recorded using localized <sup>31</sup>P CSI. Voxels of interest were selected from the VL muscle (i.e., directly stimulated) and from the rectus femoris muscle (RF) (i.e., non-directly stimulated). During the second visit, a SE-EPI sequence was used to obtain images from the thigh muscles at rest and immediately after each exercise bout. T<sub>2</sub> maps illustrating muscle activation were then generated. **Results:** A larger PCr consumption and acidosis were observed for the VL after NMES as compared to VOL. On the contrary, both PCr depletion and acidosis were similar for the RF regardless the contraction mode. Consistently, T<sub>2</sub> maps showed a significant activation of the VL only after NMES while the RF was similarly activated by the two exercises. **Discussion:** The localized measurements reported in the present study demonstrated that the larger metabolic demand previously observed after NMES as compared to VOL was actually due to larger changes occurring within the stimulated muscle area. No difference was observed for the muscle area located outside the stimulated region. Interestingly, the metabolic changes were largely explained by the spatial distribution of muscle activation as illustrated by the T<sub>2</sub> maps. **References:** 1Vanderthommen M, Duteil S, Wary C, Raynaud JS, Leroy-Willig A, Crielaard JM, Carlier PG (2003), *J Appl Physiol*, 94, 1012-1024. 2Vanderthommen M, Depresseux JC, Dauchat L, Degueudre C, Croisier JL, Crielaard JM (2000), *Muscle Nerve*, 23, 482-489.

09:50 - 11:20

## Invited symposia

### IS-SH05 Social-Psychological Issues in Team Sports

#### EFFECTS OF COACH-ATHLETE RELATIONSHIP AND COACH LEADERSHIP ON TEAM EFFICACY

Jowett, S.

Loughborough University

**Effects of Coach-Athlete Relationship and Coach Leadership on Team Efficacy** Jowett, S. & Hampson, R. Loughborough University **Introduction** The phenomenon of mediocre players outperforming teams of seemingly superior talent during a match, series or possibly an entire season is something that researchers have recently started to explore through the notion of collective efficacy. Collective efficacy is viewed as a group's shared confidence in their conjoint capabilities to successfully organise and perform collective tasks. Feltz and Chase (1998) highlighted a number of sources of collective efficacy within the context of sport including past performances, leadership/verbal persuasion, vicarious experiences, motivational climate, group cohesion, and team size. While coach-athlete relationships were not mentioned as a potential source of collective efficacy, this study examined the independent and combined effects of coach-athlete relationships and coach leaderships on team efficacy. The rationale for it was that quality relationships is essential for effective and successful leadership (Schrujijer & Vansina, 2002). **Methods** A total of 150 British footballers participated in the study. They responded to instruments measuring the quality of the coach-athlete relationship (CART-Q), coach leadership (LSS), and collective efficacy (CEQS). In order to reveal the contribution of athletes' perceptions of coach leadership and coach-athlete relationship upon perceived collective efficacy, a hierarchical multiple regression analysis using a step-wise method was performed. **Results** The results indicated that leadership behaviours ( $F(5, 144) = 10.16, p < .01$ ), direct-perspectives of the coach-athlete relationship ( $F(8, 141) = 7.78, p < .01$ ), and meta-perspectives of the coach-athlete relationship ( $F(11, 138) = 6.7, p < .01$ ) all significantly predicted collective efficacy. **Discussion** Results highlighted that leadership variables and relationship variables together accounted for more efficacy variance than did each set of variables separately. Thus the coach-athlete relationship just like coach leadership is a potential psychosocial source of collective efficacy and thus could be added to the antecedents of collective efficacy. This study has both theoretical and practical significance. **References** Feltz, D.L., & Chase, M.A. (1998). The measurement of self-efficacy and confidence in sport. In J.L. Duda (Ed.). *Advances in sport and exercise psychology measurement*. (pp.65-80). Morgantown, WV: Fitness Information Technology. Schrujijer, S. G. L., & Vansina, L. S. (2002). Leader, leadership and leading: From individual characteristics to relating in context. *Journal of Organizational Behavior*, 23, 869-874.

## SUCCESSFUL TALENT DEVELOPMENT IN SOCCER: THE CHARACTERISTICS OF THE ENVIRONMENT

Larsen, C.H., Alfermann, D., Christensen, M.K.

*University of Southern Denmark*

**Introduction** A number of more recent studies have investigated talent development environments and the way in which such environments underpin the nurturing of athletic talent. Martindale and Mortimer (2011) highlighted coherent communication and support, ensuring that philosophies, aims and daily practices are coherently linked, which suggests a strong focus on overall strategy and culture of the club. Henriksen, Stambulova and Roessler (2010) have introduced a holistic ecological approach to talent development, which highlights the central role of the overall environment as it affects a prospective elite athlete, and investigated a number of successful athletic talent development environments in different sports and in different Scandinavian countries. Among the common characteristics found in these successful environments was the fact that the environments were characterized by a strong group culture that pervaded every aspect of the environment's functioning. This presentation will present a description of a successful soccer environment (a) provide a holistic description of the environment and (b) highlight the factors influencing its success in the development of elite soccer players. **Methods** The study was organized as an explorative integrative and qualitatively-oriented case study. Methods of data collection included interviewing coaches, prospect soccer players, professional soccer players, parents, and also observations of daily life in the environments to obtain systematic and detailed knowledge of the environment as it occurs in the real world. **Results** The environment was centered on a strong relationship between prospects and a community of coaches, experts, team assistants and club house manager. A learning environment focused on teaching the players a holistic approach, self awareness and the ability to work very hard. **Discussion** These characteristics as well as a strong and cohesive family atmosphere were perceived as essential for success in the environment. We argue that the holistic ecological approach opens new venues in talent development research and holds the potential to change how sport psychology practitioners work with prospective elite athletes. **References** Henriksen, K., Stambulova, N., & Roessler, K. K. (2010). Holistic approach to athletic talent development environments: A successful sailing milieu. *Psychology of Sport and Exercise*, 11, 212-222. Martindale, R. J. J. & Mortimer, P. (2011). Talent Development Environments - Key Considerations for Effective Practice. In D.Collins, H. Richards, & A. Button (Eds.), *Performance Psychology* (pp. 61-77). Kidlington: Elsevier.

## CAREER DEVELOPMENT IN TEAM SPORTS: PSYCHOLOGICAL AND CULTURAL PERSPECTIVES

Alfermann, D.

*University of Leipzig*

**Introduction** The development of athletic careers is subject to several sources of influence from the athletes themselves, the micro-environment (e.g., parents and coaches) and the macro-environment (e.g., culture). In contemporary sport psychology, emphasis is placed on psychosocial variables, with particular focus on the "athletic triangle" — the athlete, the parents, and the coaches (Wylleman and Reints, 2010). As for young athletes' personal resources, the current literature suggests that adherence and success in sport are largely related to measures of achievement motivation and of self-concept. Less emphasis, however, has been placed on possible cultural differences. This presentation will therefore focus on psychosocial factors in different cultural contexts. **Methods** Male adolescent soccer players from China (n = 274, M = 15.8 yrs, SD = 1.0) and Germany (n = 248, M = 14.9 yrs, SD = 1.7), and male adolescent field hockey players from Pakistan (n = 144, M = 16.2 yrs, SD = 1.4) and Germany (n = 127, M = 14.4 yrs, SD = 2.0) who were all in the developmental phase of their career filled in standardized scales of motivation (goal orientation and competitive anxiety), and of physical self-concept. **Results** It was hypothesized that due to the high emphasis on collectivistic values in China and Pakistan, players from these countries would score higher on competitive orientation and competitive anxiety, but lower on physical self-concept. As expected, Chinese and Pakistan players showed higher ego and lower task orientation and higher cognitive anxiety than German players. With regard to physical self-concept, results showed the expected large differences in all subscales between German and Chinese players, and small, but significant differences in three subscales between German and Pakistan players, with Germans scoring higher than players from China and Pakistan. **Discussion** The recommended or/and typical empirical pattern of results in Western countries for a promising athletic career shows a relatively high physical self-concept, higher task than ego orientation, and low cognitive anxiety in competitions. In both studies, German athletes showed this "recommended" pattern of results. In contrast, Chinese and Pakistan athletes scored differently on these variables. The question is, if this would hinder their career or if this pattern of results is functional for the players within their cultural environment. It is suggested to consider culture as an important social influence factor in career development and to be sensitive to cultural differences in players' development. **References** Wylleman, P., Reints, A. (2010). *Scandinavian J Med Sci Sports*, 20 (Supl. 2), 88-94.

**09:50 - 11:20**

## Invited symposia

### IS-BN04 Balance Control in Elderly: Fall Risk and Prevention

#### EXERCISE FOR PREVENTING FALLS IN OLDER PEOPLE: SYSTEMATIC REVIEW AND DISCUSSION OF CRUCIAL COMPONENTS OF EFFECTIVE PROGRAMS

Lord, S.

*Neuroscience Research Australia*

Exercise is recommended in evidence-based guidelines for fall prevention. However, there are many different types of exercise; some of which are likely to result in greater reductions in falls than others. It is therefore important to identify exercise types and components that are optimal for maximising physical functioning and preventing falls in the elderly. This presentation will initially provide a summary of the findings from a recent systematic review of 54 randomised controlled trials that have evaluated the effectiveness of exercise interventions in preventing falls in older people. The review meta-analysis revealed that exercise as a single intervention was effective in preventing falls (OR=0.84, 95% CI=0.77-0.91) and meta-regression revealed that programs that included (a) challenging balance exercises (exercises

conducted while standing in which people aimed to stand with their feet closer together or on one leg, minimize use of their hands to assist, and practice controlled movements of the centre of mass), (b) a higher total dose of exercise (>50 hours over the trial period) and (c) did not include a walking program, to have the greatest effect on reducing falls. Resistance, endurance and flexibility training provide additional benefits if combined with balance exercises. Whether the exercise is conducted in a group or on an individual basis was unimportant. The presentation will conclude by providing examples of effective exercise fall prevention programs evaluated in randomised controlled trials in Australia and New Zealand. These trials have included diverse exercise programs (home-based physiotherapy, group exercise and Tai Chi), but all have included the crucial component of high intensity balance training.

### **GAIT STABILITY AND FALL RISK IN THE ELDERLY, THE IMPORTANCE OF MUSCLE STRENGTH**

van Dieën, J.

*VU University Amsterdam*

Falls are common incidents, which can have major consequences. Especially among older adults, falls occur frequently, even in the large group of relatively fit and healthy elderly. Consequences of falls are known to contribute substantially to the prevalence of health problems, to health care costs, and to lost quality of life. The fact that the population of elderly is rapidly growing in the industrialized world suggests that the scope of this problem can be expected to increase in future decades. To develop effective and efficient approaches towards fall prevention in the elderly, causal factors for falls among the elderly need to be determined. Many epidemiological studies have been published on predictors of falls in the elderly. However, given the limitations of such observational designs, these studies often only provide general directions for prevention. Experimental studies can complement data from observational studies with more detailed insight, which can be used to determine who are at risk for falls and which are the modifiable factors determining fall risk. I will present evidence from a series of experimental studies to show that muscle strength may be a key factor in preventing falls after a perturbation of gait. Inverse dynamics analysis of recovery reactions after a trip showed that rapid development of high joint torques is necessary to prevent a fall. In older adults, and in older fallers in particular, the rate of moment development was reduced. In addition, isometric strength measurements were shown to differentiate older adults that fell during the experiments from those that did not fall. While recovery reactions after major perturbations of gait clearly require high muscle strength, it is less obvious to what extent strength is a determinant of stability of steady-state gait, which is a sub-maximal task for most individuals. Therefore, we have recently performed a cross-sectional study relating muscle strength to gait stability in a cohort of older adults and an experimental study on the effects of unilateral leg muscle fatigue on gait stability in older adults. The observational data show a moderate but significant correlation between muscle strength and stability of steady-state gait. In addition, leg muscle fatigue caused a decrease in gait stability in older adults, in spite of compensatory changes in the gait pattern. In conclusion, both the ability to recover from major mechanical perturbations of gait and the ability to deal with the small perturbations that occur continuously even in steady-state gait appear to be limited by muscle strength.

### **BALANCE AND AGEING: NEUROMUSCULAR ASPECTS**

Baudry, S.

*Université Libre de Bruxelles*

One of the functional consequences of the ageing process is a decrease in balance stability, as evidenced by the greater sway amplitude during upright standing in elderly compared with young adults. This decrease in balance stability has been attributed to alterations in muscular, vestibular, visual and proprioceptive systems. For example, the responsiveness of the muscle afferent pathway is reduced at rest in elderly adults, suggesting an alteration in the efficacy of this pathway to activate spinal motoneurons. Moreover, the modulation of this pathway for leg muscles in upright stance also differs with age (Koceja & Mynark, 2000) likely due to a distinct control at a presynaptic level that reduces the direct contribution of muscle spindle afferents to the motoneuron activation in elderly adults. In addition, the spinal pathway that conveys inhibition from muscle spindle afferents of a muscle group to its antagonist counterpart is less active in elderly adults and should contribute to the greater leg muscle co-contraction observed in elderly adults when standing. Nonetheless, compared with the expected role of the stretch reflex in balance control, recent work reported paradoxical muscle movements during upright stance. Indeed, based on the pioneer work of Sherrington at the beginning of the 20th century, it was assumed that reflex activities originating from muscle sensors play a key role in controlling upright posture. However, the observation that plantarflexor muscles shortened during forward sways and lengthened during backward sways questions whether the stretch reflex contribute by itself to postural sways (Loram et al. 2004). Furthermore, the magnitude of muscle length changes is decreased in elderly adults while no significant differences were observed for tendon lengthening and shortening during sways (Baudry et al. 2012). This suggests that elderly adults increase muscle stiffness when standing, likely to compensate for the age-related decrease in tendon stiffness (Narici et al. 2008). Such observations indicate an age-related change in the control of leg muscle activity to provide the adequate ankle joint stiffness for maintaining upright standing. Such a shift could be responsible for the progressive increase in cognitive demand required by balance control, as attested by the greater postural instability of elderly adults when performing a cognitive task while standing upright (Shumway-Cook & Woollacott, 2000). Together, these changes impair the performance of elderly adults in daily living tasks that require balance control and challenge the independence of this growing part of the population. Baudry et al. *J Appl Physiol* 112:296-304, 2012; Koceja, Mynark, *Int J Neurosci* 103:1-17, 2000; Loram et al. *J Physiol* 556: 683-9; Narici et al. *Disabil Rehabil* 30:1548-54, 2008; Shumway-Cook & Woollacott, *J Gerontol* 55:10-6, 2000.

09:50 - 11:20

## Oral presentations

### OP-BN07 Coaching

#### PASSING IN FOOTBALL: FAST OR SLOW, HOW TO DECIDE?

Vicente, A., Fernando, C., Lopes, H.

*University of Beira Interior, University of Madeira, CIDESD*

**Introduction** It's common to believe that success in football depends on the speed at which problems are solved: it is accepted that players need to be faster, shoot with greater speeds, dribble faster or pass the ball with higher speeds. We have already verified (e.g. Vicente et al., 2010; Vicente et al., 2011) that in the feint and in the penalty kick in football there is a relation between the velocity of the stimulus and the response time: higher stimulus velocity tend to involve higher response times and vice-versa. Does the same occur in a passing situation in football where players also need to take into account other players actions (teammates and opponents) to act? The aim of this study was to verify whether a correlation exists between the velocity of the stimulus in a passing situation in football and the player's response. **Methods** We've used a software (MeSiR1.2) designed to measure the relation between the velocity of the stimulus and the time to respond it. In a very simplified way, the test was based on a stimulus that consisted on a defender that moved from the center of the screen to each side (overcoming 3 meters in a real football field) at different velocities (5, 3 and 1 meter per seconds) randomly. The players (45 university football players) had to press one of six matching letters in the keyboard previously known for six possible passing ball velocities (Q(10km/h), W(30km/h) and E(50km/h) for left, and I(10km/h), O(30km/h) and P(50km/h) for right) for 24 trials. Each test data was automatically collected by the software which provided the response time (and correspondent ball velocity) to each stimulus velocity. **Results** From the 1080 trials performed, the results showed that for the fastest stimulus the average response time was 280 milliseconds; for the 3m/s velocity players took in average 328ms to respond, and for the slowest stimulus the average time to respond was 343ms. Players choose the faster ball velocity in 79% of the fastest stimulus, and 84% of the times the slowest ball speed in the parallel slowest stimulus. **Discussion** The results showed that the stimulus velocity influenced the response time and the hypothetic passing ball velocity. As the stimulus was faster or slower, the response was also faster or slower respectively; also as the stimulus was faster or slower, the ball velocity chosen was also faster or slower. This may suggest, as indicated by ecological studies that we are still carrying out, that in passing in football where players are permanently exchanging stimulus with the opponents and teammates in order to get advantage over the first ones and trying to coordinate to the second ones, players should be trained to relate with the opponents and teammates being aware that they can influence their actions and their response time. **References** Vicente A., Lopes H., Fernando C. (2011). 7th WCSF, Nagoya. Vicente A., Fernando C., Lopes H., Almada F. (2010). 15th ECSS, Antalya.

#### COMPARISON OF DIFFERENT FORMAT OF 15-SEC INTERMITTENT EXERCISES IN YOUTH SOCCER PLAYERS – WITH A SPECIAL REFERENCE TO THE PHYSIOLOGICAL IMPACT

Chardon, F.

*Université Claude Bernard Lyon 1*

**Comparison of different format of 15-sec intermittent exercises in youth soccer players – with a special reference to the physiological impact.** Chardon F. (1), Dellal A. (2), Pialoux V. (1), Hautier C. (1). (1) Sport Science University of Claude Bernard, Lyon, France; (2) Olympique Lyonnais FC (soccer) **Introduction** The ability to repeat high intensity actions is an essential characteristic in elite soccer. In this context, intermittent exercises (i.e. 15-15-sec) are commonly used in order to improve this capacity but there is not a consensus of their characteristics, especially in youth categories. Therefore, the aim of this study was to compare different type of 15-15-sec intermittent exercises and to examine their physiological impacts on elite young soccer players. **Methods** Twelve U17 players (172.9±5.8 cm; 64.5±5.8 kg, HRmax: 198.6±7.9 bpm, MAS: 15.6±0.9 km.h-1) from the same elite team participated in this study. During a 5-a-week period of competitive season, players have performed according to their individual maximal aerobic speed (MAS) the following different format of 15-sec intermittent exercises during 2 blocks of 8 min with active recovery: 1) 15-15-sec in-line running at 115% of MAS; 2-3) 15-15-sec including 180° turns at 110% and 115% of MAS; 4) a 15-15-15-sec at 115% of MAS; and 5) 15-45-sec including in-line running at 115% of MAS and specific physical (footwork) and technical actions (with the ball) according to the playing position. Players were tested in the Vameval test, 30-15 intermittent fitness test (30-15IFT) and a repeated sprint ability (RSA) test before and after the 5-a-week period. Heart rate responses during the exercise (HRres), heart rate recovery (HRR) post-exercise and ratings of perceived exertion (RPE) were monitored during all the tests and intermittent exercises. **Results** The intermittent exercise including 180°directional changes induced higher HRres responses and RPE values than during the others intermittent exercises (p<0.05). The lower HR responses, HRR and RPE values were observed during the 15-15-sec including the ball (p<0.001). Furthermore, the combination of the different format of intermittent exercises during the 5 weeks not improved the performance in the different tests (NS). **Discussion** The present study revealed that the 15-sec intermittent exercises with directional changes allow to reach higher HR response and RPE in youth soccer players whereas it is was the opposite for the format including the ball. These greater physiological responses are probably due to this format including 180° turns induced a deceleration, a block and a re-acceleration, and therefore a greater peripheral and anaerobic solicitation. In conclusion, it is suggested that coaches could include and combine different format of 15-15-sec (in-line, with ball and including footwork exercises) without altering the physiological solicitation. However, coaches should pay a special attention to the format including 180° directional changes.

#### IS THE COMMUNICATION OF CORRECTIVE FEEDBACK RELATED WITH ATHLETES' PERCEIVED JUSTICE OF THE COACH

De Backer, M.

*KULeuven*

**IS THE COMMUNICATION OF CORRECTIVE FEEDBACK RELATED WITH ATHLETES' PERCEIVED JUSTICE OF THE COACH** De Backer, M. 1, Ceux, T. 1, Callens, F. 1, Vandebroek, G. 1 1: KULeuven (Leuven, Belgium) **Introduction** Perceived justice of the coach is a key predictor of elite athletes' team identification and cohesion (De Backer, 2011). Considering the fact that both team identification and team cohesion have shown to be linked with performance (Carron, Colman, Wheeler, & Stevens 2002; Walumbwa, Cropanzano, & Hartnell, 2009), coaches

must be concerned about their players' perception of fairness. Therefore, the aim of the present study was to examine if the communication style of corrective feedback (i.e., autonomy supportive or controlling) and the transparency of the coach would affect team athletes' perceived justice. Method Elite female volleyball players ( $N = 56$ ;  $M = 22.33$ ) and elite male handball players ( $N = 35$ ;  $M = 23.59$ ) from Belgian top level teams completed one general and five weekly web-based questionnaires during consecutive midseason weeks. We used MLwiN software to perform the multilevel analyses. Results The results showed that autonomy supporting corrective feedback positively predicted overall perceived justice ( $p < .01$ ). In contrast, controlling corrective feedback negatively predicted perceived justice ( $p < .05$ ). Furthermore, coaches' transparency was positively related to athletes' perceived justice ( $p < .01$ ). This positive effect was stronger when coaches used controlling feedback than when they communicated their feedback in an autonomy-supportive way. Discussion The style of providing corrective feedback and the transparency of the coach are significant predictors of team athletes' perceived justice of the coach. Our results might be explained by the fact that, players who get autonomy supporting feedback will understand the purpose of this feedback and as a result, perceive their coach as fair. However, players who get controlling feedback lack this understanding. Consequently, it is vital for coaches to be transparent and explain this controlling corrective feedback afterwards. Otherwise athletes can misinterpret the coach's motives and intentions and perceive him as unfair. References Carron, A. V., Colman, M. M., Wheeler, J., & Stevens, D. (2002). Cohesion and performance in sport: A meta analysis. *Journal of Sport & Exercise Psychology*, 24, 168-188. De Backer, M., Boen, F., Ceux, T., De Cuyper, B., Høigaard, R., Callens, F., et al. (2011). Do perceived justice and need support of the coach predict team identification and cohesion? Testing their relative importance among top volleyball and handball players in Belgium and Norway. *Psychology of Sport and Exercise*, 12, 192-201. Walumbwa, F. O., Cropanzano, R., & Hartnell, C. A. (2009). Organizational justice, voluntary learning behavior, and job performance: A test of the mediating effects of identification and leader-member exchange. *Journal of Organizational Behavior*, 30, 1103-1126.

### TACTICAL ANALYSIS ON 9 WOMEN WATER POLO MATCHES DURING THE 2011-2012 REGULAR SEASON

Napolitano, S., Di Tore, A., Raiola, G.

*University of Salerno*

Introduction The coaches of team sports analyze matches and performances of team and opposing teams to get useful data in coaching (Hughes&Franks, 2008). Water polo have some distinctions, compared to other team sports because it develops in water that has much more resistance than in other fluids. So it has a significant impact on game development, allowing a detailed analysis of attack and defense patterns. However, in water polo lacks a codified tactic system for training, which is thus only left to the coaches' expertise This work examined 9 women water polo matches during season 2011/2012 (Italian female Serie A1), considering tactical patterns suggested by the coach in relation to tactical patterns implemented during the game and to actions number and outcome, in order to acquire elements useful to create a codified tactic system Methods It uses pilot work and the research approach is integrated and consists of 3 distinct methods: case study (9 matches of Italian Serie A1 Women's Championship, season 2011/2012, played by Volturno) for the analysis of matches, action research method for coach contribution, and theoretical-argumentative to deduce a theoretical framework in which define the data processing The survey of data is entrusted to performance analysis, carried out by a team: performance analyst, coaches and statistical analyst "The practical value of performance analysis is that well-chosen performance indicators highlight good and bad techniques or team performances" (Hughes 2008) The tool used for measuring is the Dartfish TeamPro software The assessment of compliance for the tactical patterns has prescribed by the coach with the tactical patterns implemented in training session, based on previously determined parameters Results The performance analysis was performed to evaluate parameters as frequency of occurrence of actions, time duration, number, result, position and type of shots in relation to tactical patterns, and an evaluation table was constructed by combining the Boolean evaluation of the coach on the compliance of patterns with the action final outcome. The results show a positive and statistically significant correlation ( $p > 0.6$  for up to now processed data) coefficient between tactical compliance and action outcome "The correlation coefficient indicates magnitude or amount of a relationship and the direction of relationship" (Morrow 2010) Discussion The results confirm the need for developing a shared tactical system to analyze waterpolo through tactics References Hughes, MD, Franks I. (2008) Notational Analysis of Sport: Systems for Better Coaching and Performance in Sport, Routledge Hughes, M. (2007). The essentials of performance analysis: an introduction, Taylor & Francis. Morrow, J. R., A. Jackson, et al. (2010). Measurement and Evaluation in Human Performance, Human Kinetics

### MANAGING ATHLETES ON THE EDGE: OVERTRAINING AND THE COMPLEXITIES OF COACHES' DECISION MAKING

Smith, T., Pope, C., Penney, D.

*University of Waikato*

Introduction In many elite sport performance contexts it is acknowledged that overtraining is a critical issue for coaches to understand, be able to recognise and respond to. While much scientific research has been conducted on overtraining, no diagnostic test exists that reliably predicts impending overtraining. The research reported in this study anticipated that successful endurance coaches have developed effective strategies for managing overtraining amongst elite athletes. In a first of its type, this study explored in depth the practices and beliefs of three highly successful professional elite rowing coaches as they managed the risk of athlete overtraining during crucial periods of intensive training. Methods The coaches took part in a series of open-ended semi-formal interviews that explored their practices, philosophies and experiences. This study draws on sociological perspectives pertinent to coaching pedagogy and more specifically, the tenets of naturalistic decision making in exploring how the coaches define and make decisions about overtraining. This framework reflects recognition that coaching involves decision-making in complex and demanding situations. Results The coaches were found to monitor the fatigue of their rowers through observation, communication and measures of training pace. In general, the intuitions and cues for overtraining employed by them had little in common with those promoted in the sport science and medical literature. Discussion We contend that the coaches' decision-making is based largely on subjective processes and influenced by various stressors unique to their positions, which may explain the differences between their definitions and practices and those of the sport science and medical fraternity. We suggest that successful coaches have unique insights into this topical area that is worthy of further exploration.



**09:50 - 11:20****Oral presentations****OP-PM33 Training and Testing: Pacing Strategies****MATCH FATIGUE IN ELITE AUSTRALIAN FOOTBALL, RUGBY LEAGUE AND SOCCER PLAYERS**

Varley, M.C., Aughey, R.J., Gabbett, T.J.

*Victoria University*

MATCH FATIGUE IN ELITE AUSTRALIAN FOOTBALL, RUGBY LEAGUE AND SOCCER PLAYERS Varley, M.C. 1, Aughey, R.J. 1,2, Gabbett, T.J. 3,4 1: School of Sport and Exercise Science, Institute of Sport, Exercise and Active Living (ISEAL) Victoria University, Melbourne, Australia 2: Western Bulldogs, Melbourne, Australia 3: School of Exercise Science, Australian Catholic University, Brisbane, Australia 4: School of Human Movement Studies, The University of Queensland, Brisbane, Australia Introduction Players in all football codes may experience fatigue during a match, however it is unclear whether between-code differences exist in any performance decrements. Our aim was to investigate the reductions in physical performance in footballers during soccer, Australian football and rugby league matches, played at the highest level of competition in Australia, using the same analysis technique and movement definitions. Methods Movement data were collected via 5-Hz global positioning systems from 28 elite Australian football, 36 rugby league and 30 soccer players competing in the Australian Football League (AFL), National Rugby League (NRL) and Australian A-League. Distance covered in the first and second halves were reported for the movement categories; low-intensity activity (LIA; 0.1–5.4 m.s<sup>-1</sup>) and high-velocity running (HiVR; ≥5.5–10 m.s<sup>-1</sup>) as well as the number of maximal accelerations (>2.78 m.s<sup>-2</sup>). All data were expressed relative to playing time. Main effects were tested for code and half using a two-way mixed method ANOVA. Tukey post hoc testing was used to determine specific between-code differences and paired samples t-tests for within code-differences. Results Australian footballers covered a greater HiVR distance than NRL and soccer players in the first half ( $P<0.001$ ,  $14.5 \pm 4.7$  vs.  $5.2 \pm 3.1$  vs.  $5.6 \pm 2.8$  m.min<sup>-1</sup> respectively). While NRL and AFL players experienced a 12 and 13% decrement in HiVR distance ( $P<0.001$ ) during the second half, HiVR distance was maintained by soccer players ( $P=0.896$ ). The LIA distance performed by soccer and AFL players was significantly reduced ( $P<0.001$ ) in the second half by 6% and 5% respectively, but no first half to second half decrements in LIA were observed in NRL players ( $P=0.455$ ). All codes performed fewer accelerations ( $P<0.05$ ) in the second half (-14%; AFL, -18% NRL and -8% soccer) compared to the first half. Discussion Australian footballers experienced decrements in all running activities in the second half despite being allowed unlimited player rotations. This is likely due to the large HiVR distances covered per minute. Similarly, the reduction in HiVR distance in NRL may be due to the high number of accelerations per minute or other physically demanding tasks such as collisions and rapid changes in direction. In soccer, players must physically prepare with the expectation of playing a full match, thus players may adopt a pacing strategy to conserve energy by reducing LIA in order to maintain HiVR.

**PACING STRATEGY DURING A SIMULATED MOUNTAIN BIKE RACING**

Viana, B.1, Impellizzeri, F.M.2,3, Inoue, A.1, Santos, T.M.1

*1:PPGCEE-UGF (Rio de Janeiro, Brazil), 2: Schulthess Clinic (Zurich, Switzerland), 3: University of Verona (Italy)*

Introduction Mountain biking is a high-intensity endurance event. Studies have shown very high heart rates at the beginning of Olympic cross-country (XCO) competitions, corresponding to the fastest lap time (Impellizzeri and Marcora, 2007; Stapelfeldt et al. 2004). However, the pacing strategy of XCO simulations has not been purposely examined. The aim was to examine the pacing strategy adopted during a simulated XCO race by bikers with different performance levels. Methods Regional and national level bikers from Brazil ( $n=17$ ,  $30.2 \pm 5.6$ yr,  $174.8 \pm 5.5$ cm,  $67.9 \pm 6.3$ kg,  $292.4 \pm 21.9$ Wmax and  $64.4 \pm 4.5$ ml/kg/min) performed an incremental exercise test and an XCO race simulation on Computrainer™ (Seattle, USA). The simulation consisted of four laps (9.9km and 0-10% grade each). All athletes were asked to complete the race in the shortest time as possible. Heart rate (HR) was monitored using Polar®RS800CX. Subjects were divided into two groups (high and low) based on performance time. Results No group x time interactions were found in lap time ( $p=0.153$ ; linear), RPE ( $p=0.551$ ; linear), HR ( $p=0.145$ ; linear and cubic), power in W/kg ( $p=0.584$ ; linear). The decrease in performance every lap was linear ( $p<0.001$ ), with the last lap being slower than the first lap ( $3.49 \pm 0.6$ min; [CI95% 1.57, 5.42];  $p=0.001$ ). Based on a regression analysis, the riders decreased power every lap by 0.21W/kg corresponding to a lost of 1.6min. The power output decreased in the last lap compared to the first ( $42.9 \pm 7.2$ W; [CI95% 20.3, 65.5];  $p=0.000$ ). Both HR and RPE increased linearly with the last lap showing higher values than the first ( $4.4 \pm 0.9$ beats/min; [CI95% 1.5, 7.2];  $p=0.003$  and  $32.8 \pm 3.6$ ; [21.3, 44.5];  $p=0.000$ ). The mean power and HR of the simulation was  $234.9 \pm 31.1$ W ( $3.5 \pm 0.5$ W/kg) and  $173.7 \pm 10.8$ beats/min. Discussion During the simulation a pacing strategy similar to that reported for real events was found (Impellizzeri et al., 2002; Stapelfeldt et al., 2004). Furthermore, the pacing seems to be not influenced by the performance level. Although the strategy adopted (first laps faster) has been demonstrated to be detrimental to performance (Foster et al., 1993), the use of a faster start is technically important for the success in XCO because the cyclists can gain the first positions for avoiding to be slowed down by other riders, especially in the single tracks. In conclusion the study showed that the simulation has a good external validity and may be potentially useful for investigating the effect of interventions in controlled laboratory conditions.

**RELIABILITY OF PACING PROFILES DURING COMPETITION IN TOP-LEVEL SWIMMERS**

Skorski, S.1, Faude, O.1,2, Meyer, T.1

*1University of Saarland, 2University of Basel*

Introduction Estimates of the variation in performance between competitive events are useful for coaches and scientists to determine the size of a performance enhancing strategy (Stewart & Hopkins, 2000). Since it is assumed that pacing has a major effect on competition (CO) performance, the aim of this study was to analyze the consistency of pacing profiles (PP) in elite swimmers during 200m front-crawl, butterfly, backstroke and breaststroke CO. Methods Finals of 65 elite male swimmers (age:  $23.6 \pm 2.9$  y, front-crawl:  $n=25$ , butterfly:  $n=15$ , backstroke:  $n=16$ , breaststroke:  $n=15$ ) from 12 different nations in 29 international and national CO during the year 2010 were analysed using the website swimrankings.net. The Pan Pacific Games (PPG) were chosen as the main CO, since it is the international top meeting in non-Olympic and non-WorldChampionship years. Additionally, a CO as close as possible to the PPG (at least national Championships)

was analysed for each swimmer; both were on average  $6.7 \pm 5.8$  weeks apart. Typical error (TE) between COs as well as coefficient of variation (CV) with 90% confidence limits (CI) for each 50m split time as well as for total time between COs were calculated. Results Showing a fast-start profile in all races, no significant differences in PP were observed between COs for all strokes ( $p > 0.63$ ). CV for total time was small: front-crawl: 1.0% (CI=0.8-1.4%), butterfly: 0.8% (CI=0.6-1.1%), backstroke: 2.0% (CI=1.6-2.9%), breaststroke: 1.4% (CI=1.1-2.1%). Regarding split times crawl showed a consistent PP in all sections: CV range 1.3-1.4%. During butterfly and backstroke CVs were low in the first three sections; CV range between 1.5-1.8% and 1.6-1.9%, respectively. The last 50m-section showed greater variability in both strokes (butterfly: 2.0%, backstroke: 2.2%). In breaststroke variability between COs was higher in all sections compared to all other strokes (CV range 2.0-3.0%), except the first one (CV=1.7%). Discussion PP of elite swimmers are consistent during the first 3 sections in 200m front-crawl, butterfly and backstroke. Variability increases towards the end of a race. Breaststroke showed greater variability during the whole race. These results are in accordance with data on the consistency of PP during simulated swimming competitions (Skorski et al., 2011) and support the assumption that pacing is a combination of anticipatory forecasting and actual sensory feedback (Tucker, 2009). References Stewart AM & Hopkins WG (2000) *Med Sci Sport Exerc*, 32, 997-1001. Skorski S, Faude O, Rausch K, Meyer T (2011). *Book of Abstracts of the 15th Annual Congress of the European College of Sport Science*: 183. Tucker R (2009). *Br J Sports Med*, 43, 392-400.

### PACING PROFILES RELATIVE TO INTERCHANGES IN ELITE RUGBY LEAGUE

Highton, J.1, Waldron, M.1,2, Daniels, M.2, Twist, C.1

1: University of Chester (Chester, UK), 2: St Helens Rugby League Football Club (St Helens, UK)

Introduction Differences in high-intensity ( $> 14$  km/h) movement between playing positions in elite rugby league match play are well documented (Sykes et al., 2011; Waldron et al., 2011), yet little information exists on the exercise profile of interchanged players. Understanding exercise intensity during multiple interchanges is important for match conditioning, but also offers an opportunity to explore the potential for pacing in team sports due to the unstable nature of the exercise end-point (Edwards & Noakes, 2009). Accordingly, the aim of this study was to document pacing profiles of elite rugby league players relative to the nature of their playing bout. Methods Thirty-five performances from 18 elite males during 14 Engage Super League matches were analysed. Movement characteristics and heart rate (HR) were recorded via a portable 5 Hz GPS device (SPI-Pro; 5Hz, GPSports, Canberra, Australia). Match performances were analysed by quartile and separated in to three categories: whole match ( $n = 19$ ; players who completed  $\geq 80$  min), interchange 1 ( $n = 16$ ; the initial match play bout; mean =  $20.2 \pm 3.9$  min) and interchange 2 ( $n = 9$ ; players coming on for their second bout; mean =  $22.5 \pm 11.0$  min). Results In interchange 2, high intensity m/min declined from quartile 1 to quartile 3 only ( $18 \pm 4.1$  c.f.  $13.4 \pm 5$  m/min), whilst whole match players declined from quartile 1 ( $18.3 \pm 4.7$  m/min) to quartile 4 ( $14 \pm 4.6$  m/min). In contrast, interchange 1 players had a higher initial high intensity m/min in quartile 1 ( $24.2 \pm 7.9$  m/min), which declined progressively between match quartiles. Whole match players' %HRpeak progressively decreased across match quartiles, and was lower at quartile 3 ( $81.7 \pm 4.5\%$ ) and 4 ( $79.9 \pm 7\%$ ) compared to interchange 2 ( $86.3 \pm 5.4\%$  and  $90.3 \pm 2.9\%$ ) and at quartile 3 compared to interchange 1 ( $87.3 \pm 4.2\%$ ). Discussion In agreement with previous rugby league data (Sykes et al., 2011), whole match players demonstrate a subtle progressive decline in high intensity movement. In contrast, players in their first interchange adopt a higher initial exercise intensity followed by a rapid decline. During their second interchange, players exercise at an intensity which is closer to that of whole match players and that can be maintained until the exercise end-point. These data have implications for rugby league interchange strategy and the development of match-specific conditioning programs, and provide preliminary evidence of variable macro-pacing strategies in rugby league (Edwards & Noakes, 2009). References Edwards AM, Noakes TD. (2009). *Sports Med*, 39, 1-13. Sykes D, Twist C, Nicholas C, Lamb K. (2011). *J Sports Sci*, 29, 1263-1271. Waldron M, Twist C, Highton J, Worsfold P, Daniels M. (2011). *J Sports Sci*, 29, 1223-1230.

### COMPARISON OF THE PACING PROFILE DURING INTERMITTENT SINGLE- AND DOUBLE-LEG CYCLE TRAINING

Abbiss, C.R., Peiffer, J.J., Laursen, P.B., Martin, J., Martin, D.T.

Edith Cowan University

Introduction It has been suggested that fatigue during high-intensity exercise may have both central and peripheral origins. Intermittent self-paced single-leg cycling exercise offers a unique model to examine fatigue because it has previously been shown that greater leg blood flow during single-leg cycling permits higher individual-leg cycling power outputs but reduced cardiac load, compared with double-leg cycling. However, how work is self-regulated during intermittent single and double leg cycling is not known. The aim of this study was to examine the self-selected distribution of work during six repeated intermittent double and single leg cycling protocols. Methods In a randomised counterbalanced order, eight endurance-trained cyclists (mass:  $83 \pm 15$  kg,  $VO_{2max}$ :  $55 \pm 7$  ml/kg/min) performed six intermittent cycling sessions (S1-6) using either single- or double-leg cycling. The intermittent cycling protocol consisted of 3 (double) or 6 (3 right and 3 left; single) maximal 4 min intervals, with 6 min recovery between efforts/intervals. Total work and the decrement in work over consecutive intervals and throughout each minute of each interval were calculated. Participants were instructed to complete each of the intervals and each session at their highest sustainable power output. Significance was accepted at  $p < 0.05$ . Results Total work completed in each session was highly reliable (CV: mean S1-6 = 2.5 and 1.8% for single and double-leg training, respectively) and significantly greater in the single compared to the double-leg training condition ( $384 \pm 58$  vs.  $330 \pm 36$  kJ, respectively). The decrement in work each minute during the intervals was greatest during double, compared with the single-leg training condition in S1 ( $4.9 \pm 5.1$  vs.  $-1.3 \pm 5.2\%$ , respectively), but was similar for the remaining trials (S2-6; 0.6 to 2.2%). The decrement in work over consecutive intervals was greater in double, compared with single-leg cycling during all training sessions (mean S1-6:  $3.2 \pm 3.1$  and  $-0.2 \pm 3.2\%$ , respectively). Discussion Following familiarisation, the distribution of pacing during the four minute high-intensity intervals was similar between the single and double leg cycling. Despite, a low per leg power output during the double leg cycling, the decline in work during repeat intervals was greater in double, compared with single leg cycling. It therefore appears that localised fatigue during high-intensity intervals may be reduced when using a reduced muscle mass, possibly by due to greater blood flow and more rapid recovery.

### DO CHANGES IN BRAIN NEUROTRANSMITTER CONCENTRATIONS INFLUENCE PACING STRATEGY IN THE HEAT?

Roelands, B., de Koning, J., Foster, C., Hettlinga, F., Meeusen, R.

Vrije Universiteit Brussel; Funds for Scientific Research Flanders (FWO)

Do changes in brain neurotransmitter concentrations influence pacing strategy in the heat? Bart Roelands, de Koning, J., Foster, C., Hettlinga, F., Romain Meeusen Introduction/purpose: Exercise-induced changes in the concentrations of dopamine, noradrenaline and serotonin have been linked to central fatigue (Roelands and Meeusen, 2010), with the most pronounced outcomes measured when

exercise is performed in the heat. Little is known about the changes in pacing strategy induced by administration of central nervous system drugs acting on these neurotransmitter systems. Methods: Data were collected from 41 subjects ( $W_{max} 341 \pm 37W$ ). All subjects were endurance-trained cyclists and performed 60 min fixed intensity exercise (55%  $W_{max}$ ) followed by a time trial that was started at 75%  $W_{max}$ , but subjects were free to change resistance. Environmental temperature was set at 30°C (relative humidity 50%). Power output was measured continuously and averaged in 5% intervals for statistical analysis. The pharmacological agents bupropion (2x300mg), methylphenidate (20 mg), reboxetine (2x8mg), citalopram (2x10mg) were compared to a placebo administration. Results: Methylphenidate and bupropion (mainly dopamine reuptake inhibitors, noradrenaline to a lesser extent) improved performance and increased core temperature, while no change in RPE and thermal comfort was apparent. The initial decrease in power output – observed in the placebo trial in the heat – was much smaller in the drug conditions. Reboxetine (noradrenaline reuptake inhibitor) significantly decreased performance. Power output during the reboxetine trials decreased more from the outset of exercise compared to the placebo situation. It remained parallel during the middle part of the time trial and was still lower during the end sprint. During the initial ten minutes of exercise, power output declined more in the citalopram trial (serotonin reuptake inhibitor); furthermore, subjects are unable to produce an end sprint after citalopram administration. Discussion/Conclusion: Dopaminergic drugs appear to override a central safety switch and allow athletes to use a reserve capacity that is not present in a normal (placebo) situation as it is a mean to avoid catastrophic outcomes. Manipulations of serotonin but most obviously noradrenaline have an opposite effect and force subjects to decrease power output early in the time trial. Despite the lower power output during the citalopram trial, subjects do not possess the drive and motivation to augment power output when approaching the end point. Reference: ROELANDS, B. & MEEUSEN, R. 2010. Alterations in central fatigue by pharmacological manipulations of neurotransmitters in normal and high ambient temperature. *Sports Med*, 40, 229-46.

09:50 - 11:20

## Oral presentations

### OP-PM34 Metabolic Physiology

#### EFFECT OF STIMULATING SALIVA FLOW ON THE CHANGES IN CORTISOL AND $\alpha$ -AMYLASE WITH PROLONGED EXHAUSTIVE EXERCISE

Allgrove, J., Oliveira, M., Gallen, A., Gleeson, M.

*University of Greenwich at Medway*

Saliva analysis is a useful non-invasive tool commonly used to monitor the stress hormone response to exercise (Chicharo et al., 1998). Athletes frequently consume food and beverages during exercise; however, stimulating saliva flow via mechanical or gustatory stimuli during exercise may alter the quantity and quality of saliva (Allgrove et al., 2007). This study examined the effect of stimulating saliva flow on the levels of cortisol (a marker of the hypothalamic-pituitary-adrenal axis) and  $\alpha$ -amylase (a marker of sympathetic nervous system activity) in response to strenuous exercise. Twelve fit, healthy, men (mean  $\pm$  SD age: 21  $\pm$  2 years; maximal oxygen uptake,  $VO_{2max}$ : 59.1  $\pm$  4.6 ml/kg/min) cycled for 2.5 hours at 60%  $VO_{2max}$  (with regular water ingestion) and then cycled to exhaustion at 75%  $VO_{2max}$ . Timed collections of whole saliva were made immediately before exercise, mid-exercise, after completion of the 2.5 hour moderate exercise bout and immediately after the exhaustive exercise bout. After each unstimulated saliva collection (three minutes) a stimulated saliva flow sample was collected following chewing mint-flavoured gum for one minute. Saliva was analysed for cortisol and  $\alpha$ -amylase activity via ELISA technique and secretion rates were calculated. Data were analysed using a 2-factor repeated measures ANOVA with post-hoc t-tests. Saliva flow rate was ~3-fold higher when saliva flow was stimulated ( $P < 0.01$ ). Saliva flow rate decreased 20% with exercise for stimulated saliva flow only ( $P < 0.01$ ). Exercise was associated with increases in cortisol (52%) and  $\alpha$ -amylase (170%) (all  $P < 0.01$ ). Stimulating saliva flow had no effect on the concentration or variability of cortisol and  $\alpha$ -amylase, though the secretion rates were greater (~3-fold higher) compared with unstimulated saliva flow (both  $P < 0.01$ ). In conclusion, stimulating saliva flow during exercise increased the quantity of saliva but had no effect on the concentration and variability of cortisol and  $\alpha$ -amylase. These findings suggest that stimulating saliva flow via mechanical or gustatory stimuli does not affect the stress hormone response to exercise. Allgrove, et al. (2007) 8th ISEI Symposium. Chicharo et al. (1998) *Sports Medicine*. 26: 17–27

#### DIFFERENTIAL NITRIC OXIDE LEVELS IN THE BLOOD AND SKELETAL MUSCLE OF TYPE 2 DIABETIC SUBJECTS MAY BE CONNECTED WITH ADIPOSITY

Krause, M.1,2, Rodrigues-Krause, J.C.1,2, O'Hagan, C.3, De Vito, G.3, Boreham, C.3, Susta, D.4, Colleran, G.1, Newsholme, P.2,5, Murphy, C.1

*(1) ITT Dublin, Ireland; (2) UCD Conway Institute and (3) Institute for Sport and Health UCD; (4) Dublin City University and (5) Curtin University, Perth, Western Australia*

Background: Nitric oxide ( $NO$ ) exerts key regulatory functions including vasodilation and glucose uptake. Thus reduced  $NO$  levels are associated with insulin resistance and hypertension. In this preliminary work we aimed to measure the levels of  $NO$  metabolites in serum and skeletal muscle of obese and non-obese subjects, with or without T2DM. Methods: Fifteen sedentary male participants [7 obese controls (C) vs. 5 obese and 3 non-obese T2DM; age 54 $\pm$ 9 years] were selected according to their BMI (30kg/m<sup>2</sup> for obese and 23-27kg/m<sup>2</sup> for non-obese participants) and evaluated for fasted values of erythrocyte glutathione (GSH), adiponectin, leptin and cytokines, serum and skeletal muscle nitric oxide metabolites (tNOx) and skeletal muscle nNOS and iNOS expression. Results: In the obese control and obese T2DM group a higher level of leptin (ng/mL) was observed (13.2 $\pm$ 4.7 and 26.3 $\pm$ 1.6, respectively) when compared with non-obese T2DM (2.8 $\pm$ 0.12). The opposite behavior was found for adiponectin concentrations where the non-obese group presents higher levels. TNF $\alpha$  concentration was higher in both obese groups when compared to the non-obese T2DM. Reduced glutathione was highly decreased in the obese T2DM group when compared to the obese control and non-obese T2DM. We found that serum tNOx (total nitrite/nitrate;  $\mu$ M) was lower in obese T2DM group (12.7 $\pm$ 3.5) when compared with their controls (21.1 $\pm$ 2.4), although the non-obese group presented higher concentration of tNOx (33.8 $\pm$ 7.2). Skeletal muscle nNOS was higher in obese controls, lower in non-obese T2DM and undetected in obese T2DM. On the other hand, expression of iNOS had an inverse relationship with nNOS, showing higher expres-

sion in obese T2DM, decreased in non-obese T2DM and absence in obese control group. tNOx levels ( $\mu\text{mol}/\text{mg}$  protein) were decreased in the non-obese T2DM group ( $12.07 \pm 0.59$ ) when compared with the obese control ( $21.68 \pm 6.2$ ) and the obese T2DM group ( $26.3 \pm 7.26$ ). Conclusions: We conclude that the decreased serum NO $\cdot$  production in obesity and T2DM seems to be associated with adipose mass as lower adiposity was associated with normal NO $\cdot$  which was reduced in the skeletal muscle of the non-obese T2DM patients. We suggest that the lower adiposity (and higher adiponectin) in non-obese T2DM could be responsible for differential levels of NO $\cdot$  production and insulin resistance.

### ERYTHROPOIETIN INCREASES FAT OXIDATION IN LEAN RATS AND IMPROVES GLUCOSE REGULATION IN HIGH FAT FED ANIMALS

Ainge, H.1, Madsen, A.3, Simar, D.2, Ruell, P.1, Barres, R.3, Caillaud, C.1

1:USYD (Sydney, Australia), 2:UNSW (Sydney, Australia), 3:NNF-CBMR (Copenhagen, Denmark)

Introduction. Clinical trials using recombinant Erythropoietin (EPO) for the treatment of anaemia report that, in addition to the resolution of anaemia, insulin sensitivity is increased (Khedr et al., 2009), but the mechanism by which EPO influences glucose metabolism is unclear. The aim of this study was to investigate the acute and chronic effects of EPO on glycaemic control using a rodent model of high fat diet (HFD)-induced insulin resistance. Methods. Male Sprague Dawley (SD) received intraperitoneal injections of EPO (Eprex, 500IU/kg) or saline (CON). Physical activity (PA) and energy expenditure (EE) were recorded for 24hrs. In a separate experiment, male SD rats were fed either standard chow (CC, n=16) or HFD for 7 weeks. For 3 weeks, HFD rats received twice a week either an injection of EPO (HFE, n=16) or saline (HFC, n=16). Prior to the first EPO injection, fasting blood glucose (FBG) was measured in all animals. Blood glucose (BG) was also recorded at 15, 30, 45, and 60 min post acute EPO injection in HFE rats. At week 7, all animals underwent an intraperitoneal Glucose Tolerance Test (IPGTT). Muscle tissues were collected 48 hours after the last EPO injection. Results. In chow fed rats, there was no change in PA activity, yet in animals that received EPO, EE increased and respiratory exchange ratio (RER) was reduced during the 12hr dark phase compared to CON. In HFD fed rats, acute EPO injection lowered BG ( $11.9 \pm 2.2\%$ ,  $p < 0.003$ ) during the 60 min post injection. Chronic EPO treatment lowered FBG (CC  $6.3 \pm 0.7$ , HFC  $7.6 \pm 0.5$ , HFE  $5.1 \pm 0.5$ mm,  $p < 0.001$ ), total cholesterol (CC  $69.1 \pm 8$ , HFC  $75.6 \pm 11$ , HFE  $59.6 \pm 5$ mg/ml,  $p < 0.05$ ) and serum TNF- $\alpha$  levels (CC  $0.7 \pm 0.6$ , HFC  $2.26 \pm 0.7$ , HFE  $1.06 \pm 0.7$ pg/ml,  $p < 0.05$ ). During IPGTT, glucose levels were reduced in HFE as compared to HFC ( $p = 0.002$ ). As compared to HFC, HFE rats showed strong trends towards elevation of HSP72 expression, reduced activation of JNK and increased activation of AKT. Conclusion. Here we report that acute EPO treatment enhances fat oxidation and chronic EPO ameliorates glucose metabolism in insulin resistant rats. The fact that normalisation of glucose tolerance was associated with lower cholesterol and TNF $\alpha$  levels strongly suggests that chronic EPO treatment alters glucose tolerance via changes in lipid metabolism and systemic inflammation levels. This effect could be promoted through the elevation of HSP72 expression and the associated reductions in JNK activation, leading to a better insulin action (Chung et al., 2009). References: Khedr et al (2009). Hemodialysis Int. 3. 340-346. Chung et al (2009) Proc Natl Acad Sci USA 105. 1739-1744.

### EFFECT OF MUSCLE BIOPSY SITE ON GENE EXPRESSION IN PATIENTS UNDERGOING TOTAL HIP REPLACEMENT FOR OSTEOARTHRITIS

Okoro, T.1,2, Andrew, J.G.2, Stewart, C.3, Al-Shanti, N.3, Maddison, P.1, Lemmey, A.B.1

1:Bangor University (Bangor, UK), 2: Gwynedd Hospital (Bangor, UK), 3: MMU (Manchester, UK)

EFFECT OF MUSCLE BIOPSY SITE ON GENE EXPRESSION IN PATIENTS UNDERGOING TOTAL HIP REPLACEMENT FOR OSTEOARTHRITIS Okoro, T.1, 2, Andrew J.G.2, Stewart C.3, Al-Shanti N.3, Maddison P.1, Lemmey A.B.1 1: Bangor University (Bangor, UK), 2: Dept. Orthopaedics, Betsi Cadwaladr University Health Board (Bangor, UK), 3: Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University (Manchester, UK) Introduction Severe hip osteoarthritis is associated with increased inflammation and pain. This study aimed to assess the preferential local and distal effects of known hip inflammation on gene expression in the vastus lateralis (VL) muscle of patients undergoing total hip replacement surgery (THR) Methods Following local research committee approval, 17 patients awaiting THR were recruited (average age (mean  $\pm$  SD)  $65.3 \pm 8.8$  years in men (n=9) and  $59.8 \pm 13.3$  years in women (n=9)). Muscle biopsies were obtained from the proximal (3cm distal to insertion on greater trochanter; via the surgical wound) and distal VL (~5cm proximal to suprapatellar pouch) at the time of operation. RNA was isolated from the muscle biopsies obtained and real-time quantitative PCR performed using a panel of genes including those coding for inflammation (TNF- $\alpha$ , IL-6), hypertrophy (JunB, Calpain1 (CAPN1), calpain2 (CAPN2), calpastatin (CAST)), atrophy (myostatin (MSTN), cathepsin 2 (CTSL2)) and lipid metabolism (lipoprotein lipase (LPL), peroxisome proliferated-activated receptors alpha and gamma (PPARA, PPARG)). Gene expression was assessed using the comparative Ct method. Results 17 proximal VL samples and 15 distal VL samples were obtained. Distal vs. Proximal VL analysis revealed little impact of biopsy site on comparative gene expression, with no significant differences evident. Elevations of TNF (%fold increase/decrease (p value)) +16% ( $p = 0.71$ ) and IL-6 +15% ( $p = 0.97$ ), CAPN1 +63% ( $p = 0.71$ ), CAPN2 +110% ( $p = 0.64$ ), CAST +130% ( $p = 0.64$ ) were apparent, but far from significant. Jun B expression declined distally -27.5% ( $p = 0.79$ ), as did MSTN expression (-27%,  $p = 0.54$ ), but again without approaching significance. CTSL2 (+0.1%,  $p = 0.99$ ) showed near equivalence. Non-statistically significant changes were observed with markers of lipid metabolism (LPL (+6.7%), PPARG (+15%) and PPARA (-26.3%). Conclusions Hip joint inflammation appears to have no statistically significant effect on expression of the genes assessed in the VL muscle in this population, suggesting that for these analyses, single site muscle sampling is appropriate for subsequent analyses of training effects.

### IS ELECTRON TRANSPORT ACTIVITY REGULATED BY CONTRACTION? EVIDENCE THAT MITOCHONDRIAL COMPLEX I SENSITIVITY TO NADH INCREASES IN RESPONSE TO EXERCISE IN HUMAN SKELETAL MUSCLE

Perry, C.G.R.1, Herbst, E.1, Wright, D.C.1, Heigenhauser, G.J.F.2, Spriet, L.L.1, Holloway, G.P.1

University of Guelph, Guelph, Ontario

1: University of Guelph (Guelph, ON, Canada), 2: McMaster University (Hamilton, ON, Canada) Introduction Classic models pinpoint the major sites of skeletal muscle metabolic regulation during exercise at key enzymatic control points upstream from the entry point of electrons into the electron transport chain (ETC). The prevailing belief has been that the affinity of respiratory protein complexes (ie. Complex I) to electron entry from reducing equivalents (ie. NADH) is not subject to regulation by signals generated during contraction. One challenge in isolating potential effects of contraction on respiratory complexes is to monitor their activity in real-time while preserving mitochondrial structure and organization within their local environment in situ. Through the use of permeabilized muscle fibre bundles (PmFB) we tested the hypothesis that the sensitivity of complex I to NADH provision increases in response to exercise in human skeletal

muscle, consistent with improved coupling of oxidative phosphorylation to ATP turnover during contraction. Methods Muscle biopsies (vastus lateralis) were taken before and immediately after 2 hr of cycling exercise (~60% VO<sub>2</sub>peak) as well as 3 hr into recovery in 5 lean recreationally active males (mean age, weight, height and BMI: 21.8 ± 0.6 y, 1.78 ± 0.03 m, 76.4 ± 3.9 kg and 24.1 ± 0.9 kg•m<sup>-2</sup>, respectively). PmFB (~2 mg wet weight) were prepared from each biopsy and used to assess mitochondrial respiratory kinetics using high resolution respirometry (OROBOROS Oxygraph-2k). Specifically, in the presence of malate and saturating ADP, pyruvate and glutamate were titrated into separate PmFBs to permit the assessments of the respiratory sensitivity (Km) to each substrate. Results Exercise increased the respiratory sensitivity (decreased Km) for pyruvate by 38% immediately after exercise (p<0.05). However, 3 hr of recovery was sufficient to return pyruvate Km to resting values. Likewise, exercise increased the respiratory sensitivity to glutamate immediately after exercise (26% lower Km, p=0.07), with no effect observed at 3 hr recovery. Exercise did not change the respiratory control ratio (Pre, 11.1 ± 0.9; Post, 9.8 ± 1.0; 3hr Post, 9.1 ± 0.9). Discussion These results provide compelling evidence that exercise transiently increases Complex I sensitivity to NADH as it is unlikely that exercise altered both pyruvate and glutamate metabolism upstream of Complex I (ie. PDH and GDH sensitivities). These findings provide a strong basis for future investigations into the regulation of the ETC in response to exercise, a potential regulatory system which has previously been underappreciated.

## 11:30 - 12:45

### Plenary sessions

#### PS-PL03 Olympism & Sport (\*)

##### THE IOC AND THE OLYMPIC ATHLETE

Engebreetsen, L.

*University of Oslo Medical School*

Since 2007 the International Olympic Committee is developing various programs for prevention of injuries and diseases in high level and recreational sports. This development is occurring with the cooperation of IFs such as FIFA, IHF, IAAF and FINA as well as with renowned research institutions worldwide. The Medical and Science Department of the IOC is currently developing research in the prevention field with several major institutions to focus on research, education and implementation of the new knowledge to all NOCs around the world (2). This strategy is highlighted with the IOC support of special issues of the British Journal of Sports Medicine. Every year at least two consensus conferences will be held- recently on Pre Participation Exams and on Age Determination in young athletes. Finally, the IOC has developed an injury and disease surveillance system for the Olympic Games- successfully conducted in Beijing and Vancouver (1). Through these initiatives, The International Olympic Committee (IOC) will increasingly emphasize the protection of the athletes' health and the prevention of injuries. REFERENCES 1.Engebreetsen L et al Br J Sports Med. 2010 Sep;44(11):772-80. 2. Bahr R, van Mechelen W, Kannus P. Prevention of sports injuries. In: Kjær M, Krogsgaard M, Magnusson P, et al. Oxford: Blackwell Science, 2002:299-314.

##### CAN THE OLYMPIC GAMES CONTRIBUTE TO A BETTER WORLD? LESSONS FROM BEIJING 2008

Brownell, S.

*University of Missouri-St. Louis*

Since the end of the Cold War, the significance of the Olympic Games as a vehicle for inter-state diplomacy has lessened, while greater emphasis has been placed upon the "legacy" of the games for the host city and country. To a degree unprecedented in the Olympic context, human rights advocacy groups utilized the Beijing 2008 Olympics as a platform to exert pressure upon the Chinese government to improve its human rights record. Based on ethnographic fieldwork in Beijing in 2007-2008, interviews, and organizational analysis, this paper examines the relationships among the International Olympic Committee, Beijing organizing committee, Chinese government, human rights groups, and other actors, to provide an empirically-based answer to the question of whether the Olympic Games have the potential to contribute to a better world. It argues that attempts to answer the question have failed to identify the concrete organizational structures and event management strategies that would be necessary for the Olympic Games to fulfill the potential for positive social impact that is claimed for them. Academics have a responsibility to promote a more accurate understanding of the Olympic phenomenon in all its complexity.

## 13:45 - 14:45

### Poster presentations

#### PP-PM27 Training & Testing 6: Swimming

##### BLOOD LACTATE RESPONSE AND VENTILATORY PARAMETERS AROUND THE MAXIMAL LACTATE STEADY STATE IN SWIMMING: A CASE STUDY.

PELARIGO, J.G.1,2, PIMENTA, R.A.1, RIBEIRO, J.1, SOUSA, A.C.1, FARIAS, L.B.3, DENADAI, B.S.4, FERNANDES, R.J.1, GRECO, C.C.4, VILAS-BOAS, J.P.1,2

*1ICIFI2D, Faculty of Sport, University of Porto, Portugal, 2Porto Biomechanics Laboratory (LABIOMEPI), Portugal, 3Regional University of Blumenau - FURB, Brazil, 4São Paulo State University, Brazil.*

Introduction The understanding of the mechanisms that occur at the exercise intensity correspondent to the maximal balance between lactate production and removal, and the intensities above (metabolic imbalance) and below (prolonged metabolic stability), is important

to understand the respiratory adjustments that occur in parallel with the lactate responses during aerobic capacity training exercise. The objective of this study was to analyze in a case study, the respiratory adjustments required to perform the maximal lactate steady state test (100%MLSS), and compare them with what happens at intensities above (102.5%MLSS) and below (97.5%MLSS) that gold standard intensity for the evaluation of aerobic capacity. Methods One elite female endurance swimmer (16 yr; 56 kg; 1.64 m) performed in different days: 1) a intermittent incremental protocol until voluntary exhaustion, with steps of 200m, increments of 0.05m.s<sup>-1</sup> and 30s rest intervals to determine the velocity (v), blood lactate concentration ([La-]), expiratory ventilation (VE) and the peak oxygen uptake (VO<sub>2peak</sub>); 2) three to five 30min sub-maximal continuous tests to determine v, [La-], VE and oxygen uptake (VO<sub>2</sub>) corresponding the 100%MLSS, 97.5%MLSS and 102.5%MLSS (Pelarigo et al., 2011). The VO<sub>2</sub> and VE values were directly and continuously measured using a telemetric portable gas analyser (K4 b2, Cosmed, Italy), connected to a special respiratory snorkel (Baldari et al., 2011). The values were analyzed at the 3rd and the last minute of the continuous test. Results At the intensities corresponding the 97.5%MLSS and 100%MLSS (1.30 and 1.33m.s<sup>-1</sup>), a stability in [La-] was observed (1.4 – 1.3 and 1.7 – 1.9mmol.l<sup>-1</sup>, respectively) and a slightly decrease in VO<sub>2</sub> and VE from the 3rd to the last minute of exercise (respectively: 50.81/49.7 – 72.68/69.91 and 56.70/51.66 ml.kg.min<sup>-1</sup> – 76.71/71.5 l.min<sup>-1</sup>). At an intensity of 102.5%MLSS (1.36m.s<sup>-1</sup>), any stability of physiological parameters was not observed – exhaustion at the 27th min ([La-] = 3.3 – 4.1mmol.l<sup>-1</sup>) with a slightly decrease in VO<sub>2</sub> and increase in VE between the 3rd and the last minute of exercise (57.90/57.30 ml.kg.min<sup>-1</sup> and 82.94/97.12 l.min<sup>-1</sup>). At the intensity corresponding the VO<sub>2peak</sub> (1.44m.s<sup>-1</sup>), the values of VO<sub>2</sub>, VE and [La-] were, respectively, 72.59 ml.kg.min<sup>-1</sup>, 90.74 l.min<sup>-1</sup> and 4.4mmol.l<sup>-1</sup>. Conclusions Thus, even the exercise being conducted or in stability or in metabolic imbalance, it seems that the swimmer adopts other adjustments (hydrodynamic drag / propulsive efficiency) to decrease the oxygen uptake between the 3rd and the last minute of exercise during the 30min test, making the aerobic bioenergetic system apparently more efficient along time. References Pelarigo JG et al. (2011). J Sci Med Sports, 14, 168.e1-168.e5. Baldari C et al. (2011). Port J Sports Sci, 11, (suppl 3): 65-68. Acknowledgments This research was supported by grants from Capes Foundation, Ministry of Education of Brazil.

### OXYGEN UPTAKE KINETICS DURING DIFFERENT SWIMMING INCREMENTAL PROTOCOLS

de Jesus, K., Sousa, A., Ribeiro, J., Machado, L., Vilas-Boas, J.P., Fernandes, R.J.

*Faculty of Sport Sciences, University of Porto*

Introduction The maximal oxygen uptake (VO<sub>2max</sub>) is one of the areas of interest in swimming performance and training diagnostic. Despite being widely assumed as a standard for maximal aerobic power, less attention has been given to its kinetics, namely during swimming incremental protocols of different step lengths. Since some authors refer to the necessity of using steps of longer duration, it was aimed to compare the VO<sub>2</sub> kinetics in three variants of a swimming incremental protocol to assess VO<sub>2max</sub>. Methods Four national level swimmers (20.5±3.4yrs, 1.84±0.07m, and 76.5±5.7kg), performed 7x200, 7x300 and 7x400m front crawl incremental protocols until exhaustion, with increments of 0.05m/s and 30s rest intervals between steps, and 24h between each protocol. O<sub>2</sub> was measured bxb (averaged every 5s) using a gas analyzer (K4b2) connected to a snorkel. VO<sub>2</sub> kinetics was estimated using a double exponential regression model. Amplitudes for exponential terms (A1 and A2), time delays (TD1 and TD2) and time constants (τ1 and τ2) were assessed, representing the fast (1) and slow (2) components of VO<sub>2</sub> kinetics. Significance was set at p≤0.05. Results VO<sub>2</sub> kinetics had a similar behavior along the 7x200, 7x300 and 7x400m, respectively: (i) A1 values of 48.7±2.5, 48.5±1.7 and 49.1±1.1ml.kg<sup>-1</sup>.min<sup>-1</sup>; (ii) A2 values of 11.2±2.7, 11.9±1.9 and 11.7±1.7ml.kg<sup>-1</sup>.min<sup>-1</sup>; (iii) TD1 values of 11.3±2.3, 11.6±2.0 and 11.8±2.0s; (iv) TD2 values of 96.5±5.5, 98.7±2.5, 99.2±2.1s; (v) τ1 values of 48.7±1.5, 50.1±1.6 and 54.3±3.4s; and τ2 values of 95.7±1.5, 96.5±1.9 and 99.2±1.7s. Discussion There were no differences in the amplitudes of the VO<sub>2</sub> response corresponding to fast (A1) and slow component (A2), corroborating data observed in running and cycling incremental protocols with 6 vs. 4 and 3 min steps duration (Burnley et al., 2001). No differences were observed for TD1, TD2, τ1 and τ2. Carter et al. (2000), conducting different incremental running and cycling protocols to assess VO<sub>2max</sub>, showed that time parameters remains remarkably constant as exercise intensity increased. Moreover, it has been suggested that the constant time parameters obtained in heavy exercise of long duration, might be related to an increase in lactic acidosis (Burnley et al., 2001). These current results suggest that 200 and 300m should be used in detriment of 400 m steps for VO<sub>2max</sub> assessment in swimming. Furthermore, short steps duration are easy to implement and more specific to the training and competitive swimming requirements. References Carter H, Jones A, Barstow T, Burnley M, Williams C, Doust J. (2000). J Appl Physiol, 89, 899-907. Burnley M, Doust J, Carter H, Jones A. (2001). Exp Physiol, 86, 417-425. Acknowledgements CAPES 5431-10-7/2011

### TIME OF DAY EFFECT ON THE LACTATE MINIMUM ASSESSMENT AND TIME TO EXHAUSTION IN SWIMMING RATS

Beck, W., Scariot, P., Dos Reis, I., Gobatto, C.

*UNICAMP*

Introduction Forced swimming in rats has been used in sports and medicine sciences by presenting several advantages, however, some experiments do not attempt to the nocturnal habits of these animals. Unfortunately, time of day effect on exercise performance in rats has been neglected in the specific scientific literature, despite the potential possibility of influence on the results. The aim of this study was to compare the lactate minimum test (LMT) variables and time to exhaustion at lactate minimum intensity (TTE) at two different times of the day in swimming rats. Methods Eighty rats were used in this study, which was approved by the institutional review board (UNESP protocol 018/2010). Rats were housed under 12/12 h light-dark cycle and were divided in two groups: handled and assessed at 12:00 h (G12, n = 40) or 20:00 h (G20, n = 40). For G20 assessment was used a red filter for the light (>600nm; <15lux). After two weeks of adaptation, at 90 days old, all animals performed the LMT according to De Araujo et al., (2007). LMT intensity (LMI) determination success rate (%S) was accepted for animals that complete at least 3 incremental loads, elicited the "a" positive for polynomial function and the coefficient of determination was greater than 0.80. Forty-eight hours after LMT, 20 rats per group were submitted to an exhaustive trial at the lactate minimum intensity at group's hour. Individual time to exhaustion was taken as the moment at which all coordinated movements ceased and the animal could no longer return to the surface (McArdle and Montoye, 1966). Blood lactate samples (25µl) were analyzed by enzymatic method and all data were compared using unpaired t test (p<0.05). Results LMI determination success rate was 65 % for G12 and 85 % for G20. LMI was 4.94±0.38%bw and 4.89±0.44%bw for G12 and G20 (p=0.71), respectively, being lactatemia equal to 7.29±1.72mM and 6.73±1.96mM (p=0.34). G12 shown lactate peak (lF) at 9.22±1.83mM and G20 at 9.16±2.36mM (p=0.92). The TTE was correspondent to 77.96±30.81min for G12 and 108.89±46.33min for G20 (39.67% greater for G20, p=0.03). Discussion To our knowledge this is the first study addressing the time of day effect on the time to exhaustion at an individualized intensity in rodents. We found that only %S and TTE are affected by the circadian rhythm. LMI do not suffer variations caused by time of day, however, the %S and TTE were greater at dark period, showing this like the ideal moment to aerobic assessment in swimming for rats. References McArdle WD, Montoye HJ. (1966). J Appl Physiol, 21(4):1431-1434. De Araujo GG, Papoti M, Manchado FB, Mello MAR, Gobatto CA. (2007). Comp Biochem Physiol A Mol Integr Physiol, 148:888-892. Supported by FAPESP-Proc. 2011/13226-1

## EVALUATION OF THE AEROBIC CAPACITY IN SWIMMING: COMPARISON AMONG DIFFERENT METHODS IN A CASE STUDY.

PELARIGO, J.G.1,2, PIMENTA, R.A.1, LEAO, H.F.P.3, JÚNIOR, M.A.H.S.3, FILHO, E.A.R.3, SILVA, T.C.A.3, da SILVA, P.M.A.3, DENADAI, B.S.4, FERNANDES, R.J.1, GRECO, C.C.4, VILAS-BOAS, J.P.1,2

*1CIFI2D, Faculty of Sport, University of Porto, Portugal, 2Porto Biomechanics Laboratory (LABIOMEPI), Portugal, 3Federal University of Pernambuco, Brazil, 4São Paulo State University, Brazil.*

**Introduction** In recent decades, one of the most debated topics in sport sciences has been the anaerobic threshold (AnT), with several researchers using different methods (and concepts) to find the intensity associated to the maximal aerobic pace, defined as the highest intensity of exercise that can be maintained without continuous accumulation of lactate along the time (Heck et al., 1985). The aim of this case-study was to compare the generally recognized gold-standard method for the evaluation of the aerobic capacity, i.e., the maximal lactate steady state test (MLSS) with different methods of evaluation of AnT in swimming. **Methods** A female elite endurance swimmer (16 yr; 56 kg; 1.64 m) performed in different days a intermittent incremental protocols until voluntary exhaustion, with steps of 200m, increments of 0.05m.s<sup>-1</sup> between steps and 30s rest intervals, and two to four 30min sub-maximal tests at imposed pace to determine the MLSS, with a 2.5% difference between intensities (Pelarigo et al., 2011). In the incremental test, the blood lactate and the heart rate were analyzed during the 30s rest intervals and, in the MLSS, at the 10th and the 30th minute. MLSS was defined as the exercise intensity correspondent to the highest [La<sup>-</sup>] value that do not increase by no more than 1mmol.L<sup>-1</sup> between the 10th and 30th minute, and calculated as the average of the two [La<sup>-</sup>] values. The individual anaerobic threshold (IAnT) was calculated by the [La<sup>-</sup>] vs velocity curve modeling method (Machado et al., 2006) and the swimming velocity corresponding to 3.5 (3.5AnT) and 4mmol.L<sup>-1</sup> (4AnT) (Heck et al., 1985). **Results** The values of MLSS (1.33 m.s<sup>-1</sup>, 1.80 mmol.L<sup>-1</sup> and 194 bpm) showed that the IAnT (1.30 m.s<sup>-1</sup>, 1.46 mmol.L<sup>-1</sup> and 186 bpm) slightly underestimate the gold standard outcomes, while the 3.5AnT (1.41 m.s<sup>-1</sup> and 201 bpm) and 4AnT (1.43 m.s<sup>-1</sup> and 203 bpm) overestimate the correspondent exercise intensity. **Conclusions** Therefore, when compared the anaerobic threshold assessed through fixed [La<sup>-</sup>] values (3.5 and 4mmol) with the gold-standard method to evaluate the aerobic capacity (MLSS), the difference is higher than when IAnT is used. When MLSS is not possible to implement, the present case study results suggests that the IAnT will allow a more reliable prescription of exercise intensity for the evaluation of elite endurance athletes. **References** Pelarigo JG et al. (2011). *J Sci Med Sports*, 14, 168.e1-168.e5. Heck H et al. (1985). *Int J Sports Med.* 6 (3):117-30. **Acknowledgments** This research was supported by grants from Capes Foundation, Ministry of Education of Brazil.

## RESPIRATORY BEHAVIOR OF SWIMMERS USING A SPIOMETRIC SNORKEL SYSTEM

Götz, J.K., Sperling, W., Schlicht, K., Hartmann, U.

*Universität Leipzig, Faculty of Sport Science*

**Introduction** In front crawl swimming, the timing and duration of breathing, especially for inspiration (Ins), highly depends on the swimming motion. If a snorkel is used, this constraint is canceled. Therefore, it is relevant to know whether the coupling between respiration and swimming movement (CRM), while swimming with the snorkel system, keeps equal or changes to arbitrary breathing. The aim of this study is to investigate the respiratory behavior using a snorkel system for gas analysis in swimming front crawl. We want to determine if there are any differences in the CRM at different performance levels of the athletes and if the increase in movement frequency affects the CRM. Furthermore it should be clarified whether the time of Ins is similar to swimming without snorkel. **Methods** A total of 17 subjects (12 ♂/5 ♀; age 17.7±5.4/16.6±3.4 years; height 185.2±7.1/167.0±4.2 cm; weight 73.3±12.9/55.6±6.4 kg) performed a step test swimming front crawl in the swimming flume. They were divided into three groups, elite, juniors and young swimmers. The test started at a speed of 75% of the actual best time in 200 m front crawl (BT2C), followed by a speed increase of 0.05 m/s every minute until subjective exhaustion. In order to collect the flow-volume curve (FVC) the snorkel system MetaSwim (Cortex, Leipzig) was used. The FVC and the swimming movements were simultaneously recorded on video. Using a double-blind video evaluation the last 30 s of each step were analyzed. In the process the FVC was tracked for the duration of Ins and expiration (Exp). Additionally the swimming movement was checked for the duration of the recovery phase of the arm, in which the swimmer inhaled. The duration of the respiratory cycles were compared with those of the movement cycles. Paired t-tests were used for comparison with a 95% level of confidence. **Results and Discussion** It could be shown that a CRM was not implemented by all athletes. Differences between movement and breathing cycle amounted up to 0.18-0.60 s. The performance level and the increase of the movement frequency were found not to be relevant factors. It was striking, that for all swimmers, who named their main stroke front crawl a CRM could be shown. With prevailing CRM the time of the start of Ins is comparable to swimming without a snorkel. The duration of Ins in swimming with a snorkel is high significantly longer ( $p \leq 0.001$ ) than the duration of the recovery phase of the according arm, which can be explained by the increased dead space of the snorkel. It was noticeable that in exception of one, all swimmers with CRM held their breath after Ins. This means that by increasing the movement frequency not only the duration of Ins and Exp was reduced, but also the duration of the breath holding. This was not seen by swimmers with arbitrary breathing.

## A METHOD FOR DETERMINING CRITICAL FORCE AND ANAEROBIC IMPULSE CAPACITY IN TETHERED SWIMMING

Papoti, M.1, Silva, A.S.R.2, Vitório, R.3, Araújo, G.G.3, Santhiago, V.3, Martins, L.E.B.4, Cunha, A.S.4, Gobatto, C.A.5

*1:UNESP (Presidente Prudente, Brazil), 2:USP (Ribeirão Preto, Brazil), 3:UNESP (Rio Claro, Brazil), 4:UNICAMP (Campinas, Brazil) e 5: UNICAMP (Limeira, Brazil).*

**Introduction** The critical power model has been used to measure aerobic and anaerobic capacity. The aerobic and anaerobic capacities measured in tethered swimming by the critical power model are named critical force (CriF) and anaerobic impulse capacity (AIC), respectively. The objective of this study was to determine whether CriF and AIC - estimated by tethered swimming - reflect the aerobic and anaerobic performance of swimmers. **Methods** Twelve swimmers performed incremental test in tethered swimming until exhaustion to determine lactate threshold (LT), maximal oxygen uptake (VO<sub>2</sub>max) and force of swimming associated with the VO<sub>2</sub>max (iVO<sub>2</sub>max). The swimmers performed four exhaustive (flim) exercise bouts (100, 110, 120 and 130% ) to compute the CriF and AIC (F vs. 1/flim model); a 30-s all out tethered swimming bout to determine their anaerobic fitness (ANF); 100, 200, and 400-m time-trials to determine the swimming performance. **Results** CriF (57.09 ± 11.77 N) did not differ from LT (53.96 ± 11.52 N,  $P > 0.05$ ) but was significantly lower of iVO<sub>2</sub>max (71.02 ± 8.36N). In addition, CriF presented significant correlation with LT ( $r = 0.76$ ;  $P < 0.05$ ) and ( $r = 0.74$ ;  $P < 0.05$ ). On the other hand, AIC (286.19 ± 54.91 N.s) and ANF (116.10 ± 13.66 N) were significantly correlated. In addition, CriF and AIC presented significant correlations with all time-trials. **Discussion** In the present investigation, CriF did not differ from LT, but presented significant correlation with the same

variable. Perandini et al. (2007) found significant correlations between CritF values determined from different mathematical models and CV ( $r=0.89$  to  $0.91$ ), concluding that CritF could be used as an indicator of aerobic capacity. Another interesting finding of our investigation was the significant correlation between AIC and ANF ( $r=0.81$ ;  $P=0.001$ ), and between AIC and maximal free swimming performances. These significant correlations contradicted results generally found in associations between AIC and ANF and between AIC and free swimming performances (Soares et al. 2003, Toussaint et al. 1998, Dekerle et al. 2001). In summary, this study demonstrate that CritF and AIC can be used to evaluate LT and ANF and to predict 100, 200, and 400-m free swimming. References Dekerle J, Sidney M, Hespel JM, Pelayo P. (2002). *Int J Sports Med* 23: 93-98. Perandini, LAB, Okuno, NM, Kokubun, E and Nakamura FY. (2007). *Rev Bras Cineantropom Desempenho Hum* 8: 59-65. Soares, S, Vilar S, Bernardo C, Campos A, Fernandes R and Vilas-Boas, JP (2003). *Portuguese J Sport Sci* 3: 108-110. Toussaint, HM, Wakayoshi, K, Hollander, PA and Ogita, F (1998). *Med Sci Sports Exerc* 30: 144-151.

## SWIMMERS SOMATOTYP PROFILE

Leko, G., Siljeg, K.

*Faculty of Kinesiology*

**Introduction** Morphological structure plays an important role in competitive swimming. Creating a large propulsive force with minimal frontal resistance ensures maximum swimming speed. It is therefore very important to achieve the optimum relationship between muscle mass and adipose tissue in order to achieve maximum results. The aim of this research was to determine the somatotype profiles of 14-16-year-old male swimmers. **Methods** In that regard, 68 swimmers from swimming clubs in Zagreb were examined using 10 anthropometric measurements that were subsequently used to determine the somatotype according to the method proposed by Heath and Carter. **Results and discussion** The results point towards somewhat increased body fat percentage in comparison to swimming population. The somatotype of the examined swimmers indicates strong ectomorphic (3,31) component while the endomorphic (2,21) and mesomorphic (2,34) components are similar in their values. The results indicate that all swimmers evaluated in this research have not completed their pubertal development and that the significant positive relationship can be evident only in the mesomorphic component which is characterized by larger muscle mass and butterfly technique which is the most demanding in terms of energy expenditure. **References** Carter JEL, Heath BA. *Somatotyp-development and applications*. Cambridge: Cambridge University Press, 1992. Carter JEL, Ackland TR. *Kinanthropometry in Aquatic Sports: A study of world class athletes*. Champaign. Human Kinetics, 1994; 158-90. Stang J, Story M. Adolescent growth and development. In: Stang J, Story M. (eds): *Guidelines for Adolescent Nutrition Services*. /on line/, 2004. Wilmore JH, Costill DL. *Children and adolescent in sport and exercise*. U J.H. Wilmore i DL Costill (ur), *Physiology of sport and exercise*. 3. ed. Champaign, IL: Human Kinetics, 2004.

## ANALYSIS OF THE PERCEPTION OF THE EFFORT IN FRONT CRAWL AND BREASTSTROKE SWIMMING

Invernizzi, P.L., Michielon, G., Longo, S., Scurati, R.

*Università degli studi di Milano*

**Introduction** Fatigue is generally defined as a decreased performance due to physiological or psychological limitations. Among them, the intensity and the duration of the exercise and the conscious perception of the effort are very relevant. CR10 scale (Borg, 1982) is useful to measure the perception of the effort during the exercise. This study aimed to assess some subjective features of the perception of effort in breaststroke and front crawl swimming. **Methods** Ten swimmers (18.2±0.2 years, 67.9±3.6 kg, 180±1.0 cm, 21.07±0.66 kg/m<sup>2</sup>) participated in the study. Swimmers were asked to perform 50, 100 and 200 meters front crawl (FC) and breaststroke (BR), at the maximum velocity. The subjective perceptions of the general, muscular and respiratory efforts were assessed through the CR10 scale and compared with respect to the distance and to the swimming technique. **Results** The perception of the effort was higher ( $p<0.001$ ) after the trial on 100m than after the trial on 50m, both in front crawl and breaststroke (AU±SD; general effort: 6.70±1.34 vs. 4.00±0.94 and 8.20±0.79 vs. 3.70±1.16; muscular effort: 6.30±0.95 vs. 3.05±0.90 and 7.50±1.08 vs. 3.90±1.37; respiratory effort: 6.20±1.48 vs. 3.80±1.01 and 7.40±1.17 vs. 3.80±1.03, FC and BR, respectively). The perception of the effort surveyed after the trial on 100m did not differ with respect to the trial on 200m. In the between-technique comparison of the general perception of the effort, CR10 showed lower values in FC than in BR after the 100m trial ( $p<0.05$ , 6.70±1.34 vs. 8.20±0.79, AU±SD). The perception of the muscular effort was also lower in FC than in BR, but only after the 50m trial ( $p<0.05$ , 3.05±0.90 vs. 3.90±1.37, AU±SD). No difference was found between FR and BR in the respiratory effort, in all trials. **Discussion** In front crawl and in breaststroke, the distance seems to have the same effect on the perception of the general, muscular and respiratory effort, measured by CR10 scale. However, these differences are noticeable only comparing the efforts between 50m and 100m. Moreover, even if the energetic demand of front crawl and breaststroke are quite different (Capelli et al, 1998), the participants of the present study seemed to perceive only partially this difference in the general and in the muscular effort perception (in 100m and 50m trials, respectively). In the respiratory effort, subjects scarcely discriminate between the techniques, as expected from the literature. **References** Borg GA (1982). *Psychophysical bases of perceived exertion*. *Medicine and Science in Sports and Exercise*. 1982; 14:377-381. Capelli C, Pendergast DR, Termin B (1998). *Energetics of swimming at maximal speeds in humans*. *Eur J Appl Physiol Occup Physiol*. 1998 Oct;78(5):385-93.

## RELATIONSHIP BETWEEN POWER DECREASE AND SWIMMING PERFORMANCE: A PILOT STUDY

Dias, P., Costa, A., Morouco, P., Garrido, N., Amaro, N., Marinho, D., Marques, M.C.

*Polytechnic Institute of Leiria*

**Introduction** Evaluation of athletes should be specific to nature of the sport. Apart from being used in dry-land, biokinetic swim bench tries to replicate the swimming arm movement. Indeed, Stager and Coyle (2005) stated that the decrease in power production may indicate sprint vs. distance profiles. Therefore, the aim of the present study was to analyse possible relationships between power production in swim bench and swimming performance. **Methods** Five male national level swimmers (age: 18.4 ± 2.3 years; body mass: 73.1 ± 7.7 kg, stature: 1.78 ± 8.3 m) volunteered to take part in the study. After a 600 m standard warm-up, each swimmer performed a 30 s maximum effort in a classic Vasa Swim Ergometer (Vasa, Essex Junction, USA). Individual power to time - P(t) - curves were assessed and registered to obtain the following parameters: maximum power (Pmax), average power (Pavg), average power in first 10 s (10Pavg), average power in last 5 s (5Pavg) and fatigue index (Findex). Additionally, fatigue slope (Fslope) was calculated as proposed by Morouço et al. (2012). One day after each subject executed one 50 m maximum crawl swim in a 25 meters swimming pool, being time registered (t50). After Shapiro-Wilk normality test, paired-samples t-Test to identify differences and Pearson's correlation coefficient (r) to establish relationships between variables were used. The level of statistical significance was set at  $p < 0.05$ . **Results** Swimmers took 3.4 ± 2.2 s to reach maxi-



mum power ( $204.2 \pm 37.5$  W). Average power in first 10 s was significantly higher than in last 5 s ( $181.4 \pm 29.4$  W;  $127.7 \pm 21.6$  W,  $p < 0.001$ ), with an associated Index of  $28.8 \pm 5.7\%$  and an Fslope of  $-2.63 \pm 0.88$ . Swimming performance was  $25.7 \pm 0.75$  s and it presented high correlations with time to reach Pmax ( $p < 0.01$ ), Pmax, Pavg, 10Pavg, 5Pavg and Fslope ( $p < 0.05$ ). Discussion Present data corroborate the studies suggesting that performance in short duration efforts is well related to the stroking power that a swimmer can generate (e.g., Costill et al., 1983). The assessment of this data may be an individual approach to performance in sprint distance races and, therefore, a helpful procedure to coaches. The presented parameter (Fslope) association with swimming performance induces the idea that short distance swimmers present higher decreases in P(t) curve, than long distance counterparts. References Costill DL, King DS, Holdren A, Hargreaves M. (1983). *Swim Tech*, 20(1), 20-22. Morouço P, Vilas-Boas J, Fernandes R. (2012). *Ped Exerc Sci*, in press. Stager JM, Coyle MA. (2005). *Swimming – Handbook of Sports Medicine and Science*, 1-19.

### ASSOCIATIONS BETWEEN PARTIAL TIMES AND TOTAL TIME IN 50 M FRONT CRAWL, ACCORDING TO AGE

Amaro, N., Dias, P., Marques, M.C., Marinho, D., Morouco, P.

*Polytechnic Institute of Leiria*

Introduction In Portugal there are several clubs training in 25 m swimming pools and competing in 50 m ones. Concerning the 50 m front crawl training bouts, it is expected that different velocities are obtained in the first and second 50 m. Coaches are aware of that and estimate differences without taking into consideration the start, turn and gliding. Therefore, the aim of the present study was to analyze possible relationships between times to accomplish 4 m before turn and before finish, with overall 50 m time. Methods Two groups of 6 male swimmers each (G1:  $13.5 \pm 0.32$  years of age,  $49.0 \pm 7.9$  kg,  $1.64 \pm 6.8$  m; G2:  $18.8 \pm 2.64$  years of age,  $73.3 \pm 8.6$  kg,  $1.81 \pm 8.1$  m) took part in the study. After an 800 m warm-up, each subject performed a maximum 50 m front crawl swimming, assessing swimming time (t50). Tests took place in a 25 m swimming pool and two cameras recorded the trials at 60 fps (Casio Exilim, FH1). A PVC structure (15 x 2 m) allowed the calibration of video images. Utilius easy inspect (CCC software, Germany) was used to estimate swimming time in two separate fractions: from 16 to 20 m (t1) and from 41 to 45 m (t2). Since the reduce sample size and the rejection of the null hypothesis in the normality assessment, non-parametric procedures were adopted. The level of statistical significance was set at  $p < 0.05$ . Results In younger swimmers the difference between t1 and t2 presented high correlations with t1 ( $\rho = 0.94$ ,  $p < 0.01$ ) and t50 ( $\rho = 0.81$ ,  $p < 0.05$ ). Were assessed significant correlations between t1 with t50 for G1 ( $\rho = -0.88$ ,  $p < 0.05$ ) and G2 ( $\rho = -0.83$ ,  $p < 0.05$ ). In older swimmers no other relationships were assessed. Coupling groups, multi factorial analysis obtained an adjusted  $R^2 = 0.838$ ,  $p < 0.001$  for  $t50 = 6.464 + (3.968 \times t1) + (5.554 \times t2)$ . Predicted times presented an estimated error of  $0.36 \pm 0.12$  s for G1 and  $-0.36 \pm 1.22$  s for G2. Discussion The main finding of the present study is that in 50 m maximum front crawl can be predicted by partial times. The association between the difference in partial times and the overall time in G1 indicate that faster swimmers in the beginning of the bout obtain higher performances, even if they aren't able to maintain velocity, presenting higher decrease. This data points that race tactics should be trained in order to enhance performance in young swimmers.

### EFFECTS OF DIFFERENT COMPOSED SQUAT RESISTANCE TRAINING ON LEGS STRENGTH AND START POWER PERFORMANCE IN COLLEGE SWIMMERS

CHO, C.J.1, TAI, Y.J.2, WU, C.M.3, YE, C.C.4

1: NUTN (Tainan, Taiwan), 2: NKMU (Kaogsiung, Taiwan), 3: CSU (Kaogsiung, Taiwan), 4: NKFUST (Kaogsiung, Taiwan)

Introduction Many swimming competition results indicate that legs strength also influence turn performance, but how to improve by training still controversy. Therefore, the aim of this study was to realize the effect of six weeks different composed squat resistance training in addition to the habitual swimming program on legs strength (LS) and start power (SP) performance. Methods Twenty college swimmers were average assigned to two groups according to 1RM legs strength, groups A (n= 10; age:  $20.00 \pm 3.40$  y; body mass:  $70.27 \pm 12.37$  kg; height:  $170.90 \pm 6.24$  cm; body fat:  $23.66 \pm 7.63\%$ , GA) and groups B (n= 10; age:  $20.80 \pm 3.71$  y; body mass:  $65.32 \pm 10.65$  kg; height:  $168.40 \pm 7.47$  cm; body fat:  $22.77 \pm 8.33\%$ , GB) were trained two times a week for six weeks. In weeks 1-3 and 4-6, GA performed 65% 15RM plus 90% 4RM (Wathen, 1994) GB performed 90% 4RM plus 65% 15RM squat weight training. Body fat, LS, and SP (calculate with body mass, 5m push wall start time, and  $75 \text{ kg} \cdot \text{m/s}$  for hp) were measured before and after training, t-test was applied to analyze these data in group and group. Results The results of this study indicated that two groups were effective at increasing LS after training ( $p < 0.05$ ), GA improved from 83 to 144.5kg, GB improved from 83 to 130kg. In SP, only GB improved from 3.14 to 3.60hp ( $p < 0.05$ ), all the swimmers decreased body mass (67.79 to 66.92kg) and body composition (23.21% to 22.70%) significantly ( $p < 0.05$ ). Discussion Results suggested a positive effect of GA and GB training program, because of these swimmers did not accept the routine training before, so the different composed course should increase the strength, off season national football player correspond to have a positive influence (Brechue and Mayhew, 2012). GB set training program from muscle strength to endurance and significant increase in SP, which was in accordance with previous studies that the importance of lower body strength and power to start time (west et al., 2011), we did not find the same effect in GA, probably due to the testing distance and other start skills. Previous reports have found that sprint swimming performance was related to body mass, lean body mass (Geladas et al., 2005), this study showed that both training programs transferred fat to muscle mass and increased strength, further study need to consider the swimmers' lever, resistance training experience, and sprint performance test is necessary. References Brechue, WF, Mayhew, JL. (2012) Lower-body work capacity and one-repetition maximum squat prediction in college football players. *J Strength Cond Res*, 26(2), 364-372. Geladas, et al., (2005) Somatic and physical traits affecting sprint swimming performance in young swimmers. *Int J Sports Med*, 26, 139-144. Wathen, D. (1994) Essential of strength training and conditioning, pp451-454. West, et al. (2011) Strength and power predictors of swimming starts in international sprint swimmers. *J Strength Cond Res*, 25(4), 950-955.

13:45 - 14:45

## Poster presentations

## PP-PM28 Physiology 8

**THE INFLUENCE OF INTERMITTENT HYPOXIC TRAINING ON LIPID METABOLISM OF MIDDLE-AGED OBESE ADULTS**

Wu, C.M.1, Lin, J.C.2, Tai, Y.J.3

1: CSU(Kaohsiung, Taiwan), 2: PCCU(Taipei, Taiwan), 3: NKMUI(Kaohsiung, Taiwan)

Introduction Simulated hypoxia chamber had been use for improve human performance in many years, no matter via resting or sleeping strategy, or intermittent hypoxic training (IHT). In other aspects, it may improve energy efficiency; our purpose of this study was to investigate the effects of combined 16 week IHT via hypoxic chamber on lipid metabolism, cardiopulmonary fitness on middle-aged obese adults. Methods Thirty obese (BMI >25 or body fat percentage >30%) subjects(38.9±9.2years old, 163.2±8.4cm, 68.1±15.2kg) were recruited and randomly assigned into two exercise groups (oxygen concentrations of 16% and 14%, respectively) and underwent 16weeks IHT program, including 4weeks of normoxia, 8weeks of IHT, and 4 weeks of follow-up period. Exercise protocol consisted of 10 minutes warm-up, 30 minutes brisk walking on treadmill at 50%VO<sub>2</sub>max, and 10 minutes cool-down, 3 times a week. Cardiopulmonary fitness, total cholesterol, HDL, LDL, triglycerides were collected at pre-training, 4th, 8th, 12th and 16th week, respectively. Two-way ANCOVA with mixed design was used for statistics. Results Weight and %body fat did not show significant difference between groups; however, %body fat of 16% group significantly decreased in 8th week compared with that of pre-training (30.45± 6.72 vs. 31.87± 6.91%), whereas %body fat of 14% group in 12th week was significantly lower than pre-training (27.59± 6.69 vs. 28.85± 7.25%). Cholesterol in 12th week was significantly lower than that of the 4th week; however, it returned to the baseline and reversed higher in 16th week (mean differences= -13.50,-8.71 mg/dL). No difference between-group in TG response at stages. Only TG of 12th week was significantly lower than that of pre-training in 16% group (79.58± 29.69vs. 91.25± 32.73 mg/dL). After hypoxic training, LDL of 16% group showed significant improvement from 8th to 12th week, compared with 4th week (118.75± 26.09,120.33± 27.75vs. 133.17± 20.23 umol/L). Discussion IHT could improve blood lipids metabolism for obese adults, especially in total cholesterol and LDL (Tin'kov, et al., 2002). In also, cardiopulmonary fitness was improved after training (Glazachev, et al., 2010). However, although both groups had improved during IHT, but within each stage, non significant difference were found in this results, these maybe resulted from oxygen concentrations and exercise intensity that had cross effects, or even the physiological accommodations(Wilber, et al., 2007). We suggested future study could focus on exercise intensity interaction with oxygen concentrations. References Glazachev, O. S., Zvenigorodskaja, L. A., Dudnik, E. N., Iartseva, L. A., Mishchenkova, T. V., Platonenko, A. V., et al. (2010).Eksp Klin Gastroenterol, (7), 51-56. Tin'kov, A. N., & Aksenov, V. A. (2002). High Altitude Medicine & Biology, 3(3), 277-282. Wilber, R. L., Stray-Gundersen, J., & Levine, B. D. (2007). Medicine & Science in Sports & Exercise, 39(9), 1590-1599.

**SHORT-TERM INTERMITTENT HYPOXIA DOES NOT AFFECT VENTILATION BUT REDUCES BLOOD LACTATE CONCENTRATION DURING SUBMAXIMAL EXERCISE AT SIMULATED ALTITUDES UP TO 4000 M**

Faulhaber, M.1, Dünwald, T.1, Gatterer, H.1, Bernardi, L.2, Burtcher, M.1

University Innsbruck

SHORT-TERM INTERMITTENT HYPOXIA DOES NOT AFFECT VENTILATION BUT REDUCES BLOOD LACTATE CONCENTRATION DURING SUBMAXIMAL EXERCISE AT SIMULATED ALTITUDES UP TO 4000 M Faulhaber, M. 1, Dünwald, T. 1, Gatterer, H. 1, Bernardi, L. 2, Burtcher, M. 1 1 Department of Sport Science, University Innsbruck, Austria 2 Department of Internal Medicine, University of Pavia and IRCCS San Matteo, Italy Introduction Acute high-altitude exposure reduces endurance performance whereas chronic high-altitude exposure improves endurance performance at high altitude predominantly by ventilatory acclimatization (Burtcher et al. 2006). Intermittent hypoxia (IH), applying repeated passive hypoxic short-term ( $\leq 1$  hour) exposures, induces ventilatory acclimatization by increasing the hypoxic ventilatory response (HVR). This increase in HVR seems to increase exercise ventilation and improve arterial oxygen saturation (SaO<sub>2</sub>) depending on the test altitude (Katayama et al. 2001, 2007). No study evaluated IH effects at different altitudes within the same group of persons. Therefore, we tested in the same group of persons whether IH affects submaximal exercise responses depending on different altitudes. Methods Eight volunteers participated in the study (25±3 years, 179±4 cm, 74±5 kg). Measurements before IH included the determination of HVR and hypercapnic ventilatory response (HCVR) and 4 submaximal cycle ergometer tests at different simulated altitudes (1000m, 2000m, 3000m, and 4000m) in a randomized order. The subjects cycled for 10 minutes at 2 different work loads (corresponding to 40% and 60% of VO<sub>2</sub>max in normoxia). Ventilatory parameters, SaO<sub>2</sub>, and blood lactate concentrations (LA) were determined at each intensity. The subsequent IH application comprised 7 resting 1-hour sessions at 4500 m. Measurements after the IH application were the same as before and took place one day after finishing the IH application. Results The applied IH protocol resulted in a significant increase in HVR whereas HCVR remained unchanged. Submaximal exercise ventilation was not affected, but carbon dioxide production and LA were reduced after IH independent of altitude. SaO<sub>2</sub> improved slightly after IH. We found no interaction between the effects of altitude and those of IH. Discussion Our results suggest that there are no ventilatory effects of the applied IH protocol during submaximal exercise at altitudes up to 4000 m. However, it might be possible that the effect of an increased HVR was opposed by the reduced blood lactate concentration and carbon dioxide output. Further research has to investigate if the reduced blood lactate concentrations result in an improved endurance performance at high altitude. References Burtcher M, et al. (2006). Int J Sports Med, 27, 629-635. Katayama K, et al. (2001). J Appl Physiol, 90, 1431-1440. Katayama K, et al. (2007). Int J Sports Med, 28, 480-487.

**PAO<sub>2</sub> IS MORE IMPORTANT THAN CAO<sub>2</sub> IN FATIGUE DEVELOPMENT DURING EXERCISE IN SEVERE ACUTE HYPOXIA**

Losa-Reyna, J., Ponce, J., Siebenmann, C., Rasmussen, P., Torres, R., Morales, D., Guadalupe, A., Rodríguez, L., Feijóo, D., Pérez, I., De la Calle, J., Sheel, A.W., Lundby, C., Calbet, J.A.L.

University of Las Palmas de Gran Canaria

Aim: To determine if fatigue during exercise in severe acute hypoxia is more influenced by arterial O<sub>2</sub> pressure (PaO<sub>2</sub>) or arterial O<sub>2</sub> content (CaO<sub>2</sub>). Methods: Eleven healthy men (age: 20±2 yrs, VO<sub>2</sub>max: 3.8±0.4 L/min, mean±SD) performed 2 incremental cycle ergometer tests (80 rpm;  $\Delta 20$ w/2 min) in acute hypoxia (FIO<sub>2</sub>=0.108; Barometric pressure: ~730 mmHg; PaO<sub>2</sub>: 33±2 mmHg; SaO<sub>2</sub>: 62±5%) to

exhaustion on different days (H1). At exhaustion (E1), when they were unable to keep a pedaling rate above 60 rpm despite strong verbal encouragement, the gas mixture was swiftly changed to FIO<sub>2</sub>=0.135 to overcome fatigue, and subjects instructed to continue pedalling. In few seconds they overcame fatigue as evidenced by the ability to continue cycling and achieve the desired pedalling rate. On the first experimental day the FIO<sub>2</sub>=0.135 gas mixture contained carbon monoxide (CO) in order to increase the carboxyhemoglobin (COHb) to 15±4% in 10-15 s; and on the second day, the FIO<sub>2</sub>=0.135 gas mixture contained only O<sub>2</sub> and N<sub>2</sub>. In both experiments, at E1, after two minutes of breathing hypoxia (FIO<sub>2</sub>=0.135), the intensity was increased again ( $\Delta$ 20w/2 min, FIO<sub>2</sub>=0.135, H2) and continued until exhaustion (E2). At exhaustion E2, subjects were swiftly switched to a normoxic inspirate (FIO<sub>2</sub>=0.21). After two minutes of breathing room air the intensity was increased ( $\Delta$ 20w/2 min) until exhaustion (E3). Results: Subjects cycled slightly longer while breathing CO+hypoxia (84 s) compared with hypoxia alone (72 s, p=0.56). A greater 12% VO<sub>2</sub>max was achieved without CO in H2 (p<0.05), although the PETO<sub>2</sub> at E2 was identical (65 mmHg) between conditions. The administration of CO+hypoxia at E1 increased SaO<sub>2</sub> to 71.3±5.0 and PaO<sub>2</sub> to 47.0±4.7 mmHg. However, arterial CaO<sub>2</sub> was 13% lower when the subjects breathed CO+hypoxia compared to hypoxia without CO, due to an increase of COHb (+14.6±3.5%). At E2, increasing the FIO<sub>2</sub> to 0.21 relieved fatigue instantaneously, allowing the continuation of the incremental exercise to a new exhaustion (E3). At E3 all subjects achieved their normoxic VO<sub>2</sub>max in the condition without CO. Conclusion: Fatigue during exercise in hypoxia is predominantly caused by a reduction in PaO<sub>2</sub>. This conclusion is based on the rapid relief of fatigue caused by small increases in PaO<sub>2</sub> even in the presence of an experimentally reduced CaO<sub>2</sub> Supported by MICINN, Spain (DEP2009-11638).

### EFFECTS OF NORMOBARIC HYPOXIC CONDITIONS ON SLEEP DURATION AND QUALITY IN PROFESSIONAL AUSTRALIAN FOOTBALL LEAGUE PLAYERS

Herrera, C.P.1, Farooq, A.1, Coutts, A.2,3, Bilsborough, J.C.3, Hocking, J.3, Cordy, J.3, Racinais, S.1, Buchheit, M.4

(1)Aspetar-Qatar Orthopaedic & Sports Medicine Hospital, (2)University of Technology (UTS), Sydney, Australia, (3)Carlton Football Club, Melbourne, Australia, (4)ASPIRE - Academy of Sports Excellence

Introduction Sleeping at simulated hypoxic environments in athletes is a common strategy to enhance performance as part of a 'live high-train low' camp but may be associated with reduced sleep duration and poor sleep quality. The purpose of this study was to investigate, in professional Australian Football League players, the effects of sleeping in a normobaric hypoxic dormitory on sleep using wrist actigraphy. Methods Actigraphy sleep was measured during a 2-week 'live high-train low' camp. After one night at 0m for laboratory adaptation and recovery from travel, sleep data were analyzed from a control group sleeping at normoxia (n=9, 22±2 y, 24.3±1 kg/m<sup>2</sup>) and compared with a second group sleeping at hypoxia (n=9, 22±2 y, 24.9±1 kg/m<sup>2</sup>); there was a progressive increase in simulated altitude - two nights at 2500m, two nights at 2800m, and subsequent nights at 3000m. A sleep diary was administered each morning to assess subjective sleep quality. Results There was a general decline in sleep duration and reduction in sleep quality across the study period in all players. Time in bed, total sleep time, and sleep efficiency were significantly reduced whereas the number of awakenings and total time spent awake after sleep onset were increased (all p<0.05). Comparing groups, time in bed was significantly lower in hypoxia (521.4±13.6) than normoxia (538.6±14.2, p<0.05). Excluding nights (4, 8, and 12) when there was an unrestricted sleep opportunity, total sleep time was significantly lower in hypoxia (430.7±5.0) than normoxia (453.0±5.1, p<0.01). All subjects reported a reduction in subjective sleep quality throughout the training camp but there were no group differences. Discussion This study provides novel evidence using actigraphy to confirm that sleep duration is reduced under normobaric hypoxic environments between 2500-3000m in Australian Football League players. The reduction in sleep duration was demonstrated only when the sleep period was fixed. In other words, when the sleep period was unrestricted there was no difference in total sleep time. These findings suggest that an extended sleep opportunity may attenuate possible sleep loss in athletes during a 'live high-train low' camp.

### TIME COURSE OF BLOOD PRESSURE AND VASCULAR ADAPTATIONS TO INTERMITTENT HYPOBARIC HYPOXIC EXERCISE

Ogita, F.1, Kurobe, K.1, Huang, Z.1, Nagira, A.1, Nishiwaki, M.2, Tanaka, T.1, Tamaki, H.3

1 National Institute of Fitness and Sports, 2 Prefectural University of Kumamoto, 3 Niigata University of Health and Welfare

Introduction Recently, we have observed that aerobic exercise in hypobaric hypoxia of 4 weeks could induce beneficial circulatory adaptations, such as a reduction of total peripheral resistance and blood pressure, and an increase in flow mediated vasodilation (FMD) response, stroke volume, and cardiac output (Ogita 2008). However, time course of such cardiovascular adaptations have not been clarified. Therefore, the present study evaluated the time course of blood pressure and vascular adaptations to intermittent hypobaric hypoxic exercise. Methods Twelve healthy male adults (22±1 yrs) were matched for physical fitness level into two groups, and then randomized to normobaric normoxic exercise group (N, n=6) and hypobaric hypoxic exercise group (H, n=6). The subjects had aquatic exercise training in swimming pool located in a chamber where atmospheric pressure could be regulated. The exercise was performed at the intensity of around 50%VO<sub>2</sub>max for 30 minutes/training session, 4 days/week, for 4 weeks. H had the exercise in hypobaric hypoxia corresponded to 2000m above sea level, and was exposed to the condition for 2 hours/session. Before and after the training, systolic (SBP), diastolic (DBP), and mean blood pressure (MBP) were determined at rest and during cycling exercise at 50%VO<sub>2</sub>max, which was determined before the training. Also, arterial stiffness was assessed by cardio ankle vascular index (CAVI), and FMD was evaluated by peak diameter of the popliteal artery during reactive hyperemia, which was measured by ultrasound imaging system. Results After the 4 weeks of training, no significant changes were observed in most variables in N through the training period. On the other hand, a significant decrease in SBP and MBP during moderate exercise was found within one week in H (P<0.05). A significant decrease in arterial stiffness assessed by CAVI was also observed within 2 weeks (P<0.05), whereas no significant changes were observed in %FMD through the training period. Discussion Our findings suggest that intermittent hypobaric hypoxic exercise could bring beneficial vascular adaptations within 1-2 weeks, such as a significant reduction of blood pressure associated with a decrease in arterial stiffness. Reference Ogita, F. et al. (2008) Effects of exercise training at different hypobaric hypoxic conditions on cardiovascular adaptations. Book of Abstracts, 12th Annual Congress of ECSS: 394-395. Acknowledgement This study is partly supported by a Grant-in-Aid for Scientific Research from the Japan Society for the promotion of the Science (project No 16500446).

## RHYTHMIC INTERACTION OF THE HEART AND PRE-AND-AFTERLOAD INDICES IN NORMOBARIC HYPOXIC EXPOSURE IN HEALTHY MALES

Radchenko, A.S., Kalinichenko, A.N., von Duvillard, S.P., Rodionova, Y.Y., Golubev, V.N., Korolev, Y.N.

*Saint-Petersburg Scientific-research Institute for Physical Culture*

**RHYTHMIC INTERACTION OF THE HEART AND PRE-AND-AFTERLOAD INDICES IN NORMOBARIC HYPOXIC EXPOSURE IN HEALTHY MALES**  
Radchenko, A.S.<sup>1,2</sup>, Kalinichenko, A.N.<sup>4</sup>, von Duvillard, S.P.<sup>5</sup>, Rodionova, Y.Y.<sup>4</sup>, Golubev, V.N.<sup>3</sup>, Korolev, Y.N.<sup>3</sup> 1: SpbSRIPC, 2: HC "Gladiator" (Saint-Petersburg, Russia), 3: MMA (Saint-Petersburg, Russia), 4: EU (LETI) (Saint-Petersburg, Russia), 5: NSSS (Oslo, Norway) Introduction The peripheral vascular resistance (SPR) and the left ventricular end-diastolic pressure (EDP) variability play a central role in the arterial blood pressure and cardio-rhythm regulation (Shibata et al., 2006). We investigated the normobaric intermittent hypoxia exposure (IHE) associated with the rhythmic interaction of pre-and-afterload heart indices calculated from the heart beat-to-beat as result of adaptation. Methods Seven healthy young males underwent 20 IHE sessions. Subjects were exposed for 5 min of hypoxia (FIO<sub>2</sub>=0.1) combined with 5 min of normoxia 6 x each hour. The hypoxia tests (HT) were conducted pre and pos IHE sessions. The HT consisted of the same O<sub>2</sub> breathing concentration (FIO<sub>2</sub>=0.1) for 15 min in hypoxic condition. In HT, the SaO<sub>2</sub>, HR, central hemodynamics indices (tetrapolar rheography via impedance plethysmography), and ECG were recorded. SPR, EDP (Elizarova et al., 1987), minute blood flow (MBF), RR intervals were recorded and calculated in beat-to-beat in the last 3 min of HT. The estimation of pair oscillation in SPR-EDP, SPR-RR, EDP-RR interaction at dominant frequency component (DFC) in low and high frequency (~0.03–0.15 Hz and ~0.15–0.35 Hz) range of spectra was implemented via mutual spectral power density (SPD), phase (•°) and coherence (Coh) and square of sector (S) that was formed by Coh as radius and angle of •° mismatch in DFC. The mathematical calculations were derived from the analog of work (Shibata et al., 2006). Results The adaptation from IHE significantly changed SaO<sub>2</sub> and MBF. •° advance of EDP changes before RR fluctuations were increased significantly in DFC in all subjects (p<0.5). The alterations in Coh and S were unidirectional too, but there were large variations of individual data similar as in SPR-EDP. SPD increased significantly (p<0.05) in SPR-RR fluctuations in all cases and in this couple were no change in rhythmical interaction of •°, Coh, and S. Discussion We postulate that the decrease in MBF from hypoxic adaptation is related to alterations in vessel lumen that depends on oxygenation of hemoglobin (Jensen, 2009). The myoglobin expression in hypoxia at rest was only present in cardiomyocytes (Kanatous et al., 2009). These mechanisms may be the basis for unidirectional augmentation of phase lead EDP fluctuations before SPR and RR. References Elizarova N et al. Bulletin of USSR AMS Allun Cardiol Sci Center. (1987), 10(2), 41-47 Jensen B (2009) J Exp Biol, 212, 3387-3393 Kanatous S et al. (2009). Am J Physiol Cell Physiol, 296, C393-C402 Shibata S et al. (2006). Am J Physiol Heart Circ Physiol, 291, H2142-H2151

## HYPOXIA IMPAIR GLUTAMINE LEVELS AFTER ACUTE EXERCISE

Machado, P.P., Lira, F.S., Santos, S.A., Silva, E.T., Caris, A., Tufik, S., de Mello, M.T., Santos, R.V.T.

*Unifesp*

**Introduction** The glutamine of performance a role key in the immune system at rest and during periods of stress. Is known that, during and after exercise glutamine levels can be modulated. However, the modulation this amino acid during and after exercise in the hypoxia exposure is unknown. Our hypothesis is that exercise performance in the hypoxia exposure may impair glutamine levels. **Methods** Eight male subjects were exposed to normobaric hypoxic exposure at 4,200 m or sea level and performance treadmill exercise for 1 hour (~50% VO<sub>2</sub>peak). The glutamine, glutamate, insulin and cortisol levels were determined at rest, and immediately and 1 h after exercise bouts. **Results** Insulin levels did not show time-dependent changes under the different altitudes (p>0.05). Cortisol levels showed increased immediately after exercise than rest and 1 hour after exercise (p<0.05), only exercise performance hypoxia exposure. The glutamine and glutamate levels were decreased 1 hour after exercise than rest and immediately after performance exercise in sea level. However, in hypoxic exposure at 4,200 m glutamine and glutamate levels were increased immediately after exercise than rest (p<0.05), and decreased 1 hour after exercise when compared with rest and immediately after exercise (p<0.05). **Discussion** Glutamine is a conditionally essential amino acid that comprises 20% of the total plasma amino acids and is actively produced in organs such as the liver, kidneys, lungs, and skeletal muscle (Parry-Billings et al. 1990). The mechanism by which this decrease in plasma glutamine concentration occurs during prolonged physical exercise and recovery is not well understood, but is suggested that hormonal alterations can modulate this amino acid concentrations. During prolonged exercise, it has been suggested that lower glutamine plasma concentration is promoted by increases in glutamine uptake in several tissues, mainly the liver, kidneys and some immune cells, while other hypotheses suggest that glutamine release changes in skeletal muscle because of a partial impairment in glutamine syntheses (Newsholme and Calder 1997, Neto et al 2011). Our data the exercise in sea level to be accord with literature, demonstrated that glutamine and glutamate levels are reduced after exercise. However, the state is impairing when exercise is performance in hypoxic exposure at 4,200 m. This alters may, least in part, favor the immunosuppression state. These findings can help to better knowing upon effects the hypoxic exercise regimen on immune system response. References Neto JC, Lira FS, de Mello MT, Santos RV. (2011) Amino Acids, 41(5):1165-72. Parry-Billings M, Leighton B, Dimitriadis GD, Bond J, Newsholme EA (1990), Biochem Pharmacol 40:1145–1148 Newsholme EA, Calder PC (1997). Nutrition 13:728–730

## HYPOXIC EXPOSITION INFLUENCE IN LENGTHENING PERFORMANCE INDICATORS IMPROVEMENT AFTER INTERMITTENT HYPOXIC TRAINING

NAKAMOTO, F.

*FEDERAL UNIVERSITY OF SAO PAULO*

Nakamoto FP, Lira CA, Andrade MS, Silva AC. Department of Physiology - UNIFESP (São Paulo, Brazil) **Introduction** The persistence of the enhanced performance endurance capacity obtained with intermittent hypoxic training (IHT) is a topic of extensive debate. **Methods** to lengthen positive effects of IHT should be studied. The aim of this study is to investigate the influence of intermittent hypoxic exposition (IHE) following IHT on lengthening its benefits. **Methods** Twenty well-trained runners (WTR) were assigned to either a hypoxic/hypoxic (HH) group (n = 9), a hypoxic/normoxic (HN) group (n = 6), or a normoxic/normoxic control (C) group (n = 5). Into their usual normoxic training schedule, athletes included two weekly training sessions, performed either in normoxia [C group, inspired O<sub>2</sub> fraction (FIO<sub>2</sub>) = 20.9%] or in normobaric hypoxia (both HH and HN groups, FIO<sub>2</sub> = 14.5%), for 6 wk. Following the 6th wk, only HH subjects were exposed to normobaric hypoxia during rest, for 60 min, twice a wk for 4 wk (IHE). The athletes in all groups continued their normal training program in normoxia during the study. Lactate threshold velocity (LTv), 1st and 2nd ventilatory threshold velocities (1VTv and 2VTv), running time to exhaustion (Tlim), maximal oxygen uptake (VO<sub>2</sub>max) and resting hematological (HT) status were measured before IHT (Pre IHT), after IHT

(Post IHT), and after IHE (Post IHE) in all athletes. Results show increase ( $p < 0.05$ ) in  $VO_{2max}$  values, LTv, 1TVt, 2TVt and Tlim in both HH and HN groups (Pre IHT x Post IHT values) in normoxia. The C group displayed no improvements. No significant changes were observed in all groups concerning Post IHT x Post IHE values. HT values were unaltered during the study. Discussion Successful results were obtained from IHT in WTR. Similar results had been found in competitive runners (Dufour et al., 2006). However, IHE procedures adopted in this study were not able to lengthen the adaptations of IHT, probably due to their low frequency or intensity. It's known that IHE produces physiologic adaptations and enhancement in endurance performance at sea level (Katayama et al, 2004; Bonetti et al., 2009). Once the purpose of our study was not eliciting further changes following IHT, it was thought that this amount of IHE could be enough to increase the persistence of IHT benefits. We either need more athletes participating in the study or a different IHE approach, which might lengthen the benefits of IHT. References Bonetti DL, Hopkins WG, Lowe TE, Boussana A, Kilding AE. 2009. *Int J Sports Physiol Perform.* Mar;4(1):68-83 Dufour SP, Ponsot E, Zoll J, Doutréleau S, Lonsdorfer-Wolf E, Geny B, Lampert E, Flück M, Hoppeler H, Billat V, Mettauer B, Richard R, Lonsdorfer J. 2006. *J Appl Physiol.* Apr;100(4):1238-48 Katayama K, Sato K, Matsuo H, Ishida K, Iwasaki K, Miyamura M. 2004. *Eur J Appl Physiol.* Jun;92(1-2):75-83

## EARLY OXYGEN DESATURATION IS RELATED TO ACUTE MOUNTAIN SICKNESS DEVELOPMENT DURING ACUTE HIGH ALTITUDE EXPOSURE

Mandolesi, G.1, Pomidori, L.1, Giovanni, A.1, Bernardi, E.1, Bartesaghi, M.2, Cogo, A.1

1: University of Ferrara, 2: University of Milano Bicocca

**Introduction** Early oxygen desaturation during HA exposure (both in the field and during HA simulated test) has been reported to be significantly related to AMS development. **Aim:** to monitor oxygen saturation (SpO<sub>2</sub>) and AMS development during the ascent from Alagna (1200m) to Capanna Regina Margherita (4559m) with an overnight stay in Gnifetti Hut (3647m). **Methods** Sixty-six subjects (11F, age 18-67), intending to climb M. Rosa, were recruited at the cable car station in Alagna, informed of the purpose of the study and equipped with a 24-h data memory pulse oximeter (Pulsox-3Si, Minolta, Japan). They were also asked to fill the Lake Louise questionnaire at the arrival, in the evening and in the morning in Gnifetti Hut and at the arrival in Capanna Regina Margherita. Twenty-five subjects (37.8%) showed a LL score  $\geq 3$  (AMS+). The remaining 41 are the AMS- group. **Results** In Alagna at rest, the SpO<sub>2</sub> values were similar between AMS+ and AMS- ( $94.6\% \pm 1.9$  vs  $95.1\% \pm 1.2$  n.s.) but during HA exposure the AMS+ showed a significantly lower SpO<sub>2</sub>: at Punta Indren (3275m) after 30-45 minutes of cable car ascent ( $85.5\% \pm 4.1$  vs  $87.7\% \pm 3.5$ ,  $p = 0.035$ ); in Gnifetti Hut during 3 hours at rest after the arrival ( $84.5\% \pm 2.3$  vs  $86.4\% \pm 2.4$ ,  $p = 0.003$ ) and during the subsequent night ( $76.9\% \pm 4.6$  vs  $79.5\% \pm 3.7$ ,  $p = 0.01$ ). No significant difference was found in the SpO<sub>2</sub> values during the 2 hours climb to Gnifetti Hut ( $81.7\% \pm 2.8$  vs  $82.4\% \pm 2.5$  n.s.). As regard the monitoring, the AMS+ group always spent more time with a lower SpO<sub>2</sub>: percentage of total time spent with SpO<sub>2</sub>  $< 80\%$  at rest in Gnifetti Hut was  $15.8\% \pm 13.8$  vs  $7.2\% \pm 7.7$ ,  $p = 0.001$ ; with SpO<sub>2</sub>  $< 75\%$  during the night was  $33.2\% \pm 32.9$  vs  $15\% \pm 18.5$ ,  $p = 0.008$  and with SpO<sub>2</sub>  $< 70\%$  was  $11.8\% \pm 19.3$  vs  $2.7\% \pm 6.2$ ,  $p = 0.01$ . Concerning the ascent to Capanna Regina Margherita only data of 34 subjects (8F, 26M) were available (14 AMS+, 20 AMS-). The difference in SpO<sub>2</sub> was maintained significantly lower in AMS+ group ( $73.4\% \pm 5.1$  vs  $76.8\% \pm 3.8$ ,  $p = 0.03$ ) and significant differences were also found in time (expressed in hours) spent with SpO<sub>2</sub>  $< 80\%$  ( $3.5 \pm 1.2$  vs  $2.7 \pm 0.9$ ,  $p = 0.03$ ) and with SpO<sub>2</sub>  $< 75\%$  ( $2.5 \pm 1.4$  vs  $1.57 \pm 0.8$ ,  $p = 0.02$ ). **Discussion** Lower SpO<sub>2</sub> in AMS+ occurs very early at the beginning of HA exposure after 30-40 min. of ascent. The new finding is that 24-hours SpO<sub>2</sub> monitoring, showing that subjects which subsequently develop AMS always spend more time with SpO<sub>2</sub> significantly  $<$  healthy subjects (AMS-). References Loeppky JA et al. (2008). *High Alt Med Biol* 9(4),271-79. Burtcher M et al. (2004). *High Alt Med Biol*, 5(3),335-40.

## TOTAL HAEMOGLOBIN MASS, HYPOXIC VENTILATORY RESPONSE, AND CEREBRAL AND MUSCLE OXYGENATION BEFORE AND AFTER A TWO-MONTH MT. EVEREST EXPEDITION

Cheung, S.S.1,2, Mutanen, N.E.2,3, Karinen, H.M.2,4, Koponen, A.S.2, Kyrolainen, H.5, Tikkanen, H.O.2,3, Peltonen, J.E.2,3

1: Brock University, (Canada) 2: University of Helsinki (Finland), 3: Foundation for Sports & Exercise Medicine (Finland), 4: University of Tampere (Finland), 5: University of Jyväskylä (Finland)

**Introduction** We investigated the effects of chronic hypobaric hypoxic acclimatization, performed over the course of a 72-day self-supported Everest expedition, on total haemoglobin mass (tHb-mass) and cardiorespiratory adaptation in nine elite climbers (age  $37 \pm 7$  y, peak aerobic capacity  $55 \pm 7$  mL/kg/min). **Methods** PRE and POST ( $< 15$  days) expedition, participants performed separate tests for tHb-mass and exercise with graded hypoxia. tHb-mass was measured using carbon monoxide-rebreathing. Exercise-hypoxia was tested using a constant treadmill exercise of 5.5 km/h at 3.8% grade with 3-min steps of progressive normobaric poikilocapnic hypoxia (159, 120, 105, 90, 86, 80, 75 mmHg) to simulate the different camp altitudes (0, 2,400, 3,500, 4,800, 5,200, 5,800, 6,400, 7,100 m) during an ascent. The test was terminated upon volition or when arterial oxygen saturation (SpO<sub>2</sub>) fell to 62%. Breath-by-breath ventilatory responses, SpO<sub>2</sub>, and cerebral (frontal cortex) and active muscle (vastus lateralis) oxygenation were measured throughout the exercise-hypoxia. Acute hypoxic ventilatory chemosensitivity (AHVR) was determined by linear regression slope of ventilation vs. SpO<sub>2</sub>. **Results** Post-expedition, exercise-hypoxia tolerance improved ( $11:32 \pm 3:57$  to  $16:30 \pm 2:09$  min,  $P < 0.01$ ). Absolute tHb-mass ( $973 \pm 153$  g PRE and  $1026 \pm 125$  g POST,  $P = 0.27$ ) did not significantly differ. AHVR was elevated ( $1.25 \pm 0.33$  to  $1.63 \pm 0.38$  L/min per % decrease in SpO<sub>2</sub>,  $P < 0.05$ ). SpO<sub>2</sub> decreased throughout exercise-hypoxia at 2,400 and 3,500 m equally in both trials, but was preserved at higher values at 4,800 m post-expedition. Cerebral oxygenation decreased progressively with increasing exercise-hypoxia in both trials, with a lower level of deoxy-haemoglobin POST at 2,400, 3,500 and 4,800 m. Muscle oxygenation also decreased throughout exercise-hypoxia, with similar patterns PRE and POST. No relationship was observed between the slope of AHVR and cerebral or muscle oxygenation either PRE or POST. **Discussion** We observed a wide inter-individual variability in tHb-mass responses, ranging -14.5 to 20.2% from PRE to POST, with three of the nine participants exhibiting a decrease and a fourth participant demonstrating no change. This suggests that haematological adaptation is not a consistent response to chronic hypoxic acclimatization. We also conclude that ventilatory chemosensitivity changes from altitude acclimatization did not influence cerebral or muscle oxygenation during acute exercise-hypoxia.

13:45 - 14:45

## Poster presentations

## PP-PM29 Physiology 9

**CHANGES IN ADIPOSE TISSUE ADRENOCEPTOR GENE EXPRESSION AND LIPID MOBILIZATION DURING A MULTI-PHASE DIETARY INTERVENTION IN OBESE WOMEN**

Koppo, K.1,2, Czudkova, E.2, Van de Voorde, J.1, Combes, M.3, Valle, C.3, Langin, D.3, Stich, V.2

*1 Ghent University (Ghent, Belgium), 2 Charles University (Prague, Czech Republic), 3 Université Paul Sabatier (Toulouse, France)*

Introduction Calorie restriction is considered to be an effective treatment to lose weight in obese patients. It is believed that catecholamines are one of the key players that regulate lipid mobilization and mediate the remodeling of subcutaneous adipose tissue (SCAT). However, conflicting results are found regarding the changes in adrenergic control following a dietary intervention (DI) dependent on the duration of the diet and/or magnitude of the diet-induced calorie restriction. Therefore, the aim of this study was to investigate the evolution of the adrenergic regulation of lipolysis and to evaluate the expression of the beta2-, and alpha2A-adrenoceptor genes (ADRB2 and ADRA2A, respectively) in SCAT during different phases of a multi-phase DI. Methods Fifteen obese women underwent a 6-months DI consisting of 1 month very low calorie diet (VLCD), followed by 2 months low calorie diet (LCD) and 3 months weight maintenance diet (WM). At each phase of the DI, a biopsy of the abdominal SCAT was obtained to evaluate mRNA expression of the adrenoceptor genes ADRB2 and ADRA2A. In a subgroup of eight subjects, SCAT microdialysis was performed at each phase of the DI. Dialysate glycerol concentration (DGC) was determined at baseline and during local perfusions with adrenaline (a non-selective adrenoceptor agonist) in the absence or presence of phentolamine (an alpha1,2-adrenoceptor antagonist). Results The DI induced a significant body weight reduction and an improved insulin sensitivity. mRNA levels of ADRB2 increased at the end of VLCD and then decreased at the end of LCD and WM towards the pre-diet levels. The expression of ADRA2A was lower at the end of VLCD and LCD compared to the pre-diet or WM levels. Similarly, the adrenaline-induced increase in DGC was higher at the end of VLCD and LCD compared with the pre-diet and WM condition. In the probe with adrenaline and phentolamine, the increase in DGC was higher than that in the adrenaline probe at pre-diet and WM. No difference between the 2 probes was observed at VLCD and LCD. Discussion The results show that the responsiveness of SCAT lipid mobilization changes during a multi-phase DI, i.e. the adrenaline-stimulated lipolysis increases during the calorie-restricted phases due to a reduction of the alpha2-adrenoceptor mediated antilipolytic action of adrenaline. At the end of WM, adrenaline-stimulated lipolysis returned to the pre-diet levels. A similar pattern was observed at the transcriptional level of the adrenoceptor genes. These findings suggest that the regulation of lipolysis varies in function of the energy balance of the body.

**IMPACT OF ANDROID TO GYNOID FAT MASS RATIO ON FUEL UTILIZATION DURING EXERCISE IN NORMAL-WEIGHT WOMEN**

Isacco, L., Thivel, D., Meddahi Pelle, A., Lemoine-Morel, S., Duclos, M., Duche, P., Boisseau, N.

*Blaise Pascal University*

Impact of Android to Gynoid fat mass ratio on fuel utilization during exercise in normal-weight women Isacco L1, Thivel D1, Meddahi Pelle A2, Lemoine-Morel S3, Duclos M4, Duche P1, Boisseau N1 1: University Blaise Pascal (Clermont-Ferrand, France), 2: INSERM unit (Paris, France), 3: Rennes University (Rennes, France), 4: Auvergne University, INRA, CHU (Clermont-Ferrand, France). Introduction Abdominal and gynoid fat mass tissues exhibited particular metabolic profiles (Despres & Lemieux 2006; Sasai et al., 2009). If the scientific literature shows that higher android to gynoid fat mass ratio in obese individuals may alter whole body lipid oxidation during exercise (Kanaley et al. 1993), such data is missing concerning normal weight healthy subjects. Thus, the aim of this study was to investigate the impact of low (LA/G) and high (HA/G) android to gynoid fat mass ratio on metabolic and hormonal responses during exercise in normal weight healthy women. Methods Substrate oxidation (Respiratory Exchange Ratio, lipid and carbohydrate oxidation rates), metabolic (glycerol, free fatty acids, glucose) and hormonal (insulin, growth hormone, atrial natriuretic peptide, adrenaline and noradrenaline) responses were determined in a postprandial state during a 45 min exercise performed at 65% of VO2max in 21 young normal weight women including 10 HA/G women and 11 LA/G ones (determined from DXA measurements). Results No difference in anthropometric, VO2max and resting blood values were observed between the two groups. LA/G group exhibited greater reliance on lipid during exercise as compared to HA/G one. This occurred in presence of lower plasma insulin and glucose concentrations and higher plasma FFA, glycerol, GH, ANP levels in LA/G group as compared to HA/G one. Discussion To our knowledge, this is the first study to investigate the influence of fat mass ratio in lean women on substrate metabolism at rest and during exercise. Our results showed that android to gynoid fat mass ratio may impact on fuel oxidation and metabolic and hormonal responses during exercise as LA/G women female subjects showed an increase in whole-body lipid mobilization and utilization during exercise as compared to their HA/G counterparts. This may lead to a better body fat control, and a higher glycogen store sparing in LA/G individuals. References Despres JP, Lemieux I. (2006) *Nature*, 444, 881-887. Sasai H, Katayama Y, Nakata Y, Ohkubo H, Tanaka K. (2009) *Diabetes Res Clin Pract*, 84, 230-238. Kanaley JA, Cryer PE, Jensen MD. (1993) *J Clin Invest*, 92, 255-261.

**RELATIONSHIPS BETWEEN FATMAX, MAXIMAL FAT OXIDATION, PHYSICAL ACTIVITY, VO2PEAK AND BODY FATNESS IN PRE-PUBERTAL CHILDREN**

Campolier, M.

*Coventry University*

Campolier, M1., Duncan, M.J1., Hankey, J. 1, Birch, SV, Tolfrey, K. 2 1(Coventry University, UK) 2(Loughborough University, UK) Introduction It is well known that FATmax i.e. the exercise intensity that elicits maximal fat oxidation (MFO) is an individual parameter that depends on several factors e.g. gender, training status in adults (Venables, et al., 2005). However, less is known about the variables affecting this concept in children (Zakrzewski and Tolfrey, 2011). The aim of this research was to study whether FATmax and MFO were correlated to VO2peak, physical activity (PA), BMI and body fat percentage (%BF) in pre-pubertal children. Methods Twenty-eight pre-pubertal children (16 boys and 12 girls, aged 10-11) from a primary school in England completed a 3-min-incremental cycling test on a cycle ergometer to

estimate their VO<sub>2</sub>peak, FATmax and MFO. %BF was calculated by the measurement of skinfolds (Slaughter et al. 1988) and PA was estimated by the average of 4-d step count (2 weekdays and 2 weekend days) using pedometer (New Lifestyles NL-800Activity Monitor Pedometer). Physical Maturation (PM) was assessed from anthropometric measurements (Mirwald et al., 2002) and confirmed that all children were in the pre-pubertal stage of development. Results Results from Pearson's correlations showed that FATmax was negatively correlated to VO<sub>2</sub>peak ( $r=-0.532$ ) and body weight ( $r=-0.546$ ) ( $p<0.01$ ). In contrast, MFO was positively correlated to VO<sub>2</sub>peak ( $r=0.507$ ). However, when MFO is controlled by gender, the relationship between MFO and VO<sub>2</sub>peak is dismissed ( $p>0.05$ ). FATmax or MFO showed no significant correlations with BMI, PA or %BF ( $p>0.05$ ). VO<sub>2</sub>peak and MFO were significantly higher in boys compared to girls ( $p<0.05$ ). Discussion Our findings indicated that boys had a higher MFO compared to girls. That coincided with previous studies with pubertal and postpubertal children (Lazzer et al., 2007) and might be related to the higher VO<sub>2</sub>peak observed in boys compared to girls. Contrary to expectations, this study showed a negative correlation between FATmax and VO<sub>2</sub>peak which might be explained by the protocol used to identify FATmax or by other variables that might confound this association. To conclude, further research is needed to identify and understand the different variables that might affect it. References Lazzer, S., Busti, C., Agosti, F., De Col, A., Pozzo, R., & Sartorio, A. (2007). *Clinical Endo* 67, 582-588 Mirwald, R.L., Baxter-Jones, A., Bailey, D.A. and Beunen, G.P. (2002). *Med, Sci in Sports & Ex* 34(4), 689-694 Venables M., Achten J. and Jeukendrup, A. (2005). *J Appl Physiol* 98, 160-167 Zakrzewski, J. and Tolfrey, K. (2011). *Eur J Sport Sci* 11(1), 1-18

### WHEEL RUNNING EXERCISE ENHANCES FATTY ACID OXIDATION IN THE RAT SKELETAL MUSCLE DURING THE GROWING PHASE

Yamauchi, H.1, Takeda, Y.1, Tsuruoka, S.1, Abo, M.1, Minato, K.2, Shiroya, Y.2, Kitamura, H.2, Kurosaka, Y.2, Kimura, M.3, Kariya, F.4

1: Jikei University School of Medicine (Tokyo, Japan), 2: Wayo Women's University (Chiba, Japan), 3: Keio University (Tokyo, Japan), 4: International Budo University (Chiba, Japan).

Introduction: AMP-activated protein kinase (AMPK), locating at the upstream signaling pathway, regulates carbohydrate and fatty acid oxidation. Diet restriction (DR) and endurance exercise have been known to activate AMPK. However few report has been available as to whether DR+exercise produce AMPK activation efficiently to generate marked metabolic effect. Therefore, the aim of the present study is to evaluate how DR+exercise influence metabolic effects and AMPK activation in rat skeletal muscles. Methods: Twenty three F344 female rats (6-week) were divided into voluntary exercise-loaded (VE) (n=13) and control groups (n=10). The rats of VE group was further divided to 2 groups: DR to similar intakes of rats of control group (VE-DR, n=6) and no DR (free-intakeVE; VE-F, n=7) for 8 weeks. Voluntarily running on a wheel ergometer was applied with a load of 30% on their body weight. After the experiments plantaris muscle was extracted and weighed. Activities of citrate synthase (CS) and beta-hydroxyacyl-CoA dehydrogenase (beta-HAD), and composition of myosin heavy chain (MHC) isoforms were measured. Additionally the expression levels for fatty acid translocase (FAT/CD36), AMPKalpha, and peroxisome proliferator-activated receptor gamma co-activator 1 (PGC-1) were also determined using a western blotting method. Results: Average daily food intake of VE-F group (15.5 g) was higher than those of control (11.7 g) and VE-DR groups (12.5 g). Average daily running distance of VE-DR group (5198 m) tended to be higher than that of VE-F group (4194 m). Body mass was not significantly different among three groups, but muscle mass of VE-F group was significantly higher than the other two groups. In both VE groups, CS activities and beta-HAD and FAT/CD36 protein expressions were significantly higher than those of control. Beta-HAD activity of VE-DR group was higher than that of VE-F group. The ratios of MHC IIb / MHC IIa were lowered in both VE groups compared to control. And the % content of MHC I was higher only in VE-DR than that of control group. AMPK activation (phosphorylated to pan protein ratio) and expression level of PGC-1 in both VE groups were higher than those of control, but no significant difference was observed between both VE groups. The beta-HAD activity correlated with AMPK activation, but not with average daily running distance. Conclusion: The present results suggest that exercise-load with DR efficiently enhances fatty acid oxidation mediated by AMPK activation.

### THE EFFECTS OF EXERCISE AND RESTRICTED DIET ON HEPATIC FAT ACCUMULATION IN FATTY RATS

Umetsu, Y., Kitamura, H., Shiroya, Y., Minato, K., Yamauchi, H.

Wayo Women's University

THE EFFECTS OF EXERCISE AND RESTRICTED DIET ON HEPATIC FAT ACCUMULATION IN FATTY RATS. Umetsu Y.1, Kitamura H.1, Shiroya Y.1, Minato K.1, Yamauchi H.2 1: Wayo Women's University (Chiba, Japan), 2: Jikei University School of Medicine (Tokyo, Japan) Purpose Diet restriction and exercise are commonly recommended for the prevention and amelioration of obesity and lifestyle-related diseases such as fatty liver. Zucker fatty rats are a commonly studied model for obesity and fatty liver. The purpose of the present study was to investigate whether hepatic fat metabolism in Zucker fatty rats was improved with diet restriction and/or voluntary exercise. Methods Male Zucker lean rats were used as the control group (L: n = 8). Male Zucker fatty rats were divided into obese (Ob: n = 8), restricted diet (DR: n = 8), and restricted diet + exercise (DR + Ex: n = 8) groups. The rats in the L and Ob groups had free access to food. The food intakes in the DR and DR + Ex groups were restricted to 67% and 70% of the Ob group level, respectively. The rats in the DR + Ex group were made to exercise voluntarily on the wheel ergometer with a load of 30% of their body weights. After six weeks, all rats were prepared for the experiment. Blood was collected to measure serum leptin and free fatty acid (FFA) levels. Liver tissue sample was excised to measure hepatic triglyceride (TG) level and hepatic fatty acid synthase (FAS) activity. Results Body weight was significantly lower in the DR + Ex groups than that in the Ob group. There were no significant differences between the DR and DR + Ex groups in body weight and total food intake. Ob rats developed fatty liver and hyperlipidemia caused by excessive food intake. Hepatic TG level was significantly higher in the DR group than that in the Ob and DR + Ex groups. Hepatic TG level was significantly lower in the DR + Ex group than that in the Ob group. Hepatic FAS activity was significantly lower in the DR + Ex group than that in the DR group. Both serum leptin level and FFA levels were significantly higher in the DR group than those in the Ob and DR + Ex groups. Hepatic TG level was strongly correlated with hepatic FAS activity serum leptin, and FFA levels. Discussions Our results indicated that diet restriction in the Zucker fatty rats may facilitate fat accumulation in the fasted liver. And, voluntary exercise may suppress the accumulation of liver fat via inhibition of hepatic FAS activity. Although we demonstrated that diet restriction did not suppress the accumulation of liver fat, its cause is not yet to be identified. Further studies are required. The present results suggested the necessity of exercise for obesity prevention. References Rector R S, et al. (2011). *Am J Physiol Gastrointest Liver Physiol*. 300, 874-883. Luan Y, et al. (2002). *Exp Gerontol*. 42,1063-1071. Man ZW, et al. (2000). *Metabolism*. 49, 108-114.

## EFFECTS OF EXERCISE TRAINING AND INTERLEUKIN 6 UPON PANCREATIC ISLETS PROTEINS: EVIDENCE FOR A POSSIBLE SKELETAL MUSCLE AND ENDOCRINE PANCREAS CROSSTALK

Zoppi, C., Costa Jr, J., Paula, F., Oliveira, C., Carneiro, E.

*UNICAMP and UNIFESP*

EFFECTS OF EXERCISE TRAINING AND INTERLEUKIN 6 UPON PANCREATIC ISLETS PROTEINS: EVIDENCE FOR A POSSIBLE SKELETAL MUSCLE AND ENDOCRINE PANCREAS CROSSTALK Zoppi, C.1, Costa-Junior. J.1, Paula, F.1, Oliveira, C.2, Carneiro, E.1 1:UNICAMP (Campinas, Brazil), 2: UNIFESP (Santos, Brazil) Introduction Endurance training (ET) and incubation with interleukin 6 (IL6) were reported to alter pancreatic islets function and growth. Considering that contracting skeletal muscle increases blood IL6 release, we hypothesized that the crosstalk between skeletal muscle and endocrine pancreas might be mediated by this cytokine. Here we aimed to investigate the effects of ET-induced adaptations upon key proteins involved with pancreatic islets, mainly regarding beta cells, function and growth, suggesting a possible involvement of IL6 on that process. Methods Male Swiss mice were allocated into a sedentary control or an ET group. Mice were submitted to an 8 weeks ET swimming protocol. At the end of the protocol, mice swam for 1h per day, five days per week. After that, animals were sacrificed; soleus and gastrocnemius homogenate was used for citrate synthase (CS) activity measurement. Pancreatic islets were isolated by collagenase digestion of the pancreas for static insulin secretion by radioimmunoassay and western blot analysis of several proteins involved with islets function and growth. In addition, MIN6 cells were incubated or not with IL6 (5ng/ml) for 30 min and 24 h. Total content of protein kinase A (PKA), protein kinase C (PKC) and vesicle associated membrane proteins 2 (VAMP2), and the phosphorylation level of the signal transducers and activators of transcription protein 3 (pSTAT3), AKT (pAKT) and ERK1/2 (pERK1/2) were measured in isolated islets and MIN6 cells. Results ET mice showed 40% higher skeletal muscle CS activity and 50% lower insulin secretion. Significant increase in pSTAT3, pAKT, pERK1/2, PKA and VAMP2 by 33, 65, 50, 100 and 70%, respectively, from ET islets were reported. IL6 treated MIN6 cells pSTAT3, pAKT and pERK1/2 were 200, 25 and 25%, respectively increased, after 30 min of incubation, whereas PKA and VAMP2 had their total content increased by 40 and 22%, respectively, after 24 h of IL6 incubation. In addition, PKC content was not altered by any of the treatments. Discussion ET and IL6-incubated MIN6 cells displayed IL6-STAT3 signaling pathway activation and similar profile of secretory machinery and growth proteins modulation, suggesting a possible ET-induced pancreatic islets adaptations signaling by this cytokine. Thus our results provide preliminary evidence for a possible IL6-mediated contracting skeletal muscle and endocrine pancreas crosstalk.

## THE EFFECT OF UNDERWATER ENVIRONMENT ON CARDIAC PARASYMPATHETIC NERVOUS ACTIVITY DURING ARM CRANKING EXERCISE AMONG DIABETES PATIENTS

ONO, K., KUNIYOSHI, H., OKUSHIMA, Y.

*Kobe University*

The Effect of Underwater Environment on Cardiac Parasympathetic Nervous Activity during Arm Cranking Exercise among Diabetes Patients Ono, K.1, Kuniyoshi, H.2, Okushima, Y.2 1: Graduate School of Health Sciences, Kobe University (Kobe, Japan), 2: Kobe University (Kobe, Japan) Introduction It is believed that 22.1 million people are strongly suspected having diabetes or not able to deny the possibility of having diabetes in Japan (2007). Majority of the patients who undergo artificial dialysis are those who have the diabetic renal disease. Many diabetic patients also suffer from obesity. The amount of kidney blood flow is maintained during exercise in water. And by the action of buoyancy the weight which is loaded on the joint of the legs decreases. The purpose of this study is to make clear that the effect of an underwater environment on cardiac parasympathetic nervous activity during arm cranking exercise is beneficial for diabetes patients. Methods Six diabetes patients (age:  $57.5 \pm 12.3$  yrs, height:  $162.6 \pm 8.7$  cm, weight:  $75.1 \pm 23.5$  kg; mean  $\pm$  SD) participated in this study, voluntarily. They started at rest on land in a sitting position for 5 minutes. After that, they entered the tub and rested in a sitting position for 10minutes. After rest in the tub, they started arm cranking exercise for 20 minutes. The exercise intensity was at 80% of Anaerobic Threshold. Two conditions were set; exercise in the water (around 30°C) ; W-condition and exercise on the ground; C-condition. The W-condition's water depth was xiphoid process. After exercising, they recovered for 5 minutes continuously as a same position. The measurements were heart rate (HR), cardiac parasympathetic nervous activity (high frequency: HF) and blood pressure (BP) during the experiment and a time constant of HR attenuation for 30 seconds after exercise. Results HR of W-condition at the rest was lower than that of C-condition. The changes of HR during exercise were not significant in the two conditions, through HR at the end of exercise in W-condition was lower than C-condition. W-condition's HF during post exercise for 30 seconds showed lower than that of C-condition significant ( $P < 0.01$ ). There was not significant change through W-condition's systolic BP at post exercise phase was lower than that of C-condition. Discussion The water level in W-condition was kept below the subjects' upper extremities to match the C-condition's exercise pattern. It is suggested that since these were not affect from water resistance, there wasn't difference of the exercise intensity by the condition. At the recovery phase, it is suggested that since the subjects at W-condition were affected by water pressure and lead to an increase of the amount of venous return, W-condition's HF showed lower than that of C-condition's. With these factors, it is suggested that cardiac parasympathetic nervous activity plays a role in the early recovery of HR immediately following exercise in water.

## RESISTANCE TRAINING AND OVARIECTOMY ON GENE EXPRESSION OF MOLECULES RELATED TO FAT OXIDATION AND LIPOGENESIS IN THE LIVER OF RATS

PEREZ, S., RODRIGUES, M., STOTZER, U., TOMAZ, L., MARINE, D., BERTUCCI, D., BALDISSERA, V., DOMINGOS, M., SOUZA, D.

*FEDERAL UNIVERSITY OF S. CARLOS*

Introduction Decreased levels of estrogen is associated with hepatic steatosis (HS) (Volzke et al., 2006), through changes in gene expression of molecules related to fat oxidation and lipogenesis (Paquette et al., 2008). Both resistance training (RT) (Leite et al., 2009) and endurance training (ET) (Pighon et al., 2010) prevents the HS in ovariectomized (Ovx) rats. However, the molecular events were only investigated for ET but not for RT. Thus, the aim of this study was to investigate the effects of Ovx and RT on the gene expression of molecules related to fat oxidation and lipogenesis in the liver of rats. Methods Sprague-Dawley adult female rats were grouped into four groups (n = 6 per group): sham sedentary (S-S); Ovx sedentary (Ovx-S); sham RT (S-RT) and Ovx-RT. A 10-week RT period, during which the animals climbed a 1.1-m vertical ladder with weights attached to their tails, was used. The sessions were performance once every 3 days, with 4-9 climbs and 8-12 dynamic movements per climb (Hornberger and Farrar, 2004). The animals were sacrificed 48 hours after the last session of RT. The gene expression was analyzed by RT-PCR by the delta delta cycle threshold ( $\Delta\Delta Ct$ ) method. Fisher's post hoc test was used in the event of a significant ( $P < 0.05$ ) ratio. Results The Ovx decreased the gene expression of molecules related to fat oxidation, carnitine palmitoyltransferase I (53%) and  $\beta$ -hydroxyacyl-CoA dehydrogenase (27%), and increased of molecules related to lipogenesis, sterol



regulatory element-binding protein-1c (106%), acetyl-CoA carboxylase (ACC) (72%) and stearoyl CoA desaturase-1 (109%), which had their expression restored to the RT, with the exception of the ACC. Discussion Increased synthesis of new lipids is the primary disorder in HS, which is strongly stimulated by lipogenic molecules (Pighon et al., 2010). Additionally, recent results indicate that fatty acid oxidation is reduced in the liver of Ovx animals (Paquette et al., 2008). The present results indicate that the RT have important effects similar to estrogen on the prevention of HS in Ovx animals, through changes in gene expression of molecules related to hepatic lipid metabolism. References Hornberger T, Farrar R. (2004). *Can J Appl Physiol*, 29(1), 16-31. Leite R, Prestes J, Bernardes C, Shiguemoto G, Pereira G, Duarte J, Domingos M, Baldissera V, Perez S. (2009). *Appl Physiol Nutr Metab*, 34, 1079-1086. Paquette A, Wang D, Jankowski M, Gutkowska J, Lavoie J. (2008). *Menopause*, 15(6), 1169-1175. Pighon A, Gutkowska J, Jankowski M, Rabasa-Lhoret R, Lavoie J. (2010). *Metabolism*. Volzke H, Schwarz S, Baumeister S, Wallaschofski H, Schwahn C, Grabe H. (2006). *Gut*, 56, 594-595.

### EFFECTS OF OVARIECTOMY AND RESISTANCE TRAINING ON OXIDATIVE STRESS MARKERS IN RATS LIVER

Rodrigues, M.F.C., Domingos, M.M., Stotzer, U.S., Shiguemoto, G.E., Deminice, R., Ferreira, F.C., Tomaz, L.M., Gatto, C.V.G., Júnior, A.A.J., Araújo, H.S.S., Baldissera, V., Arakelian, V., Perez, S.

*Federal University of São Carlos*

Introduction Ovariectomy promotes impairment redox balance, with higher levels of oxidative stress (OS) (Maltais et al. 2009). It has been proposed that hepatic OS in postmenopausal women is related to higher prevalence of hepatic diseases such as nonalcoholic fatty liver (NAFLD) (Gutierrez-Grobe et al. 2010). Resistance training (RT) in humans has shown similar results to aerobic training in up-regulation of antioxidant system defense and protection against the oxidative damage. Therefore, the aim of this study was to assess the effects of RT on OS markers in the liver of ovariectomized rats (Ovx). Methods Sprague-Dawley adult female rats were grouped into four groups (n = 8 per group): sham sedentary (S-S); Ovx sedentary (Ovx-S); sham RT (S-RT) and Ovx-RT. A 10-week RT period, during which the animals climbed a 1.1-m vertical ladder with weights attached to their tails, was used. The sessions were performed once every 3 days, with 4-9 climbs and 8-12 dynamic movements per climb (Hornberger and Farrar, 2004). The animals were sacrificed 48 hours after the last session of RT. The OS was measured by levels of reduced glutathione (GSH) and oxidized glutathione (GSSG), the lipid peroxidation (LP), the concentration of vitamin E and gene expression of glutathione peroxidase (GSH-Px). Results The estrogen deficiency associated to Ovx decreased in the (GSH / GSSG) ratio (28%), vitamin E concentration (45%), and gene expression of GSH-Px (49%), no significant change was detected of the LP in the liver of the Ovx rats compared to Sham-Sed rats. On the other hand, the RT program adopted did not reverse the hepatic oxidative damage caused by Ovx and also provided an increase in hepatic OS. Discussion Estrogen deficiency is associated with increased oxidative stress (OS), which in turn is involved in the physiopathology of diseases such as fatty liver disease (NAFLD). (Gutierrez-Grobe et al. 2010). Resistance training (RT) may reduce oxidative damage by promoting an up-regulation in the antioxidant defense system. (Cakir-Atabek et al. 2010). The present results indicate that the resistance training program did not reverse the hepatic oxidative damage caused by Ovx. Additionally, the proposed resistance training also increased OS in the liver. References Cakir-Atabek H, Demir S, PinarbaSili RD, Gunduz N (2010). *J Strength Cond Res* 24 (9):2491-2497 Gutierrez-Grobe Y, Ponciano-Rodriguez G, Ramos MH, Uribe M, Mendez-Sanchez N. (2010). *Ann Hepatol* 9 (4):402-409 Maltais ML, Desroches J, Dionne JJ (2009). *J Musculoskelet Neuronal Interact* 9 (4):186-197.

### IS THE LAST EXERCISE DONE IN TRAINING SESSION RESPONSIBLE FOR THE INCREASE IN INSULIN-SENSITIVITY AFTER ENDURANCE-TRAINING IN GÖTTINGEN MINIPIGS?

Vincent, S.1,2, Blat, S.3,4, Lemoine-Morel, S.1,2, Lefevre, L.1,2, Malbert, C.H.3,4, Delamarche, A.1,2

*1 Laboratoire Mouvement Sport Santé (M2S) (Rennes2, France), 2M2S (ENS Cachan – antenne de Bretagne, Bruz, France), 3INRA (Saint-Gilles, France), 4Agrocampus Ouest (Rennes, France).*

Introduction Endurance Training (ET) is known to induce a transient increase in insulin sensitivity (IS). This increase in IS could be due to the last exercise realized in the training period (TP) or to the adaptations induced by the global TP. Moreover, the duration of this-protective effects is controversial (24 hours to 7 days) (Arciero et al. 1998, Shojaee-Moradie et al. 2007, Goulet et al. 2005), probably because of the diet, the training program and the body and/or fat masses' changes. So, the aim was to study the persisted effects of training on IS and the role of the last exercise done in TP. An animal model Göttingen minipigs (MP) was taken as models for humans in order to control diet and to limit body and fat masses' modification as confounding factors. Methods 12 adult MP (18-24 month-old, 30-35 kg) were placed on a standard diet during 16 weeks. They followed or not endurance training (ET). ET was individualized and consisted in a 1h/day, 5days/week running during 12 weeks at 150 bpm heart rate on a motor-driven treadmill. Food was supplied to cope energy expenditure in order to keep the body and fat masses constant throughout the protocol. Intravenous glucose tolerance tests (IVGTT) were performed at T0, T1, T24 and T72 for immediately, 1, 24 and 72 hours post exercise, respectively, before and after the TP. We followed the residual effect of ET, 7 days and 1 month after the last exercise of TP by additional IVGTT. The HOMA-IR was used as an index of glucose tolerance. The area under the curve of glucose (AUCG) and the glucose disappearance (KG) were determined as dynamic insulin-sensitivity indexes. The acute insulin response (AIR) and AUC of insulin (AUCI) were used as indexes of insulin secretion. Results - Discussion The acute exercise realized before ET was able to induce an increase in IS judged on the improvement of HOMA-IR, AUCG, KG and AUCI at T1, T24 and T72. So, the improvement of IS can persist until 72h after an acute exercise in MP. After 12 weeks of ET, these indexes were not significantly different between T0, T1, T24 and T72 but improved vs. before ET. This data argue in favor of beneficial adaptations of all exercises realized during TP on IS more than the effect of the last acute exercise. In MP with no change in body and fat masses, the improvement of IS and insulin secretion by ET, persisted 7 days but had disappeared one month after the last exercise. In fact, 12 weeks-ET induced a significant increase in KG and decrease in AIR (p=0.01) explained by an increase in IS at the end of ET. In conclusion, ET induced an increase in IS that cannot be explained by changes in body and fat masses. These beneficial effects of ET seemed to be due to all exercises and not to the last acute exercise realized at the end of the TP. The increase in IS persisted 7 days after training but disappeared after 1 month of detraining. References Arciero et al. (1998) *J Appl Physiol* 84(4):1365-1373. Shojaee-Moradie et al. (2007) *Diabetologia*. 50(2):404-13. Goulet et al. (2005) *Eur J Appl Physiol* 95:146-152.

**INSULIN ANTILIPOLYTIC EFFECT IS NOT CHANGED DURING A WEIGHT-REDUCING MULTI-PHASE DIETARY INTERVENTION IN OBESE WOMEN**

Czudkova, E.1, Langin, D.2, Stich, V.1, Kopko, K.1,3

*1 Charles University (Prague, Czech Republic), 2 Université Paul Sabatier (Toulouse, France), 3 Ghent University (Ghent, Belgium)*

**Introduction** Insulin is the major antilipolytic hormone in vivo. It acts through activation of phosphodiesterase-3B (PDE3B) which controls the activation state of lipases and lipid droplet-associated proteins. It has been shown that subjects who are less insulin sensitive are also less sensitive to the antilipolytic effect of insulin in the subcutaneous adipose tissue (SCAT) (1). Therefore, the aim of this study was to examine whether during a multi-phase diet the improvement in whole body insulin sensitivity coincided with an increased antilipolytic effect of insulin and a higher expression of PDE3B mRNA in SCAT. **Methods** Fifteen obese premenopausal women underwent a 6-months dietary intervention (DI) program consisting of a 1 month very low calorie diet (VLCD), followed by 2 months low calorie diet (LCD) and 3 months weight maintenance (WM). During each phase of the DI a 3-h hyperinsulinaemic euglycaemic clamp (HEC) was performed. Furthermore, needle micro biopsy of the abdominal SCAT was obtained to determine mRNA expression of PDE3B. In a subgroup of eight subjects, SCAT microdialysis was performed at each phase of the DI. The dialysate glycerol concentration (DGC) was evaluated at baseline and during the HEC. **Results** The body weight was significantly reduced by 9.8% at the end of WM. Compared with the pre-diet condition, glucose disposal rate was higher at the end of VLCD, LCD and WM (i.e.  $3.1 \pm 0.4$  in pre-diet condition,  $3.8 \pm 0.5$ ,  $p = 0.053$  at the end of VLCD,  $4.2 \pm 0.4$ ,  $p < 0.05$  at the end of LCD,  $4.3 \pm 0.4$ ,  $p < 0.05$  at the end of WM). At all phases of the diet, DGC progressively decreased during HEC (i.e. by  $30 \pm 11\%$  before the diet,  $37 \pm 4\%$  after VLCD,  $35 \pm 12\%$  after LCD and  $30 \pm 17\%$  after WM) and this decrease was not significantly different between the different phases of the diet. The mRNA levels of PDE3B did not significantly change throughout the DI. **Discussion** The results suggest that the sensitivity to the anti-lipolytic action of insulin in SCAT during the DI seems not to be directly related to the evolution of the whole body insulin sensitivity with respect to the carbohydrate metabolism. Also at the transcriptional level, PDE3B was unaffected by the changes in calorie intake during the DI. **Reference** 1. Eriksson JW, Smith U, Waagstein F, Wysocki M, Jansson P. Glucose turnover and adipose tissue lipolysis are insulin-resistant in healthy relatives of type 2 diabetes patients. *Diabetes* 48:1572–1578, 1999.

**13:45 - 14:45****Poster presentations****PP-PM30 Health & Fitness: Children****THE EFFECTS OF THE COMBINED EXERCISE IN WATER AND ON LAND ON BODY POSTURE OF PRESCHOOL CHILDREN**

Torlakovic, A., Simikic, I., Muffic, M.

*Olympic Swimming Pool Center-Sarajevo*

**Introduction:** Poor body posture of children of preschool and early school age is steadily increasing and is more and more present as a possible indicator of health problems in the second phase of intense growth and development. The aim of this study was to determine the effects of the transformation processes on posture of preschool children, under the combined influence of exercise in water and on land. **Methods:** The study included 80 children of both sexes, 41 male ( $n = 41$ , mean age =  $5.3 \pm 0.7$  yrs.; mean height =  $115 \pm 6$  cm; mean weight =  $21.6 \pm 4.5$  kg) and 39 female ( $n = 39$ , mean age =  $5.4 \pm 0.7$  yrs.; mean height =  $115 \pm 7$  cm; mean weight =  $21.3 \pm 4.4$  kg) which, due to decreased muscle tone, had a predisposition to poor posture. Assessment of postural status of the subjects were made according to the Wolanski method, while the estimation of basic elements and skills needed to move in the water was carried out according to a scale of 1 to 3 (non-swimmers, buoys and semi-swimmers). The combined programmed of corrective exercise, Pilates and games in water was carried out within the period of 14 weeks, twice a week per 60 minutes. For the analysis of initial and final testing, T-test for dependent samples has been used (marked differences are significant at  $p < .0500$ ). **Results:** The results of t-test for dependent samples showed that the children in final test had a statistically significant positive changes in the assessment of body posture ( $p = .000$ ). Analysis of the dynamics of learning the basic skills necessary to navigate in water, showed statistically significant increase in results for the initial and transitive ( $p = .012$ ), and the initial and final ( $p = .008$ ) test. **Conclusions:** Doctors recommend swimming as an activity which can possibly prevent poor body posture or postural disorders. As expected, based on the results and confirmed in this study, applying a coordinated program with complemented exercises of remedial gymnastics, Pilates, games and exercises in water leads to a large extent of positive effects in improvements of poor body posture of children at this age. We can conclude from this that the program is very effective and useful in practice. Since the program contains various moving exercise, it is manageable to retain children's interest, attention and positive emotions during exercise which is especially important for achieving the desired results. It is important to note that part of the program that was implemented in water was very successful for learning basic swimming skills and psychological preparation of children for active participation in advanced aquatic programs in the future. **References:** Melody, O., Schofield, G.M., & Kolt, G.S. (2007). Physical Activity in Preschoolers: Understanding Prevalence and Measurement Issues. *Sports Medicine*, 37(12), 1045-1070. Finn, K, Johansson, N, & Specker, B. (2002). Factors associated with physical activity in preschool children. *Journal Pediatric*, 140, 81-85.

**PREDICTION OF TOTAL AND REGIONAL FAT-FREE MASSES OF JAPANESE PREPUBERTAL CHILDREN BY BIO-ELECTRICAL IMPEDANCE METHOD.**

Ohta, M.1, Midorikawa, T.2, Hikiyama, Y.3, Masuo, Y.4, Sakamoto, S.4, Kawakami, Y.4, Kanehisa, H.5, Fukunaga, T.5

*1: Kanazawa Seiryō University, 2: J.F. Oberlin University, 3: Chiba Institute of Technology, 4: Waseda University, 5: National Institute of Fitness and Sports in KANNOYA*

**Background:** In the research field of growth and development, the assessment of body composition is essential. Bio-electrical impedance (BI) method is a convenient and non-invasive way to predict body composition. However, only a few studies have tried to equation for predicting fat-free mass (FFM) in children by adopting BI method, and the accuracy of prediction equations reported in these studies are unsatisfactory due to the lack of assessing segmental FFM, which is a cause producing estimation errors. At present, since child obesity is

one of the major health-related problems, developing an accurate prediction equation of FFM in children, including over-weight children, is crucial. Objective: To investigate the validity of estimating segmental and total FFM in children using segmental BI analysis. Methods: A total of 145 Japanese children aged 6-12 years participated in this study. They were divided into three groups: a validation group (46 boys; 30 girls), a cross validation group (23 boys; 15 girls) and an over-weight group (17 boys; 14 girls). Using the dual energy X-ray absorptiometry (DXA) method, the FFMs of the arm, the trunk, the leg and the total-body were determined and used as reference data. The electrical impedance was measured by a BI apparatus (500 $\mu$ A, 50kHz). A BI index was calculated as the ratio of the segment length squared ( $L^2$ ) to the impedance ( $Z$ ). Results and discussion: For the validation group, a single regression analysis showed a significant correlation between the BI index and measured FFM in each segment ( $r = 0.929 - 0.968$ ,  $p < 0.001$ ), and it produced a prediction equation with an estimate SE, 0.2 -1.0 kg (4.3 - 8.2%). There were no significant differences between the measured and estimated FFMs in the validation and the cross-validation groups without systematic error. The application of the prediction equation to the over-weight group did not produce significant difference between the measured and estimated FFMs without systematic error. Electrical impedance varies depending on the volume of the conductor (i.e. the human body), the conductor's length (i.e. the subject's height), the components of the conductor (i.e. FFM), and its impedance ( $Z$ ); i.e. shapes and sizes of various body segments affect the measured impedance values. For example, arms and legs together account for about 50% of the FFM and contribute at least 91% of the measured whole-body resistance. The current results indicate that the segmental BI analysis is essential for achieving an accurate prediction of the total and segmental FFM in children.

### CARDIOVASCULAR RISK FACTORS IN BOYS AND GIRLS

Brito, L., Titski, A.C.K., Moser, D.C., Mascarenhas, L.P.G., Góes, S.M., Mattos, F., Carvalho, H.M., Coelho-e-Silva, M.J., Leite, N.

*Federal University of Parana and CAPES*

**Introduction** The risk factors for cardiovascular disease (CVD) have been increased in children and adolescents due to overweight and sedentary lifestyle. The assessment of these factors can be accomplished by anthropometrics measuring, which allows early diagnosis in children and adolescents. (ANDERSEN et al., 2011). The aim of this study was to determine CVD risk factors in scholar and verify differences between genders. **Methods** Cross-sectional epidemiological study was conducted with 1325 scholars (591 boys and 734 girls) from five schools in Curitiba-PR-Brazil. Height, body mass, waist circumference, blood pressure (BP), cardiorespiratory fitness and physical activity history (PAH) was assessed. Student's t-test for independent sample, Chi-square test and Pearson's partial correlation were performed. These statistical procedures were calculated with significance set at  $p < 0.05$ . Results In the total sample we found 31.9% of overweight ( $X^2 = 1.60$ ;  $p = 0.205$ ), 28.5% of visceral obesity ( $X^2 = 16.6$ ;  $p = 0.000$ ), 16.9% of hypertensive levels ( $X^2 = 1.29$ ;  $p = 0.525$ ), 47.3% of low fitness ( $p = 0.000$ ) and 45.3% were below 300min/week of physical activity ( $X^2 = 17.02$ ;  $p = 0.000$ ). We found greater proportion of time expended in physical activity and cardiorespiratory fitness in the boys group, while girls showed greater incidence of visceral obesity. **Discussion** This study showed high frequency of CVD factors in south Brazilian young subjects. In addition, epidemiologists have shown that CVD risk factors traditionally associated with cardiovascular morbidity in adult life are especially common in children and adolescents today (TERRES et al., 2006). In this study there were no CVD risk factors difference between boys and girls, except in the visceral obesity, which was higher in girls compared to boys. References Andersen L B, Riddoch C, Kriemler S. Hills. (2011) Brazilian Journal Sports Medicine, 45, 871-876. Terres NG, Pinheiro RT, Horta BL, Amaral K, Pinheiro T. (2006) .Diabetes, 40 (4), 627-633.

### THE INFLUENCE OF BIOLOGICAL MATURATION ON SPORTS PARTICIPATION, PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND BODY COMPOSITION

Drenowatz, C.1, Kettner, S.1, Kobel, S.1, Fischbach, N.1, Steinacker, J.M.1

*Ulm University*

1: Ulm University Medical Centre (Ulm, Germany) **Introduction** The rising prevalence of childhood overweight and obesity has been largely attributed to environmental constraints but biological factors need to be considered as well. Specifically changes in body composition during puberty have been associated with changes in physical activity (PA) and sedentary behaviour. In younger children the effect of biological maturation on behavioural aspects is less clear. The purpose of this study, therefore, was to examine the influence of maturity status on sports participation, physical activity, sedentary behaviour and body composition in primary school children. **Methods** Baseline data including 1968 first and second grade children from a large school-based intervention in southern Germany funded by the Baden-Württemberg Stiftung was used. A sample of 1045 children (502 male; 543 female) 7.0 $\pm$ 0.6 years of age provided complete data including reported parental height to determine maturity (Khamis & Roche 1994). Sports participation, physical activity (PA), and screentime (ST) (computer and TV use) was assessed via parent questionnaire. Fitness was determined based on the results of the DKT fitness test (Graf et al. 2004). Subject height and weight was measured by trained technicians and converted to BMI percentiles (BMIPCT). Differences between early, average and late mature participants were assessed via ANCOVA, controlling for sex and age, using Bonferroni adjustment for post-hoc analysis. Results There was no difference in maturity scores between boys and girls. BMIPCT differed across all groups with highest values for early mature and lowest values for late mature children. No difference occurred in sports participation or PA but average mature subjects displayed higher fitness scores. ST was significantly higher for early maturers compared to average or late maturers but these differences disappeared after adjusting for BMIPCT. **Discussion** While no difference in PA or sports participation was observed, early mature children displayed higher body composition, which could lead to lower fitness scores. The increased sedentary behavior in addition to increased body weight in early mature children puts these children at higher risk for various chronic diseases even if PA is not different from their peers. More research, however, is necessary to clearly determine the effect of maturity on sedentary behaviour and physical activity at younger ages in order to address children at risk accordingly. References: Graf C et al. Physical activity, leisure habits and obesity in first-grade children. Eur J Cardiovasc Prev Rehabil 2004; 11: 284-290. Khamis HJ & Roche AF. Predicting adult stature without using skeletal age: the Khamis-Roche method. Pediatrics 1994; 94:504-7.

## THE ABILITY OF DIFFERENT MEASURES OF ADIPOSITY TO DISCRIMINATE BETWEEN LOW/HIGH MOTOR COORDINATION

Lopes, L.1, Santos, R.2, Pereira, B.1, Lopes, V.P.3

1: CIEC-UMinho (Braga, Portugal), 2: CIAFEL-FADEUP (Porto, Portugal), 3: CIDESD-IPB (Bragança, Portugal)

**Introduction** Several anthropometric measures, indices and other techniques have been used in the literature on associations between adiposity and MC. Therefore, the aim of this study was to determine the ability of different measures of adiposity to discriminate between low/high motor coordination (MC). **Methods** A cross-sectional school-based study was conducted on 596 Portuguese children's, aged 9-12 years during the 2009/2010 academic year. Weight, height and waist circumference (WC) were objectively measured by standardized protocols. Body fat percentage (BF%) was estimated by bioelectric impedance. Body mass index (weight/height<sup>2</sup>) and waist-to-height ratio (WHtR) were computed. MC was assessed with the Körperkoordination Test für Kinder (Kiphard & Schiling, 1974). Cardiorespiratory fitness was predicted by a maximal multistage 20m shuttle-run test of the Fitnessgram Test Battery (Welk & Meredith, 2008). A questionnaire was used for assess mother's educational level. Receiver operating characteristic (ROC) and logistic regression were performed. Results ROC curve analysis showed that all measures of adiposity performed well on average in identifying low MC, as indicated by the area under the curve greater than 0.6. The ROC performance of BF% showed a slightly better discriminatory accuracy than BMI, WC and WHtR in predicting low MC in girls. In boys, the ROC performance of WC showed a slightly better discriminatory accuracy than BMI, BF% and WHtR in predicting low MC. After adjustments, logistic regression analyses showed that BMI, WC, %BF and WHtR were positively and significantly associated with MC in both sexes, with exception of WHtR in girls. **Discussion** Measurement issues may potentially play a role in obscuring the relationship between adiposity and MC. BF% and WC showed a slightly better discriminatory accuracy in predicting low MC, for girls and for boys, respectively. **References** Kiphard, E. J., & Schiling, F. (1974). Körperkoordination Test für Kinder, KTK. Beltz Test GmbH. Weinheim. Welk, G. J., & Meredith, M. D. (Eds.). (2008). Fitnessgram / Activitygram Reference Guide (3 ed.). Dallas, TX: The Cooper Institute.

## INFLUENCING FACTORS OF SEDENTARY BEHAVIOUR IN EUROPEAN PRESCHOOL SETTINGS. AN EXPLORATION THROUGH FOCUS GROUPS WITH TEACHERS

De Decker, E.

Ghent University

**Introduction** Preschool children are sedentary for 50 to 80% of the time, in the classroom as well as during recess. Qualitative studies examining influencing factors of preschoolers' sedentary behaviour at preschool are lacking. This study was executed to explore teachers' opinions on potentially influencing factors of preschoolers' sedentary behaviour in preschool settings. **Methods** Eighty-seven teachers of 4-6 year old preschoolers from six European countries participated in a total of 18 focus groups between October 2010 and January 2011. Key findings were reported by each country separately, and were independently analyzed by two researchers using qualitative content analysis. **Results** According to the teachers, preschoolers do not sit a lot at preschool. Teachers perceive the lack of play space and the small classroom size as potentially influencing factors of preschoolers' sedentary behaviour. Play equipment and teachers' prompts are mentioned to be potentially stimulate children to be less sedentary on the playground. Computer use is reported to be more common in preschool compared to TV watching. Reported reasons for computer use in preschool are educational purposes and computers being part of daily life. **Discussion** Interventions should first focus on increasing teachers' awareness on how sedentary preschoolers are during the preschool day. Teachers should also be informed on strategies to decrease this behaviour in the classroom and at the playground. **References** Hinkley T, Salmon J, Okely AD, Trost SG (2010). Correlates of sedentary behaviours in preschool children: a review. *Int J Beh Nutr Phys Ac.*, 7: 66-76 Reilly JJ (2008). Low levels of objectively measured physical activity in preschoolers in child care. *Med Sci Sport Exer* 42(3): 502-507

## FOLLOW-UP STUDY OF OBJECTIVELY MEASURED PHYSICAL ACTIVITY LEVELS IN 3- TO 4-YEAR-OLD FINNISH CHILDREN

Mehtälä, A., Soini, A., Säkäslähti, A., Tammelin, T., Kulmala, J., Villberg, J., Poskiparta, M.

University of Jyväskylä

**FOLLOW-UP STUDY OF OBJECTIVELY MEASURED PHYSICAL ACTIVITY LEVELS IN 3- TO 4-YEAR-OLD FINNISH CHILDREN** Mehtälä, A.1, Soini, A.1, Säkäslähti, A.2, Tammelin, T.3, Kulmala, J.3 Villberg, J.1, Poskiparta, M.1. 1: Research Centre for Health Promotion, 2: Department of Sport Sciences, University of Jyväskylä, Finland, 3: LIKES Research Center for Sport and Health Sciences, Jyväskylä, Finland **INTRODUCTION** In previous studies, most of which were cross-sectional, age has been found to associate with physical activity (PA). The aim of the present study was to evaluate whether the PA of 3-year-old children changed over the course of a one-year follow-up. **METHODS** Physical activity levels of children born in 2007 were assessed during two measurement periods: from August to October in 2010 and in 2011. The accelerometer (ActiGraph GT3X) data was collected on 5 consecutive days (3 weekdays and 2 weekend days). Valid, 8h/d, PA data for at least 3 days (2 weekdays and 1 weekend day) were obtained from 46 children (23 boys) in both years. During the first measurement the children were 39 (4) months old and during the second 50 (4) months old. Parents were instructed to keep the accelerometers on their children's hip during all waking hours except during water-based activities. The cut-points established by van Cauwenberghe (2010) and 5-second epoch duration were used in this study. The Mann-Whitney U-test and Independent t-test were applied to identify differences between genders, weekdays and age. **RESULTS** Overall daily PA was calculated as mean counts per minute (cpm) for genders, weekdays, weekend days and both measurement sections separately. The overall PA was significantly higher among 4-year-old children (735±148 cpm) than among 3-year-olds (618±121cpm) (P<.001), but when viewing activity levels separately significant differences were observed only in vigorous activity spent during the week (P=.010). At the age of 4, but not 3, boys spent significantly more time than girls for all other activity levels (light, moderate and vigorous) except for the vigorous activity level on weekdays. Girls spent significantly less time in MVPA-level activity on weekend days than weekdays. **DISCUSSION** Children were physically more active at the age of 4 than 3 on average, and boys were more active than girls at the age of 4. Girls' lower activity levels on weekends are inconsistent with previous studies. Only few previous studies have reported an increase with age in children under school age (Jackson et al. 2003). The reason for this inconsistency between the results remains unclear, but it may be due to interindividual variation. Gender segregation seems to begin early in childhood. **REFERENCES** Jackson D, Reilly J, Kelly L, Montgomery C, Grant S & Paton J (2003) *Obes Res*, 11(3):420-5. Van Cauwenberghe E, Labarque V, Trost S, De Bourdeaudhuij I & Cardon G (2010) *Int J of Pediatr Obes*, Early Online, 1-8

## EXAMINATION OF INDIRECT LIFESTYLE INTERVENTION PROGRAM USING CORRESPONDENCE EDUCATION FOR OBESE CHILDREN AND THEIR PARENTS

Kawata, Y.1, Togashi, K.2, Hanaki, K.3, Iguchi, K.4

1:Teikyo University of Science, 2:Mie University, 3:Tottori University, 4:National Mie Hospital

**INTRODUCTION** There are two main methods of weight-loss instruction for obese children. One is the outpatient consultation for individuals (individual guidance), and the other is the weight-loss instruction for the group (group guidance). However, both methods are not easy to improve lifestyle as instructed, and reach to the point to make it change at home since the patients are children. In this study, we examined the indirect lifestyle intervention program to prevent obese progress for obese children and their parents, and evaluated the effectiveness. **METHODS** 34 obese children (age 9.3 years old, percentage of overweight (POW)  $38.8 \pm 20.9\%$ ) and their parents participated in this program for the totally of 3 sessions (1session 4-week). At each session we requested them to set their lifestyle goal, check the weight and the lifestyle by themselves, wear the pedometer with an uniaxial accelerometer (Lifecorder EX, Kenz, Japan) to set the aim of step counts. We also supported them by periodical telephone communication, and advised instruction by mail. We compared their height, weight, POW, percentage of body fat (BF%), blood pressure, blood biochemistry values, and step counts before and after the program. Moreover, their parents filled out questionnaires about the lifestyle and the contents of the program. **RESULTS** The number of those who declined participation before the program was eight in the 34 candidates. Five participants dropped out at the first session, and one participant dropped out at the second session. The number of those who finished the program was 20 out of the 26 participants (77%). After the program, height had significantly increased ( $140.0 \pm 7.8$  to  $142.5 \pm 8.0$  cm,  $p < 0.001$ ) and both POW and BF% had significantly decreased ( $35.8 \pm 18.1$  to  $29.8 \pm 15.2\%$ ;  $33.9 \pm 10.5$  to  $28.6 \pm 5.5\%$ ,  $p < 0.01$ , respectively) while body weight did not change ( $46.9 \pm 10.1$  to  $46.9 \pm 8.1$  kg) from pre- to post-program. AST and ALT were significantly decreased ( $p < 0.05$ ) while systolic or diastolic blood pressure, total cholesterol, HDL-C, LDL-C, or uric acid level did not change with the improving of obese. Step counts increased significantly from pre- to post-program ( $12,945 \pm 3,653$  to  $14,284 \pm 2,973$  steps/day,  $p < 0.05$ ). According to the questionnaires for parents, the program seemed to receive favorable review about having the children wear the pedometer and receiving the results of step counts. Moreover it seems to heighten the lifestyle consciousness of both the obese children and their parents. **CONCLUSION** It suggested that this program increased the life style consciousness of both the children and their parents and lead to improve of obese by carrying out the communicative program including the parents. The long-term follow-up is considered to be necessary to see the decrease of the POW is not temporary and if they could acquire the obesity prevention lifestyle through this program.

13:45 - 14:45

## Poster presentations

### PP-PM31 Health & Fitness: Disease

#### ASSESSMENT OF ANTHROPOMETRIC AND CARDIOMETABOLIC PROFILE IN MALE INDIVIDUALS WITH TYPE 2 DIABETES AFTER 12 WEEKS OF WATER TRAINING PROGRAM

Cugusi, L.1, Deidda, M.1, Caria, A.2, Cabras, S.3, Massidda, M.4, Mercurio, G.1

University of Cagliari

**Introduction:** The favorable role of exercise on health improvement and cardiometabolic profile in patients with type 2 diabetes mellitus (T2DM) is well established (ACSM and ADA, 2010). However, little is known about the effects of a specific program of aquatic physical exercise in patients with T2DM. The aim of this study was to analyze the anthropometric and physiological changes during and following 12 weeks of supervised water exercise program in a group of 15 men with T2DM. **Methods:** Fifteen men with T2DM ( $51.4 \pm 9.38$ , years) were enrolled in the study. We evaluated the daily average values of systolic and diastolic blood pressure (Spacelabs 90207 [•Spacelabs, Washington, USA]; Amoores et al., 2005) and determined the average weekly blood levels of fasting glucose (FreeStyle Freedom Lite [•Abbot Diabetes Care]; Tack C et al., 2012), before and after 12 weeks of supervised water exercise program. **Results:** We observed a significant reduction in body mass index ( $31.147 \pm 5.10$  vs.  $29.94 \pm 4.84$   $p < 0.01$ ), waist circumference ( $109.33 \pm 15.23$  vs.  $103.72 \pm 14$ ,  $51$   $p < 0.05$ ) and waist-hip ratio ( $1.01 \pm 0.06$  vs.  $0.99 \pm 0.05$   $p < 0.01$ ). As for the cardiometabolic profile, we detected a significant decrease in systolic blood pressure ( $149.66 \pm 17.99$  vs.  $142.44 \pm 13.04$   $p < 0.01$ ), diastolic blood pressure ( $88.55 \pm 10$ ,  $45$  vs.  $82 \pm 6.74$   $p < 0.01$ ) and fasting blood glucose levels ( $132.53 \pm 24.28$  vs.  $119.58 \pm 17.06$   $p < 0.01$ ), after 12 weeks. **Discussion:** Our results show that 12 weeks of supervised water exercise program are able to produce benefits for both optimization of the anthropometric profile, and improvement of the cardiometabolic profile in patients with type 2 diabetes. **References:** 1. American College of Sports Medicine (ACSM) and the American Diabetes Association (ADA). (2010). *Med Sci Sports Exerc*, 42(12), 2282-2303. 2. Amoores JN, Dewar D, Gough K, Padfield PL, (2005) *Blood Press Monit*, 10(1), 51-56 3. Tack C, Pohlmeier H, Behnke T, Schmid V, Grenningloh M, Forst T, Pflutzner A. (2012). *Diabetes Technol Ther*, 14(4), 1-8.

#### USE OF A SHORT-TERM ECCENTRIC CYCLING INTERVENTION IN THE TREATMENT OF NEWLY DIAGNOSED TYPE 2 DIABETICS

Ben, R.

University of Canberra

Use of a short-term eccentric cycling intervention in the treatment of newly diagnosed type 2 diabetics Rattray, B.1, Steele, J.1, Abhayaratna, W.2,3 1: University of Canberra, Australia, 2: Australian National University, Australia, 3: ACT Health, Australia **Introduction** Eccentric exercise may provide a promising tool in the combat of many lifestyle diseases (Paschalis et al., 2011) enabling high muscular loads at low cardiovascular strain. These advantages may assist in minimizing risk in complex disease conditions (Meyer et al., 2003) and diabetic populations in which physical activity compliance is poor (Plotnikoff et al., 2006). This study aimed to investigate the benefits of a short eccentric training period in a group of newly diagnosed type 2 diabetics. **Methods** Our preliminary data includes six female and four male newly diagnosed type 2 diabetics (age:  $50.0 \pm 15.0$  y, BMI:  $31.3 \pm 7.1$ , HbA1c:  $6.3 \pm 0.4\%$ ; mean  $\pm$  SD) in this fully controlled

randomized trial. Participants undertook an initial oral glucose tolerance test (OGTT) in which extra fasting blood samples were taken. Participants were matched for gender and randomly allocated to either a concentric (CON) or eccentric (ECC) cycling 2 wk intervention period. Supervised exercise of up to 30 min on each week day of the intervention was performed in 5 min bouts at an intensity aimed at eliciting a heart rate of 120 bpm. The OGTT and fasting blood measures were repeated the day after the last exercise session. Student *t*-tests were used to compare groups. Results There was no difference in total exercise time ( $196.0 \pm 21.3$  v  $216.0 \pm 31.9$  min; CON v ECC respectively) or exercise RPE ( $12.6 \pm 1.2$  v  $12.8 \pm 1.1$ ) between the interventions although the total work performed during ECC ( $2966.1 \pm 1026.5$  kJ) was higher than CON ( $892.1 \pm 261.9$  kJ). Greater work was performed in ECC despite not being able to match exercise heart rates ( $132 \pm 9$  v  $103 \pm 13$  bpm). There was no change in any fasting or OGTT measures including the homeostatic model assessment insulin resistance (change score:  $-0.78 \pm 1.96$  v  $0.92 \pm 0.88$ ), 2 hr glucose ( $+0.78 \pm 3.09$  v  $-0.18 \pm 2.22$  mM) or insulin ( $-47.5 \pm 75.4$  v  $+13.8 \pm 23.0$  mU/L). Discussion Preliminary data suggests that a short term bout of eccentric training is not likely to result in measurable changes in diabetic status in those newly diagnosed. Eccentric exercise enables high loads with low cardiovascular strain which may provide a safer and more compliant option for some patients. It is unclear if other advantages of eccentric exercise exist although anecdotal reports from the eccentric group were very positive. References Plotnikoff R, Taylor L, Wilson P, Courneya K, Sigal R, Birkett N, Raine K, Svenson L (2006). *Med Sci Sport Exer*, 38(8), 1526-1534. Meyer K, Steiner R, Lastayo P, Lippuner K, Allemann Y, Eberli F, Schmid J, Saner H, Hoppeler H (2003). *Med Sci Sport Exer*, 35(7), 1076-1082. Paschalis, V, Nikolaidis M, Theodorou A, Panayiotou G, Fatouros I, Koutedakis Y, Jamurtas A (2011). *Med Sci Sport Exer*, 43(1), 64-73.

### PLASMA HEAT SHOCK PROTEIN 72 AS A BIOMARKER OF SARCOPENIA IN ELDERLY PEOPLE.

Ogawa, K., Hun-kyung, K.1, Takahiko, S.1, Sigeaki, A.2, Yumi, S.3

1:Tokyo Metropolitan Institute of Gerontology (Tokyo, Japan), 2: Nippon Sports Science University (Tokyo, Japan), 3: Musashino University (Tokyo, Japan)

Introduction Sarcopenia is a geriatric syndrome in which there is a decrease of muscle mass and strength with ageing. In age-related loss of muscle strength, there are numerous observations supporting the assertion that neural factors mediate muscle strength. A possible contributing cause may be that aging changes systemic extracellular heat shock protein (eHsp)72 activity. The present study was designed to assess the plasma levels of eHsp72 in elderly people, and to investigate its potential interaction with components of sarcopenia. Methods A total of 665 men and women participated in an official medical health examination and an integrated health examination, including psychological and physical fitness tests. Blood samples were assayed for levels of plasma Hsp72, serum C-reactive protein, interleukin 6, tumor necrosis factor alpha, and regular biomedical parameters. The subjects were classified according to tertile levels of eHsp72. Results We found that higher Hsp72 in plasma is associated with lower muscle mass, weaker grip strength, and slower walking speed, and may be a potential biomarker of sarcopenia in elderly people. This finding was supported by other results in the present study: (i) older age and shrinking body and lower hemoglobin levels, all of which characterize sarcopenia, were related to higher eHsp72 tertiles; (ii) the ORs of the highest tertile of eHsp72 for the lowest tertiles of muscle mass, grip strength, and walking speed were 2.7, 2.6, and 1.8, respectively. These ORs were independent of age, sex, and the incidence of related diseases. Discussion Our results would reveal that eHsp72 in plasma is linked to sarcopenia factors and is a potential biomarker or predictor of sarcopenia. We also found that inflammatory cytokines and eHsp72 were independent and potentially associated with prevalent sarcopenia. Group (IL-6 middle + eHsp72 top, and IL-6 top + eHsp72 middle) had a significantly higher risk for being in the weaker grip strength group [OR, 3.31, 95% CI, 1.48-7.41,  $P=0.004$ ] compared to Group (IL-6 top + eHsp72 top). One possible explanation is that IL-6 and eHsp72 negate each other. These results might imply that eHsp72 reflects the opposite status of inflammation. It might be that inflammatory cytokines are related to muscle mass changes per se (i.e., sarcopenia), including muscle catabolism and synthesis, whereas eHsp72 is related to muscle strength for the protection of motor neurons (i.e., dynapenia). Geriatric syndromes have a biological basis and are considered to be highly prevalent and carry a high risk for adverse health outcomes. The present results could lead to the development of methods for screening those who require effective, targeted care.

### EFFICACY OF ONE EXERCISE PROGRAM TO IMPROVE THE PHYSICAL CONDITION IN PATIENTS WITH CARDIOVASCULAR RISK.

Meseguer Zafra, M., Manzanares Serrano, A., Menárguez Puche, J.F., Gil Pérez, T., Manzano Hernández, F.Y., Vives Hernández, J.J.

*universidad catolica san antonio*

Introduction In this is a paper we present the program "ACTIVA" and the results obtained in the same. The program "ACTIVA" is an initiative conducted by Ministry of Health from Region of Murcia (Spain). The purpose of this exercise program is promoting a moderate physical exercise habit to improve health indicators in patients with cardiovascular risk factors (CVRF). The aim of the present investigation was to confirm the short-term efficacy of this training program on physical fitness. Method The subjects in this study were 139 (35-65 years), patients of two medical centers, municipality of Molina de Segura (Spain). The criteria for inclusion in the program were the presence of two or more CVRF (hypertension, lipid disorders, overweight and smoking) and sedentary lifestyle. The subjects were included on the program for their family doctor or nurse. The program "ACTIVA" consisted of 30 sessions (10 weeks) of training on strength, flexibility and aerobic endurance, 3 days per week on circuit training. The program was designed by graduates for sport science and medical. The sessions had been in municipal places. Physical fitness was measured using the Rockport test (aerobic endurance) launching medical test ball (force) and Wells test (flexibility), made at the beginning and end of the program. For the analysis we used the T-Student test and Pearson lineal correlation. Result When we compare the results obtained at the beginner and at the end of the program, we observed that subjects improved in strength, through the launch of an average of  $5.18 \pm 1.31$  to  $5.54 \pm 1.27$  meters ( $p < 0.001$ ). Flexibility increased from a mean of  $-3.48 \pm 8.62$  to  $0.12 \pm 8.06$  cm ( $p < 0.001$ ). In relation to aerobic endurance the differences in VO<sub>2</sub> Max improved from values of  $30.43 \pm 7.95$  ml / (kg × min) at the beginning to  $32.30 \pm 6.68$  ml / (kg × min) at the end of the program ( $p < 0.001$ ). When we compared the results of men and women, we found that both sexes improved strength, flexibility and aerobic endurance similarly. Discussion The results show that following to realization of the program "ACTIVA", subjects with CVRF and sedentary obtained significant improvements in strength, flexibility and aerobic endurance, training on circuits for 30 seasons. Work protocol circuit produces improvements in physical condition, as shown by many authors (Paoli, Pacelli, Bargossi, Marcolin, Guzzinati, Neri, Bianco & Palma, 2010). References Paoli A, Pacelli F, Bargossi AM, Marcolin G, Guzzinati S, Neri M, Bianco A & Palma A. (2010) Effects of three distinct protocols of fitness training on body composition, strength and blood lactate. *Journal of Sports Medicine and Physical Fitness*, 50(1), 43-51.

## METS EQUIVALENT OF RESISTANCE TRAINING SESSIONS EXECUTED AT TWO INTENSITIES. DIFFERENCES BETWEEN HEALTHY SUBJECTS AND TYPE 2 DIABETIC PATIENTS

Benvenuti, P.1, Bergamin, M.2, Jimenez, A.3, Pugliese, G.4, Nicolucci, A.5, Balducci, S.4, Zanuso, S.3

1: University of Verona (Italy), 2: University of Padova (Italy) 3: University of Greenwich (UK), 4: La Sapienza University, Rome (Italy), 5: Consorzio Mario Negri Sud, Chieti (Italy)

**Introduction:** Metabolic equivalents (METs) are typically used to measure the caloric cost of aerobic exercises, rarely that of resistance exercises. Aim of this study was to investigate the metabolic equivalents of resistance training executed at light-moderate or vigorous effort respectively in type 2 diabetic patients and young subjects. **Methods:** Twenty type 2 diabetic patients ( $62.9 \pm 6.1$  years) and twenty-two young subjects ( $22.6 \pm 1.9$  years) performed two training sessions with 2-day recovery between each other: one at vigorous intensity (80% of 1-RM) and one at moderate intensity (60% of 1-RM) at Leg Press, Chest Press and Lat Pull Down. Oxygen consumption was continuously measured from fifteen minutes before the session, during the actual resistance training and for fifteen minutes after the session. **Results:** In both diabetic patients and young subjects no differences on METs intensities were found between vigorous and moderate intensities. A statistical difference was detected in between groups analysis, with young subject showing a statistical higher METs intensities in both 60% and 80% of 1-RM training sessions when compared with diabetic subject ( $+66.33\%$ ,  $P < 0.01$ ;  $+60.01\%$ ,  $P < 0.01$ ). METs values at rest at the end of the study were significantly higher than baseline values in both groups at both intensities:  $+0.30 \pm 0.25$  METs at 60% of 1RM ( $P < 0.01$ ) and  $+0.19 \pm 0.19$  METs at 80% of 1RM in type 2 diabetes group, and  $+0.59 \pm 0.34$  METs at 60% of 1RM ( $P < 0.01$ ) and  $+0.50 \pm 0.34$  METs at 80% of 1RM in young subject group. After 15 minutes of quiet rest, both diabetic patients and young subjects revealed no significant differences on METs in within group analysis. However in the between group comparison, at both intensities, data analysis indicated a post-exercise METs significantly higher in young subjects than type 2 diabetes patients ( $+22.43\%$ ,  $P < 0.01$ ;  $34.31\%$ ,  $P < 0.01$ ). **Discussions:** In both diabetic patients and young subjects there are no differences in executing a resistance-training program at 60 or 80% of 1-RM. The METs value that best represent training intensities is 5 METs for young subjects and 3 METs for diabetic patients. **References:** Ainsworth et al. (2011). *Med Sci Sports Exerc*, 43(8), 1575-1581 Eves et al. (2006). *Diabetes Care*, 29(8), 1933-1941 Phillips et al. (2003). *J Strength Cond Res*, 17(2), 350-355 Phillips et al. (2004). *J Strength Cond Res*, 18(3), 606-609 Zanuso et al. (2009). *Diabetes Res Clin Pract*, 85(3), 40-41

## HOW DOES PHYSICAL ACTIVITY AND FITNESS INFLUENCE GLYCAEMIC CONTROL IN YOUNG PEOPLE WITH TYPE 1 DIABETES?

Cuenca García, M.1,2, Jago, R.2, Shield, J.P.H.3, Burren, C.P.3

1: Department of Medical Physiology (Granada University, Spain), 2: Centre for Exercise, Nutrition & Health Sciences (Bristol University, UK), 3: School of Clinical Sciences (Bristol University, UK)

**Aims:** To assess physical activity and fitness levels of young people with type 1 diabetes compared to siblings without diabetes, and to investigate the association between physical activity, physical fitness and glycaemic control (HbA1c) in those young people with diabetes. **Methods:** The study consisted of 97 young people aged 8 to 16 years (62% males) from a Paediatric Diabetes Service in South West England. 60 participants (67% males) had type 1 diabetes and 37 participants (54% males) were siblings without diabetes (control group). We measured weight, height and waist circumference, calculated body mass index and waist-to-height ratio and recorded pubertal status, blood pressure and current insulin regimen information. We assessed physical activity by accelerometry, from which we calculated light and moderate-to-vigorous intensity activity. We measured physical fitness by multi-stage sub-maximal bicycle ergometer test. We obtained HbA1c by venipuncture. **Results:** There were no differences between the young people with diabetes and siblings without diabetes in body composition, blood pressure, physical activity and fitness. Moderate-to-vigorous physical activity (MVPA) was associated with better glycaemic control, accounting for 30-37% ( $R^2 = 0.295-0.374$ ) of the variance for HbA1c. Physical fitness was not associated with HbA1c. **Conclusions:** MVPA was associated with better glycaemic control while fitness was not. Findings suggest that developing strategies to increased MVPA may prove an effective method of improving glycaemic control in young people with diabetes.

## TO MOVE JUST ENOUGH OR FAST ENOUGH - A STUDY OF THE PHYSICAL ACTIVITY LEVELS AND PATTERNS IN SINGAPOREAN ADOLESCENTS

Mukherjee, S., Chia, Y.H.M., Lye, C.T.J.

National Institute of Education, Nanyang Technological University, Singapore

**To move just enough or fast enough - A study of the physical activity levels and patterns in Singaporean adolescents** **Introduction** For children and adolescents, daily 60 minutes or more of moderate to vigorous physical activity (MVPA) is recommended for beneficial health and behavioural outcomes. However, the rising prevalence and incidence of metabolic syndrome in children suggests that children are not achieving the recommended levels of physical activity. The aim of this study was to determine the physical activity levels and patterns of Singaporean adolescents. **Methods** Physical activity of 233 students (122 boys and 111 girls) aged 13-15 years was determined using the triaxial accelerometry, over a period of five consecutive days (three weekdays and two weekend days). Weight categorisation of acceptable, overweight and obese was done according to the BMI for age criteria. **Results** Results showed that none of the participants accumulated 60 minutes of daily MVPA, with a significant difference between average time spent in MVPA on weekdays compared to weekends (Mean  $\pm$  SD;  $18.1 \pm 11.6$  minutes versus  $7.6 \pm 13.0$  minutes,  $P < 0.005$ ). Compared to boys, girls were less likely to engage in MVPA (Mean  $\pm$  SD;  $21.9 \pm 12.3$  versus  $13.9 \pm 9.1$  minutes,  $P < 0.005$ ) during weekdays, though no significant difference was seen in the time spent in MVPA on weekends. Average steps during-school hours were 16% higher than after-school hours (Mean  $\pm$  SD;  $4255 \pm 1709$  steps versus  $3117 \pm 1557$  steps,  $P < 0.005$ ), with no significant difference between girls and boys. Students in the highest quintile for average accumulated daily MVPA had an odds ratio of 2.15 for being overweight or obese. On the contrary, students in the lowest quintile for average accumulated daily MVPA had an odds ratio of 0.226 for being overweight or obese. **Discussion** The results of this study imply that Singaporean adolescents may not be achieving the recommended level of MVPA and it is a crucial issue to address. The results also suggest the large potential schools possess to provide physical activity opportunities for the students, and this should be considered during curriculum planning. In addition, the low level of physical activity after school hours and on weekends highlights the significance of parental roles to increase physical activity participation in adolescents. The higher odds ratio of physically active students being overweight or obese challenges the popular notion that the overweight or obese engage in less physical activity than their non-overweight peers. This suggests that adolescents in the healthy weight category may be disregarding importance of physical activity. **References** Rowlands A. (2007). *Pediatric Exerc Sci*, 19, 252-256. Riddoch Cj, Anderson LB, Wedderkopp N, Harro M, Klasson-Heggebo L, Sardinha LB,

Cooper AR, Ekelund U (2004). *Med Sci Sports Exerc*, 36 (1), 86-92. Ward DS, Evenson KR, Vaughn A, Rodgers AB, Troiano RP (2005). *Med Sci Sports Exerc*, 37 , No 11 (Supp), S582-588. Trost SG, Loprinzi PD, Moore R, Pfeiffer KA. (2011). 43 (7), 1360-1368.

### EFFECTS OF 12 WEEKS OF WATER TRAINING PROGRAM TO PHYSICAL ACTIVITY LEVELS, HRQOL AND DIABETES-SPECIFIC EMOTIONAL DISTRESS IN MEN WITH TYPE 2 DIABETES

Cugusi, L.1, Deidda, M.1, Caria, A.2, Mercurio, G.1

*University of Cagliari*

**Introduction:** The role of general physical activity on improving cardiovascular profile and QoL in patient with type 2 diabetes is widely demonstrated (ACSM and ADA, 2010). However, little is known about the effects of specific water exercise program in patients with type 2 diabetes. Therefore, the aims of the study were to evaluate Physical Activity Levels, HRQoL and Diabetes-specific Emotional Distress in a group of 15 Men with Type 2 Diabetes after 12-weeks of supervised water exercise program. **Methods:** Fifteen men affected by type 2 diabetes (51,4±9,38, years), were enrolled in a program of 12-weeks of supervised water training. We used International Physical Activity Questionnaire (IPAQ) (Mannocci et al., 2010) to determine energy expenditure in walking (Met/min/week), in general physical activities (Kcal/week) and in the time spent sitting (h/day). The Short-form Health Survey 36 with items (SF-36) was completed to establish the Mental Summary Component (MSC) and Physical Summary Component (PSC) (Apolone et al., 1997). The Problem Areas in Diabetes Questionnaire (PAID) (Welch et al., 2003) was used to evaluate the diabetes-specific emotional distress before and after 12-weeks of supervised water exercise program. **Results:** The results showed a significant increase in general physical activity (1239,53±1730,59 vs 3888,73±5222,71 Kcal/week p<0,05), while a significant decrease in time spent sitting (6,77±3,99 vs 5,61±2,78 h/day, p<0,01). SF-36 highlighted a significant increase in the MSC (67±18,88 vs 72,28±15,92 p<0,05) only and the diabetes-specific emotional distress have showed a significant decrease (33,19±19,40 vs 20,13±18,83 p<0,001) at 12-weeks. **Discussion:** Our findings showed that structured and supervised physical activity performed in water, produced benefits both in improving of the HRQoL and in increasing of the energy expenditure in walking and in general physical activity in patients affected by type 2 diabetes. **References:** 1.American College of Sports Medicine (ACSM) and the American Diabetes Association (ADA). (2010). *Med Sci Sports Exerc*, 42(12), 2282-2303. 2.Mannocci A, Di Thiene D, Del Cimmuto A, Masala D, Boccia A, De Vito E, La Torre G. (2010). *Ital J Public Health*, 7(4), 369-376 3.Apolone G, Cifani S, Mosconi P. (1997). *Medic*, 2, 86-94 4.Welch G, Weinger K, Anderson B, Polonsky WH. (2003). *Diabet Med*, 20(1), 69-72.

**13:45 - 14:45**

## Poster presentations

### PP-PM32 Molecular Biology 1

#### WHY DO HIGH OXIDATIVE MUSCLE FIBERS REMAIN SMALL – A ROLE FOR A HIGH RATE OF PROTEIN DEGRADATION?

Van Wessel, T.1,2, Offringa, C.1, Kos, D.1, Jansen, R.J.1, De Haan, A.1, Jaspers, R.T.1

*1: VU University Amsterdam, 2: University of Twente*

**Introduction** Muscle fiber size and oxidative capacity are inversely related [1], and training induced hypertrophy and increased mitochondrial density are mutually exclusive [2]. Paradoxically, high oxidative fibers contain a large potential for protein synthesis, but remain small compared to low oxidative fibers [1]. The aim of this study was to obtain insight in the mechanisms underlying this paradox. **Methods** Soleus muscle (SOL, largely containing high oxidative fibers) and extensor digitorum longus muscle (EDL, largely containing low oxidative fibers) from 6 male Wistar rats were used to determine mRNA concentrations of growth factors, their binding proteins, E3-ligases and their transcription factors by qPCR. Activation of translational signaling pathways was assessed by Western blot. **Results** IGF-I mRNA concentration was 2.7-fold higher and myostatin concentration 2.5-fold lower (p<0.02) in SOL than in EDL, indicating higher growth factor induced protein synthesis in SOL. mRNA levels of respective growth factor inhibitors (IGFBP-4, follistatin) were also higher in SOL (p<0.005), which suggests that growth factor signaling in SOL is more inhibited than in EDL. PGC-1alpha concentrations (involved in mitochondrial biogenesis) were higher in SOL (p<0.01). Protein levels of total (t-)AKT and phospho(p-)AKT, p-mTOR, and t-S6 were similar. P-S6 and p-AMPK concentrations were higher in SOL (p<0.02). Surprisingly, despite inhibited growth factor signaling in SOL, we found a higher ratio p-S6/t-S6 (p<0.01) indicating a high capacity for protein translation compared to EDL. mRNA concentrations of factors involved in proteasome-mediated degradation (Mafbx, MuRF, NF-kB, FOXOs) were higher in SOL than in EDL (p<0.02). **Discussion** Several mechanisms may underlie the paradox between size and oxidative metabolism in a steady state situation: 1) inhibitors of IGF-I and myostatin are abundantly expressed in high oxidative fibers, and may attenuate the AKT-mTOR pathway; 2) the AKT-mTOR pathway may be inhibited by high PGC-1alpha and p-AMPK levels [3]; 3) elevated expression levels of FOXOs, NF-kB and the E3-ligases suggest that in high oxidative SOL, a large capacity for protein synthesis is accompanied by high E3-ligase activity and subsequent proteasome-mediated degradation. We conclude that signaling for biosynthesis of mitochondria is likely accompanied by an enhanced rate of degradation of contractile protein and hence limited hypertrophy. **References** 1. Van Wessel T, De Haan A, Van der Laarse WJ, Jaspers RT (2010) *Eur J Appl Physiol*, 110, 665-694. 2. Hawley J (2009) *Appl Physiol Nutr Metab*, 34, 355-361. 3. Chan A, Dyck J (2005) *Can J Physiol Pharmacol*, 83, 24-28.

#### THE ACE AND BDKRB2 GENE POLYMORPHISMS IN RUSSIAN ATHLETES

Mustafina, L.J.1,2, Timshina, Y.I.3, Astratenkova, I.V.3, Ahmetov, I.I.1,2,3

*1Volga Region State Academy of Physical Culture, Sport and Tourism, 2Kazan State Medical University, 3St Petersburg Research Institute of Physical Culture*

**Background** Human physical performance phenotypes are classical quantitative traits influenced by many gene variants and environmental factors. Studies suggest that insertion-deletion (I/D) polymorphisms in ACE and BDKRB2 genes are associated with aerobic capacity and elite endurance athlete status. Angiotensin-converting enzyme (encoded by ACE gene) exerts a tonic regulatory function in circulatory homeostasis, through the synthesis of vasoconstrictor angiotensin II, which also drives aldosterone synthesis, and the degradation of



vasodilator kinins. The presence (I allele) rather than the absence (D allele) of a 287 bp Alu-sequence insertion fragment of the ACE gene is associated with lower serum and tissue ACE activity and improved endurance performance (Puthuchery et al. 2011). Bradykinin is a potent endothelium-dependent vasodilator and acts via the bradykinin B2 receptor (encoded by BDKRB2). The absence (-9), rather than the presence (+9), of a 9 bp repeat sequence in exon 1 has previously been shown to be associated with increased gene transcription, higher BDKRB2 mRNA expression and higher efficiency of muscular contraction (Williams et al. 2004). The aim of the study was to investigate ACE and BDKRB2 gene polymorphisms in combination in a large cohort of Russian athletes. Methods One thousand three hundred and sixty four athletes from 45 sporting disciplines and 507 controls were involved in the study. Genotyping was performed by PCR. To assess the combined impact of 2 gene polymorphisms, all athletes were classified according to the number of 'endurance' alleles they possessed. Results The proportion of subjects with a high (3-4) number of 'endurance' alleles was greater but not significantly in endurance-oriented athletes (n=131) compared to controls (34.4 vs 26.8%; P=0.088). The same trend was observed in athletes with mixed endurance/power activity (n=1032; 29.5%, P=0.283) and a whole group of athletes (n=1364; 30.1 vs 26.8%; P=0.162). Conclusion. Thus, we found a trend toward an association between ACE and BDKRB2 polymorphisms and endurance athlete status. Our data suggest that each DNA locus can explain a very small proportion of the phenotypic variance. Therefore, the use of very large sample sizes and the genotyping of many genes are needed to detect associations between gene variants and sport-related phenotypes. References Williams AG, Dhamrait SS, Wootton PTE, et al. Bradykinin receptor gene variant and human physical performance. *J Appl Physiol* 2004;96:938-942. Puthuchery Z, Skipworth JR, Rawal J, et al. The ACE gene and human performance: 12 years on. *Sports Med.* 2011;41(6):433-48.

### GENETIC VARIATION OF THE HUMAN ACE AND ACTN3 GENES IN CONNECTION WITH VO2MAX AMONG HUNGARIAN ELITE ATHLETES

Bosnyák, E., Trájer, E., Udvardy, A., Protzner, A., Komka, Zs., Györe, I., Tóth, M., Szmodis, M.

*Faculty of Physical Education and Sport Sciences, Semmelweis*

**Introduction** Nowadays it is well recognized that athletic performance highly depends on genetic background. Among those, angiotensin-converting enzyme (ACE) and the  $\alpha$ -actinin-3 (ACTN3) genes are considered strong candidate genes associated with human physical performance, although their influence has not been described completely. The aim of our study was to evaluate the differences of these genetic variants and to reveal possible connections between the gene polymorphisms' combinations and the Vo2max values. **Methods** The study involved 155 Hungarian elite athletes from endurance, team, middle-distance and power sports. Human genomic DNA was isolated from blood, genotyping was performed by polymerase chain reaction. The examination consisted of a *vita maxima* test to exhaustion on treadmill with constant velocity (10 km/h) starting from a 1,5 % gradient ascending with 1,5 % every minute. During the examination we registered the maximal oxygen uptake (Vo2max). To measure the differences between the groups One-way Anova and Tukey HSD tests were performed using Statistica 9.0 for Windows® (significance level:  $p < 0,05$ ). **Results** Only 2% of the athletes (all of them are kayaking/canoeing athletes) had the combination of ACE II and ACTN3 XX genotypes with the average Vo2max value of 56.23 ml/kg/min, which was the lowest value. ACTN3 XX genotype was the least frequent in the whole sample compared to the other ACTN3 genotypes. We found significant differences between each group apart from the case of kayaking/canoeing vs. power athletes considering the average Vo2max values. Athletes with both ACTN3 XX and ACE DD genotypes had the highest Vo2max values (64.53 ml/kg/min) but there were no significant differences while comparing them with the other 8 combination. In the team sports the ACTN3 R allele occurrence was clearly dominant, whereas only 15% of these athletes presented XX genotype. 4 out of the highest 5 Vo2max results (avg: 80.56 ml/kg/min) were presented by athletes possessing ACE ID+ACTN3 RR genotype combination. **Discussion** The connection of the ACE I allele to the endurance performance has been published many times. It is well known that high maximal oxygen uptake volume is essential for a long-distance athlete. Despite this statement we found the lowest Vo2max values in the ACE II + ACTN3 RR/RX/XX group, but there were no significant differences comparing these values to that of other groups' results. Furthermore, only 8% of the athletes in the endurance group have ACE II genotype, which – based on the literature – would be preferable. The R allele is "responsible" for sprint and power. In team sports speed and muscular strength play a very important role: the ACTN3 RR genotype and R allele occurrence were determinant in this group.

### ACUTE PHYSICAL EXERCISE AND BLOOD-BRAIN BARRIER PERMEABILITY

Fontes-Ribeiro, C.A., Pinheiro, V., Baptista, S., Gonçalves, J., Leitao, R., Silva, A.P.

*Faculty of Medicine of the University of Coimbra*

**Introduction** Sports with intensive physical activity are performed around the world. Nowadays, more than ever, physical activity is widely accepted as a behavioral strategy to enhance health. Although exhaustive exercise causes oxidative stress in muscle and other tissues, references are conflicting whether or not strenuous exercise could generate oxidative stress in brain. On the other hand, doping substances have gained a great popularity in competition sports, besides the fact that they can be toxic to the brain. It is known that the blood-brain barrier (BBB) protects the brain against hazardous molecules and pathological organisms, and is also critical for brain homeostasis. Its dysfunction can lead to several and harmful consequences, such as irreversible damage of brain cells that can be translated into neurological and psychiatric abnormalities. Tight Junctions (TJs) together with Adherens Junctions (AJs) are the main components of the BBB, being responsible for its integrity. TJs are constituted by transmembrane proteins, like claudin and occludin, and by intracellular proteins, like zonula occludens (ZO). Claudin-5, the smallest protein (24 kDa), is responsible for the primary seal of the TJ, and occludin (64 kDa) is responsible for additional support. Taking into account that there is no solid information regarding the impact of exercise on these BBB proteins, the present work aims to study alterations of TJ proteins during an acute physical exercise. **Methods** Young Wistar rats (8 weeks old) were used. Half of them were subjected to an acute exercise program (forced running in a treadmill for 35 min, with a 20 cm/s speed and a 15° of inclination) (exercise group), and the other half was not subjected to exercise (control group). The rats of the experimental group were sacrificed right after exercise, and alternated with controls. The alterations of tight junction protein levels, occludin and claudin-5, were determined by western blot and in the frontal cortex, striatum and hippocampus. **Results** As far as claudin-5 protein levels are concerned, there were no significant differences between exercise and control groups in the three cerebral regions studied. In addition, there were no significant changes of occludin protein levels in the frontal cortex and hippocampus. However, there was a statistical significant decrease of the occludin protein levels in the striatum in the exercise group when compared with the control one. **Discussion** Our results suggest a slight increase of the BBB permeability during the acute physical exercise, which may lead to the entry of harmful substances into the brain, impairing in some way the normal brain function, and in particular the striatal dopaminergic system.

**ACUTE EXERCISE MODULATION OF BDNF AND HSPS CONTENT IN PBMCs FROM ELDERLY SUBJECTS**

Caporossi, D., Brunelli, A., Beltran Valls, R.M., Parisi, A., Dimauro, I.

*University of Rome Foro Italico*

Introduction Despite it is well demonstrated that acute exercise can increase the peripheral concentration of BDNF (Knaepen et al., 2010), it is matter of debate what can be the physiological meaning of such increment and from which tissues it is produced and utilized (Pedersen BK, 2009). The aim of this research is to investigate the effect of one bout of intense exercise on BDNF level in PBMCs of elderly subjects and to verify the possible correlations with intracellular changes of other proteins involved in stress response. Methods After informed consent and medical examination, 16 sedentary, healthy elderly subjects (8 males and 8 females, 72 ± 4 years old) were selected to participate. Subjects exercised on a cycle ergometer, while their heart rate HR, blood pressure BP and electrocardiogram data were continuously monitored. They started at 30 W for 2', after which the load was increased by 10 W every minute. Subjects had to cycle until the attainment of the 85% of their theoretical HRmax. After that HR target was reached they were requested to continue cycling up to voluntary withdrawal. Blood was sampled immediately before the exercise session (PRE), immediately (POST), 60 minutes (T.60) and 24 hours (T.24h) after the exercise session. The PBMCs' expression of BDNF, hsp70, hsp27 and alpha B crystallin were analysed by ELISA or Western Blot analyses. Results The average duration of exercise was 11.9 ± 3.2 min for elderly (14.4 ± 2.2 min for men vs. 8.9 ± 1.1 for women,  $p < 0.05$ ). The average power reached at the moment of maximal effort was 89.6 ± 26.1 W (110.7 ± 14.2 for men vs. 65.0 ± 5.5 for women,  $p < 0.05$ ), remaining significant different also when controlled for the subjects' body mass. No statistical differences were detected for PBMCs concentration of BDNF (PRE: 58.36 ± 27.3 pg/ml; POST: 58.7 ± 37.5; T.60: 55.9 ± 18.6 pg/ml), hsp27, alpha B crystallin and hsp70, although a trend toward an increase of hsp70 content was observed 24 hours after exercise (PRE: 0.77 ± 0.08, POST: 0.83 ± 0.08, T.60 0.84 ± 0.08, T.24h 0.91 ± 0.11) (PRE vs. T.24h,  $p < 0.097$ ). Discussion We failed to find any significant difference between baseline and post exercise values, as in PBMCs the amount of BDNF and HSPs did not show any significant change overtime. The exercise intensity and duration utilised, which is considered to be maximal and safe in this age group from a cardiovascular point of view, seems not be enough to stimulate those systemic changes at physiological level which appear to be necessary to induced the BDNF and HSPs modulation in immune cells. References Pedersen BK, J Physiol., 2009 Knaepen et al., Sports Med. 2010

**FUTSAL TRAINING FOR DIABETES PREVENTION IN MIDDLE-AGED MALES: THE "FIT-SAL" PROJECT**

Serpiello, F.R.1,2,3, Bishop, D.J.1, Wyckelsma, V.L.1,2, Banting, L.K.1, Steward, C.1,2, Stepto, N.K.1,2, Aughey, R.J.1,2,4, Anderson, M.J.5, McKenna, M.J.1

1. ISEAL (VU, Melbourne, Australia); 2. SSES (VU, Melbourne, Australia); 3. DNNMM (University of Verona, Italy); 4. Western Bulldogs FC (Melbourne, Australia); 5. Baker IDI (Melbourne, Australia)

Introduction The number of individuals affected by type 2 diabetes is projected to increase to 522 million in 2030 (Whiting et al., 2011). Exercise is a fundamental lifestyle modification to prevent diabetes in high-risk populations. Traditionally, research has employed prolonged aerobic exercise to investigate molecular mechanisms underpinning the preventive effects of exercise. However, aerobic exercise might not appeal or be motivating to many individuals (Deci and Ryan, 1985). We investigated the effects of 8 weeks of indoor football (futsal, FUT) versus moderate-intensity, continuous treadmill training (MOD) on skeletal muscle and systemic adaptations associated with the prevention of diabetes in middle-aged, sedentary males. Methods Twenty men (age 35-55 years) were allocated to either FUT or MOD for 8 weeks, 3 times per week. Before and after the training interventions, participants underwent an oral glucose tolerance test (OGTT), a resting muscle biopsy, and an incremental exercise test. Plasma glucose and insulin concentrations and peripheral insulin sensitivity were measured in response to the OGTT. Key mitochondrial biogenesis and glucose transport protein abundance in resting muscle was measured via western blotting. Blood lipids, HbA1c, blood pressure, anthropometry and self-reported dietary intake were also assessed. Results Peripheral insulin sensitivity was improved only in FUT (+31%, effect size (ES) ± 90% confidence interval: 0.67 ± 0.53). Mitochondrial complex IV, subunit II resting protein abundance was increased in FUT only (+16%, ES 0.79 ± 0.24), while glucose transporter 4 was equally increased in FUT and MOD (+45%, ES 0.78 ± 0.57; and +44%, ES 0.67 ± 0.57, respectively). Only FUT training resulted in a lowered plasma total cholesterol and triglycerides concentration (-8%, ES 0.44 ± 0.24; and -32%, ES 0.52 ± 0.3, respectively). No changes were detected for BMI, waist circumference, and self-reported dietary intake for either group. Discussion Futsal training may be employed as an effective and enjoyable exercise model to assist in the prevention of diabetes in middle-aged sedentary males.

**CHARACTERIZATION OF MITOCHONDRIAL PROTEINS IN HEART OF SPONTANEOUS HYPERTENSIVE RATS SUBMITTED TO MODERATE TREADMILL RUNNING.**

Rocha, L.A.O.1,2, Franco, O.L.2,3

<sup>1</sup> Curso de Educação Física, UCB; <sup>2</sup> Pós-graduação em Patologia Molecular, Curso de Medicina, UnB; <sup>3</sup> Pós-graduação em Biotecnologia e Ciências Genômicas, UCB.

Concentric hypertrophy of left ventricle consists in an important sustained hypertension consequence. This hypertrophic process may be initially adaptive, in that it enables heart tissue to maintain normal pump performance. However, this hypertrophic process leads to a wide number of maladaptive modifications that occur in the extracellular matrix and also at cardiac myocytes. Despite of enormous importance of metabolic modifications, the molecular mechanisms are still insufficiently clear specially when related to mitochondrial role. Otherwise, the exercise training positive effects lead to functional capacity enhance on hypertension patients, being recognized as an important side treatment. In order to understand the molecular modifications of mitochondrial protein expression in animals models before and after hypertension development and the exercise effects over this process, twenty isogenic male SHR were randomly divided into four groups with 5 animals each. Groups with 6 (normotense group) and 35 weeks old (symptomatic group) were shared in exercised and non-exercised groups. Exercised animals were submitted to moderate treadmill running during four weeks, 30 min per day, five days per week. The exercise training progress was measured by using a progressive lactate test. The blood pressure was measuring using a non invasive method. Firstly, SDS-PAGE showed few differences in protein patterns of exercise groups when compared with sedentary groups. Furthermore bidimensional electrophoresis also suggests that some mitochondrial proteins could be modulated in response to exercise. In summary data suggests the positive effects of exercise in hypertension could be associated to mitochondrial protein modifications.

## 13:45 - 14:45

## Poster presentations

## PP-PM33 Neuromuscular Physiology 2

**AEROBIC EXERCISE TRAINING IMPROVES THE FINGER-PINCH FORCE CONTROL IN OLDER ADULTS**

Critchley, K.1, Kokubu, M.2, Iemitsu, M.1, Fujita, S.1, Isaka, T.1

*1: Ritsumeikan University (Shiga, Japan), 2: Osaka University of Health and Sport Sciences (Osaka, Japan)*

**Introduction** The age-related reduction in muscular strength and neuromuscular function is an obvious contributing factor to the decline in finger-pinch force control in older people (Sosnoff et al., 2006). Keogh (2007) indicated that upper-limb strength training may improve the finger-pinch force control. It is not clear, however, moderate training improves the finger-pinch force control or not. Therefore, the aim of this study was to investigate the effect of lower-limbs aerobic exercise training on the finger-pinch force control in older adults. **Methods** Thirty nine right handed older adults ( $65.9 \pm 7.7$  y, 18 male, 21 female) participated in this study. The aerobic exercise training group ( $n=22$ ,  $65 \pm 8.4$  y) trained for 8 weeks, performing either bicycle ergometer exercise three times a week for 40 minutes or playing tennis twice a week for 45 minutes, while the control group subjects ( $n=17$ ,  $67.1 \pm 6.9$  y) maintained their normal activities. In the experiment task, subjects were requested to maintain a constant force output at 10% of each subject's maximal voluntary pinch force with visual feedback on the computer monitor. All subjects performed the task with both hands together. Changes in force variability, targeting error, mean power frequency and proportional power were assessed during a series of finger-pinch tasks. **Results** There was no significant change in maximal voluntary pinch force between aerobic exercise group and control group after the training period. Pinch force variability and targeting error were significantly reduced in aerobic exercise training group, while no significant change was observed in control group. **Discussion** Upper-limb strength training reduced pinch force variability and targeting error, as well as increased maximal voluntary pinch force (Keogh et al, 2007). In contrast, there was no significant change in maximal voluntary pinch force by aerobic exercise training, while finger-pinch force variability and targeting error were reduced by this training. Current study suggests that aerobic and resistance exercise may influence the finger-pinch force control through different mechanisms. In fact, moderate exercise lead to an increased cortical activation in the left DLPFC and it cause to improve cognitive performance (Hiroki et al, 2010). Therefore, aerobic exercise may have contributed to an elevated brain function and motor control that resulted in an improved finger-pinch force control without a significant increase in muscular strength and neuromuscular function. **References** Yanagisawa H, Dan I, Tsuzuki D, Kato M, Okamoto M, Kyutoku Y, Soya H. (2010). *Neuroimage* 50, 1702-1710 Keogh JW, Morrison S, Barrett R. (2007). *Arch Phys Med Rehabil*, 88, 1055-1063 Sosnoff JJ, Newell KM. (2006). *Exp Brain Res*, 174, 86-94

**CHANGES IN SURFACE MOTOR UNIT ACTION POTENTIALS DURING FATIGUING ISOMETRIC CONTRACTIONS OF THE VASTUS MEDIALIS MUSCLE**

Gonzalez-Izal, M., Negro, F., Farina, D.

*Public University of Navarre*

**CHANGES IN SURFACE MOTOR UNIT ACTION POTENTIALS DURING FATIGUING ISOMETRIC CONTRACTIONS OF THE VASTUS MEDIALIS MUSCLE** Gonzalez-Izal, M.1, Negro, F.2, Farina, D.2 **1: UPNA (Spain), 2: UMG (Germany)** **Introduction** Motor unit surface action potentials reflect the intracellular properties of the muscle fibers. During fatiguing contractions, the concentration of  $Ca^{2+}$  increases in the muscle and this causes the lengthening of the intracellular action potential (IAP) profile (Dimitrova et al., 2003). The influence of this change in IAP on the characteristics of the surface EMG (sEMG) is not known. In this study, we analysed the changes in amplitude of the motor unit action potential (MUAP), as obtained by spike triggered averaging (STA) of the sEMG, during a sustained fatiguing contraction. **Methods** 8 men (age, mean $\pm$ SD,  $31.3 \pm 4.4$  yr, body mass  $69.9 \pm 8.0$  kg, height  $173.4 \pm 7.2$  cm) participated in the study. The subjects performed a maximal voluntary contraction (MVC) of the knee extensors at the beginning and at the end of the protocol. They performed two isometric contractions at 30% MVC of 20s, followed by a sustained contraction at 30% MVC until task failure. During each contraction, force, sEMG and intramuscular EMG (iEMG) were concurrently recorded from the vastus medialis obliquus muscle (VMO). sEMG signals were recorded using a grid of 64 electrodes in a monopolar configuration and iEMG was recorded using 4 pairs of fine-wire electrodes in a single differential configuration. The iEMG signals were decomposed in individual MUAP trains using the EMGLAB software (McGill et al., 2005) and the sEMG was averaged using the times of occurrence of the MUAP as triggers. **Results** The MVC force decreased from baseline (mean $\pm$ SD) by  $21.1 \pm 9.8\%$  ( $P < 0.05$ ) after the sustained contraction. 148 motor units were identified at the sustained contraction. The correlation coefficients between the STA of the same motor units during the two contractions of 20s, were  $0.87 \pm 0.09$ , assuring a stable recording. The STA potential amplitude (averaged across the matrix) did not change ( $3.0 \pm 26.9\%$ ) at the middle of the contraction but increased significantly with respect to baseline at the end of the fatiguing contraction  $6.7 \pm 24.9\%$  ( $P < 0.05$ ). **Discussion** The MVC force decreased significantly after the sustained contraction until task failure due to fatigue. The STA for the identified motor units increased in the last part of the sustained contraction. This can not be related to movement artefacts of the intramuscular electrodes because this was excluded from the high correlation coefficients estimated between intramuscular STA in different contractions. These changes are compatible with the increase of afterpotentials in the IAP profile due to fatigue that has been suggested to increase the amplitude of the sEMG during a fatiguing contraction (Dimitrova et al., 2003). **References** McGill KC, Lateva ZC, Marateb HR. (2005). *J Neurosci Methods*, 149(2), 121-133. Dimitrova NA, Dimitrov GV. (2003). *J Electromyogr Kinesiol*, 13, 13-36.

**LOCAL OXYGEN SUPPLY AND UPTAKE DURING INCREMENTAL NEUROMUSCULAR ELECTRICAL STIMULATION**

Gobbo, M., Gaffurini, P., Neviani, C., Orizio, C.

*University of Brescia*

**Introduction** Near InfraRed Spectroscopy (NIRS) has been widely applied to investigate local oxygen supply and uptake in active skeletal muscles. Despite the extensive literature on NIRS parameter changes during volitional efforts, only few studies have focused on changes in intramuscular oxygenation and microvascular blood flow due to neuromuscular electrical stimulation (NMES). Aim of our work was to provide further insight into metabolic adaptations to NMES. **Methods** The tibialis anterior of 20 moderately active subjects (males, age 23-

35 yo) was electrically stimulated at the main motor point. The stimulation protocol involved five single twitches at maximal stimulus amplitude (full motor unit recruitment) and five 90-s steps with increasing amplitude and frequency of the intermittent stimulation. Basal oxygenated hemoglobin+myoglobin (O<sub>2</sub>Hb) prior to stimulation and changes in force and deoxygenated hemoglobin+myoglobin ( $\Delta$ HHb) due to stimulation were recorded. Contraction time (CT) of single twitches and fatigue index (FI) of the stimulated muscles were calculated. Results F-statistics allowed to define two groups of TA muscles: group F (more fatiguable, FI<0.69) and group R (less fatiguable, FI>0.69). For group F, CT was 36.4±4.2 ms, basal O<sub>2</sub>Hb was 87.4±16.3  $\mu$ mol and  $\Delta$ HHb was 15.8±2.3  $\mu$ mol. For group R, CT was 47.1±5.8 ms, basal O<sub>2</sub>Hb was 103.3±14.7  $\mu$ mol and  $\Delta$ HHb was 9.0±1.2  $\mu$ mol. The differences between groups were statistically significant (p<0.05) for each parameter. Discussion The proposed method revealed different metabolic responses to incremental NMES in the two identified groups of TA muscles. Group R, more resistant to fatigue, showed slower contraction velocity (higher CT), higher O<sub>2</sub> supply (higher basal O<sub>2</sub>Hb) likely due to higher capillary density and myoglobin concentration, and lower relative O<sub>2</sub> uptake (lower  $\Delta$ HHb) during muscle activity. Conversely, TA muscles belonging to group F were faster (lower CT) and showed greater fatigability: this was likely related to inadequate blood and O<sub>2</sub> supply (lower basal O<sub>2</sub>Hb) to working muscles which is essential to support the metabolic requirements and avoid decrease in performance caused by lactic acid accumulation. Moreover, group F showed higher HHb changes suggesting greater fractional O<sub>2</sub> extraction in the active muscles as a compensatory mechanism for poor muscular microvascularization. The proposed method and data interpretation may represent an objective, independent of motivation and non-invasive tool to assess muscle metabolic adaptations to training as well as oxygen supply and/or consumption impairments in specific neuromuscular diseases.

### COGNITIVE FUNCTION SEEMS TO MEDIATE THE PERCEIVED EXERTION DURING LIGHT AND MODERATE HANDGRIP PERFORMANCE

Oishi, L.M.1, Oliveira, W.G.A.1, Matsudo, S.M.M.2, Raso, V.1,3

1: UNOESTE (Presidente Prudente, Brazil); 2: CELAFISCS (Sao Caetano do Sul, Brazil); 3: ANHANGUERA-UNIBAN (Sao Paulo, Brazil)

Introduction The rating of perceived exertion (RPE) as well as handgrip (HG) dynamometry have been employed as a very easy and useful tool for a widely different purposes (Pritchett et al., 2009; McGorry et al., 2010), but both seem to be dependent of cognitive function which, in turn, is influenced by age, socioeconomic and educational levels (Alfaro-Acha et al., 2006; Leibovici et al., 1996). Therefore, the purpose of this preliminary study was to determine the power of RPE to predict light, moderate and vigorous HG dynamometry in community-dwelling elderly individuals. Methods We measured cognitive function (mini-mental state examination [MMSE]) and RPE (0 to 10) during HG dynamometry performance in 28 community-dwelling elderly individuals. Volunteers were familiarized with HG performance, and subsequently, a maximal HG (MaxHG) was performed; the RPE was reported at the end of this trial. Subsequently, in a randomized order, volunteers were asked to carry out a HG at 4 (HG4RPE), 6 (HG6RPE) and 8 RPE (HG8RPE). The results of HG at HG4RPE were associated to 40% MaxHG (40MaxHG), and so on (i.e., HG6RPE versus 60MaxHG and HG8RPE versus 80MaxHG). Results We developed prediction models to estimate HG as a function of RPE for each different score (i.e., HG4RPE, HG6RPE, and HG8RPE) and matched for important covariates as age, body mass index and cognitive function. HG at RPE was consistently associated with HG regardless of MaxHG percentage. The prediction power of the models were very satisfactory (HG4RPE: R=.85, R<sup>2</sup>=.72, P<0.0005; HG6RPE: R=.84, R<sup>2</sup>=.72, P<0.0005; and R=.88, R<sup>2</sup>=.77, P<0.0005) and mediated by cognitive function at HG4RPE (P=.008) and at HG6RPE (P=.052). Discussion HG strength can be easily measured and has been associated with multiple health outcomes in elderly individuals (Ling et al., 2010; Bohannon, 2008; Sayer et al., 2006). Our results permit to conclude that the rating of perceived exertion could represent an important predictor of handgrip strength, but cognitive function seems to exert an important mediating effect, mainly on light and moderate handgrip performance. References Alfaro-Acha A, Snih SA, Raji MA, Kuo YF, Markides KS, Ottenbacher KJ. (2006). J Gerontol A Biol Sci Med Sci; 61(8): 859-65. Bohannon RW. J Ger Phys Ther; 31(1): 3-10. Leibovici D, Ritchie K, Ledesert B, Touchon J (1996). Age Ageing; 25(5): 392-7. Ling CHY, Taekema D, Craen JM, Gussekloo J, Westendorp RGJ, Maier AB. (2010). Can Med Assoc J; 182(5): 429-35. McGorry RW, Lin JH, Dempsey PG, Casey JS. (2010). J Occup Environ Hyg; 7(5): 298-306. Pritchett RC, Green JM, Wickwire PJ, Pritchett KL, Kovacs MS. (2009). South Afr J Sport Med; 21(1): 23-26. Sayer AA, Syddall HE, Martin HJ, Dennison EM, Roberts HC, Cooper C (2006). Age Ageing; 35(4): 409-15.

### CAN A PROLONGED COGNITIVE TASK ALTER MAXIMAL FORCE CAPACITY?

ROZAND, V.1, Pageaux, B.2, Marcora, S.2, Papaxanthis, C.1, Lepers, R.1

1:INSERM 1093 (Dijon, France), 2:Centre for Sport Studies (Kent, United Kingdom)

Introduction The effects of a physical exercise on cognitive performance are well established. In contrast, the influence of a prolonged cognitive task on physical performance has been less investigated. For example, it has been shown that a mentally fatiguing task could alter the subsequent endurance performance in humans during cycling exercise (Marcora et al., 2009), and isometric contraction (Pageaux et al., 2011), without alterations of neuromuscular properties. Interestingly, Bray et al. (2012) has recently evidenced a decrease in maximal voluntary contraction (MVC) force during a handgrip squeezing task, alternated with a demanding cognitive task. The mechanisms responsible of this decrease in force were unclear and needed to be clarified, especially the possible relationship between mental fatigue and central fatigue. In this context, the aim of the present study was to investigate the effects of a demanding cognitive task on maximal force capacity and neuromuscular properties. Methods Ten subjects performed three randomized sessions lasting 27 minutes: i) a high-demanding cognitive task (modified Stroop test), ii) a moderate cognitive task (congruent Stroop task), iii) a control cognitive task (watching a movie). Every 3 minutes, the cognitive task was stopped to perform neuromuscular tests on the knee extensor muscles. Psychological state of subjects was assessed before and after the task by questionnaire (NASA Task Load Index). Results The modified Stroop task was significantly (p<0.001) more mentally demanding than the congruent Stroop task and the control task. There was no significant decrease in MVC force and voluntary activation level (VAL) at the end of 27 minutes, whatever the session. No peripheral alteration was found. Discussion Contrary to Bray's study, our results showed no influence of a prolonged demanding cognitive task on maximal force production. According to the results of Marcora et al. (2009) and Pageaux et al. (2011), a prolonged mentally fatiguing task did not induce any loss in VAL (i.e. central fatigue). The difference with Bray's study could be explained by the different muscle group tested (lower versus upper limb), although the exercise duration was longer in the present study. We assume that the amount of energy expended in the central nervous system could be quickly regenerated, during the recovery period (5-10 seconds) between the cognitive task and the maximal voluntary contraction. References Bray SR, Graham JD, Martin Ginis KA, Hicks AL (2012). Biol Psychol, 89, 195-200. Marcora SM, Staiano W, and Manning V (2009). J Appl Physiol, 106, 857-864. Pageaux B, Marcora SM, Lepers R (2011). ACAPS' 14th International Congress, 371-372.

## EFFECTS OF DIFFERENT GRAVITY LEVELS ON STRETCH- AND H-REFLEXES IN MAN

Kramer, A., Gollhofer, A., Ritzmann, R., Taube, W., Gruber, M.

*University of Konstanz*

EFFECTS OF DIFFERENT GRAVITY LEVELS ON STRETCH- AND H-REFLEXES IN MAN Kramer, A.1, Gollhofer, A.2, Ritzmann, R.2, Taube, W.2, Gruber, M.1 1: University of Konstanz (Germany), 2: University of Freiburg (Germany) Introduction Previous studies suggest that the reflexes using the Ia afferent pathways are modulated by gravitational loading and unloading of the human body (Ferris 2001; Miyoshi 2003). However, most of this research has been conducted under artificial loading or unloading conditions (immersion, additional weights or counterweights, suspension). Furthermore, these studies only examined the Hoffmann-reflex (H-reflex), thus bypassing the muscle spindle. The aim of the present study was to examine both the H-reflex and the stretch reflex under true gravitational loading and unloading induced by parabolic flights. Methods Stretch- and H-reflex responses in the soleus muscle were recorded in 15 healthy subjects (11 male and 4 female; age  $36 \pm 9$  years; height  $176 \pm 7$  cm; body mass  $71 \pm 10$  kg) during upright stance for three different gravity levels: normal gravity (NG, 1g), hypergravity (HG, 1.8g) and microgravity (MG, 0g). The stretch reflexes were evoked by a dorsiflexion movement ( $5^\circ$  amplitude,  $200^\circ/\text{s}$ ) generated by a custom-made ankle ergometer. Ten to fifteen parabolas were available per subject, which resulted in an average of  $26 \pm 6$  stretch reflexes and  $11 \pm 4$  H-reflexes per subject per gravitational condition. Statistical analyses included a repeated measures analysis of variance with the three-level factor gravity and Bonferroni corrected post-hoc tests. Results Normalized to the values during NG, the H-reflexes elicited in the soleus muscle showed a decrease during HG (-18%) and an increase during MG (+17%). Compared to NG, the stretch reflexes were reduced during HG (-12%) but showed no changes during MG. Discussion The size of the stretch and H-reflex responses was affected by the gravity level, which suggests a load-dependency of the reflexes using the Ia afferent pathway: the increased load during HG reduced the excitability of the stretch- and H-reflex, probably due a reduced Ia afferent transmission and the decreased load during MG increased the excitability of the H-reflex. The increased size of the H-reflex responses during MG is in line with the observations of Miyoshi (2003). However, the size of the stretch reflexes remained unchanged in MG compared to NG. Possible explanations include the additional influence of the fusimotor system or differences in the susceptibility to presynaptic inhibition. In conclusion, the results of the present study support the notion that reflexes are modulated to meet the requirements of the specific situation, in this case the gravitational loading. References Ferris DP et al. (2001). *J Physiol*, 530(1), 167-180. Miyoshi T et al. (2003). *Exp Brain Res*, 150(1), 109-113.

## MOLECULAR ADAPTATION OF SKELETAL MUSCLE IN POST-SURGICAL OSTEOARTHRITIS PATIENTS: MARKERS OF INFLAMMATION, HYPERTROPHY, ATROPHY AND LIPID METABOLISM

Okoro, T., Andrew, J.G., Stewart, C.E., Al-Shanti, N., Maddison, P., Lemmey, A.B.

*Bangor University*

MOLECULAR ADAPTATION OF SKELETAL MUSCLE IN POST-SURGICAL OSTEOARTHRITIS PATIENTS: MARKERS OF INFLAMMATION, HYPERTROPHY, ATROPHY AND LIPID METABOLISM Okoro, T.1 2, Andrew JG.2, Stewart CE.3, Al-Shantii N.3, Maddison P.1, Lemmey AB.1 1: Bangor University (Bangor, UK), 2: Department of Orthopaedics, Betsi Cadwaladr University Health Board (Bangor, UK), 3: Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University (Manchester, UK) Introduction Patients typically present with significant muscle wasting as a consequence of pain and disuse atrophy prior to total hip replacement (THR). This study aimed to characterise the changes in genetic markers of muscle inflammation, atrophy and lipid metabolism in the early rehabilitation phase after surgery. Methods After local research ethics committee approval, patients undergoing THR were prospectively recruited. Muscle biopsies were obtained from the distal vastus lateralis (VL; ~5cm proximal to suprapatellar pouch) during surgery and at 6 weeks postoperatively. RNA was isolated from the muscle biopsies and real-time quantitative PCR performed using a panel of genes including those coding for inflammation (TNF- $\alpha$ , IL-6), hypertrophy (calpain1 (CAPN1), calpain2 (CAPN2), calpastatin (CAST)), atrophy (muscle atrophy F-box (FBX032), calpain 3 (CAPN3) and 20S proteasome alpha7 subunit (PSMA7)) and lipid metabolism (lipoprotein lipase (LPL), peroxisome proliferated-activated receptor alpha (PPARA)). Gene expression was assessed using the comparative Ct method. Results 14 patients were recruited (average age (mean  $\pm$  SD)  $65.3 \pm 8.8$  years in men (n=9) and  $59.8 \pm 13.3$  years in women (n=5)). 14 muscle biopsies were collected during surgery and 10 obtained at 6 weeks postoperatively. At 6 weeks, there was a comparative reduction in TNF expression, compared to baseline (%fold increase/decrease (p value); -30% (p=0.02)). Significant changes were observed in markers of cell atrophy (reduction in PSMA7 (-45% (p=0.015)), with increased CAPN3 (+103% (p=0.004)) and lipid metabolism (LPL (-45% (p=0.015) and PPARA (-79% (p=0.0001)). Despite decreases in other markers of inflammation and atrophy (IL6 (~80%; FBX032 (30%)), with increases in hypertrophic markers (CAPN1 ~70%, CAPN2 ~130%, CAST ~50%), significance was not achieved for any of these genes in this model. Conclusions At the 6 week time point in this THR population, muscle inflammation in the VL was reduced. Despite apparent increases in markers of hypertrophy, these did not reach significance, although the balance in favour of hypertrophy is apparent, with the significant reduction of CAPN3 and reduced inflammation. The significant reductions in markers of lipid metabolism are of interest and warrant further investigation, with regard to metabolic efficiency in this group. It is interesting to speculate that increased exercise during this phase of recovery may facilitate hypertrophic responses and potentiate functional gains.

## POTENTIATION OF AGONIST MUSCLE ACTIVITIES BY ANTAGONIST CONDITIONING CONTRACTION

Kamimura, T.1, Muramatsu, K.2

*1: Tokyo University of Social Welfare, 2: Health Science University*

Introduction Preceding antagonist conditioning contraction (ACC) have been shown to potentiate the contraction force, electromyography (EMG) activity, and other outputs of an agonist muscle. We previously reported that the rate of force development of agonist contraction was increased by isometric ACC (Kamimura et al, 2009). The purpose of this study was to further characterize the potentiating effects of ACC on agonist muscle activities. Methods Healthy male subjects performed isometric maximal voluntary dorsal or plantar flexion from 90 degrees flexion position of the ankle joint. Then, maximal isometric plantar flexion for 3 s immediately after maximal isometric dorsal flexion for 1 s was performed. The force signal during the plantar flexion phase was recorded and numerically differentiated to estimate the rate of the force development (RFD). EMG signals were also recorded from gastrocnemius muscle and the integrated EMG (iEMG) and rate of rise of EMG amplitude (RRE) were calculated. The posterior tibial nerve was electrically stimulated and the H-wave was recorded from soleus muscle during plantar flexion with or without ACC. The statistical analysis was done using paired t-test and correlation analysis of Pearson. Results The peak torque and iEMG during plantar flexion were not significantly affected by the ACC. However, RFD, RRE and H-wave amplitude during the plantar flexion phase with preceding ACC were significantly higher than the corresponding control

values without ACC. In addition, RFD and RRE were significantly positively correlated. Discussion The muscle force outputs have been shown to be potentiated by isokinetic or isometric ACC (Sale, 1986., Kamimura et al., 2009). The present study also demonstrated that the rate of force development, but not the peak torque, was increased by ACC in the ankle joint movement. The facilitation effect of ACC may be due to neuronal influences and/or biomechanical properties of muscle-tendon complex, such as increase in elastic energy during ACC. This study further showed that electromyographic activities, RRE and H-wave, were also potentiated by ACC. This suggested that increased neural activities might contribute to the antagonist conditioned facilitation of force development. References Kamimura T, Yoshioka K, Ito S, Kusakabe T. (2009). *Human Movement Science*, 28, 407–414. Sale DG. (1986). *Human muscle power*, 289–307. Champaign, IL: Human Kinetics.

### ACUTE MODULATION OF THE SOLEUS H-REFLEX IN UPRIGHT STANCE AFTER CALF MUSCLE STRETCHING

Olbrechts, N.

*Université Libre de Bruxelles*

Acute modulation of the soleus H-reflex in upright stance after calf muscle stretching Olbrechts, N., Baudry, S., Duchateau J., Guissard N. Laboratory of Applied Biology, Université Libre de Bruxelles (Belgium). Introduction Previous work indicates that repeated stretches of the calf muscles can decrease torque steadiness by increasing muscle compliance and EMG activity of muscles around the ankle joint (Kato et al. 2011), and can affect balance stability during upright stance (Behm et al. 2004). However, a lower balance stability is accompanied by a reduced amplitude of the Hoffmann (H) reflex indicating a decrease in muscle spindle afferents input at the spinal level (Earles et al. 2000). The present study investigated the acute effect of repeated stretches of the calf muscles on balance stability and H-reflex modulation. Methods The stretching bout comprised five 60-s passive stretches of the non-dominant leg, separated by 30-s rest. Time-domain parameters of the centre of pressure, surface electromyogramme (EMG) of calf muscles and tibialis anterior were recorded for 10 adults that kept 1-leg upright stance on a force platform. In addition, soleus H reflex and Mmax (maximal M wave) were recorded in similar conditions. Measurements were performed before and immediately after the repeated stretches, and after 15 min of recovery. Results The repeated stretches did not influence significantly the parameters of balance stability ( $p > 0.05$ ). Regardless of the vision condition, the EMG activity of the calf muscles was increased (+17.7%;  $p < 0.001$ ) immediately after stretches compared with control whereas neither the H-reflex size (normalized to the Mmax that did vary after the fatiguing task) nor the EMG of tibialis anterior changed throughout the experiment. However, the H reflex/Soleus EMG ratio was significantly greater when standing with eyes open compared with eyes closed ( $p < 0.001$ ), and decreased ( $p < 0.05$ ) immediately after the stretches, regardless of the vision condition. Discussion Even though five 60-s passive stretches of the calf muscles did not alter one-leg stance stability, the results show that stronger calf muscle contractions are required to control balance after stretches. Moreover, the reduced H-reflex/soleus EMG ratio immediately after the stretches might suggest a presynaptic modulation of Ia afferents. This study indicates that balance control after repeated passive stretches of the calf muscles requires neural adjustments in leg muscle activation to maintain stability. References Behm DG, Bambury A, Cahill F, Power K (2004). *Med Sci Sports Exerc*, 36: 1397-1402. Earles DR, Kocaja DM, Shively CW (2000). *Int J Neurosci*, 105: 1-13. Kato E, Vieillevoys S, Balestra C, Guissard N, Duchateau J (2011). *J Appl Physiol*, 10: 407-415.

13:45 - 14:45

## Poster presentations

### PP-PM34 Training & Testing 7

#### ARE THERE TRADE-OFFS BETWEEN REPEATED SPRINT ABILITY AND OTHER SPEED QUALITIES DURING SOCCER PRE-SEASON?

Patras, K., Tsiaras, V., Siaravas, S., Georgoulis, A.

*Orthopaedic Sports Medicine Center, University of Ioannina*

INTRODUCTION: In professional soccer repeated sprint ability is an important performance factor [1], along with first step quickness, acceleration and maximal speed [2-4]. The purpose of the present study was to establish the interrelationship between repeated sprint ability (RAST test, 6 X 35m interspersed with 10 sec of passive recovery) and first step quickness (5m), acceleration (10m) and maximal speed (30m) in professional soccer players. We hypothesized that repeated sprint ability will be related to maximal speed rather than first step quickness or acceleration. METHODS: Nineteen soccer players were tested during the preseason for repeated sprint ability, first step quickness, acceleration and maximal speed. The magnitude of the relationship ( $r \pm 90\%$  CI) was classified as 0.1-0.3 small, 0.3-0.5 moderate, 0.5-0.7 large, 0.7-0.9 very large, and 0.9-0.99 nearly perfect and classified as practically important where there was a >75% likelihood of the correlation exceeding the smallest practically important (0.1) value, using an Excel spreadsheet [5]. Using the median split technique, players were divided into BEST and WORST groups according to the median RAST mean time [1]. The effect size (ES) was calculated to assess meaningfulness of differences. Effect sizes of 0.8, 0.8-0.5, 0.5-0.2, and <0.2 were considered as large, moderate, small, and trivial, respectively [6]. RESULTS: There was a likely moderate positive relationship between RAST and acceleration ( $r=0.33$ , 90% CI: -0.07 to 0.64) and a very likely large positive relationship between RAST and maximal speed ( $r=0.59$ , 90% CI: 0.26 to 0.80). There was a likely large negative relationship between RAST-BEST and first step quickness ( $r=-0.52$ , 90% CI: -0.85 to 0.09) and a very likely large positive relationship between RAST-WORST and first step quickness ( $r=0.69$ , 90% CI: 0.17 to 0.91). There was a small difference in both first step quickness ( $1.060 \pm 0.054$  vs.  $1.023 \pm 0.091$ ,  $ES=0.5$ ) and maximal speed ( $4.209 \pm 0.104$  vs.  $4.269 \pm 0.144$ ,  $ES=-0.48$ ) between RAST-BEST and RAST-WORST respectively. DISCUSSION: During preseason repeated sprint ability is more related to speed rather than acceleration. Furthermore, although RAST-BEST and RAST-WORST groups differ little in first step quickness, it appears that this quality is related differently to repeated sprint ability. REFERENCES: 1. Rampinini et al. *Int J Sports Med* 28:1018-24, 2007 2. Bangsbo et al. *J Sports Sci* 24:665-74, 2006 3. Little and Williams. *J Strength Cond Res* 19:76-8, 2005 4. Pyne et al. *J Strength Cond Res* 22:1633-7, 2008 5. Hopkins WG. <http://newstats.org/xcl.xls>, 2007 6. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*, 1988

## IMPROVEMENT OF THE CRUCIAL PHYSIOLOGICAL CHARACTERISTICS OF PROFESSIONAL SOCCER PLAYERS AFTER COMPETITIONAL SEASON

Olm, T., Baskin, K., Herde, K.

*Tallinn University*

**Introduction** Despite massive research work there are different views on how long and how effectively aerobic endurance can be trained in elite soccer players. The aim of this study was to assess the changes of characteristics of the soccer players after a competition season. **Methods** The subjects were 15 soccer players of the best club of Estonia. Average age was  $22.5 \pm 2.8$  years. The test battery included electro-, echo- and polycardiography, and incremental treadmill test to exhaustion. Anticipation speed and correctness were assessed. Correlation coefficients were calculated. All indices were compared with the identical indices received one year ago from the same players at the same pre-seasonal period. **Results** From 29 compared means six hadn't changed: height ( $181.5 \pm 6.4$  cm), body mass ( $74.7 \pm 3.2$  kg), body fat ( $11.3 \pm 2.1\%$ ), blood pressure ( $123/72$  mmHg), anticipation speed ( $0.574 \pm 0.07$  sec) and anaerobic threshold ( $181.1 \pm 6.0$  beat/min at  $L 4$  mmol/l). Statistically significant improvements were found in four characteristics:  $VO_{2max}$  ( $62.8 \pm 3.8$  ml/kg/min),  $VO_2$  ( $4.6 \pm 0.3$  l/min), maximal ventilation ( $174.6 \pm 19.3$  l/min) and  $maxBLa$  ( $12.4 \pm 2.7$  mmol/l). The remaining indices showed a tendency to improve, but not that strongly. **Discussion** From results we can see that the most changeable characteristics are those which are related to the energy systems.  $VO_{2max}$  increased by 8.5%. A similar increase (by 8.6%) was reported by J. Helgerud et al. (2011). The improvement of  $O_2$  uptake was accompanied by an increase of maximal ventilation by 6.6%. Heart stroke volume, heart mass/volume index increased without a significant difference of the means. The anaerobic threshold was surprisingly stable:  $181.1 \pm 6.0$  versus  $181.6 \pm 6.8$  beat/min a year ago. Similar results were reported by K. McMillan et al. (2012). B. Sterzing et al. (2011), assessing levels of aerobic endurance in young soccer players, found that neither anaerobic thresholds nor velocity at 4 mmol/l lactate differed significantly between the age groups U16, U17 and U19. Only the U23 group showed significant difference to younger age groups. The authors' opinion is that the higher aerobic capacity in U23 players is based on a selection of players. **Conclusion** The results of the study support previous researches indicating that adult professional players, having relatively high-level physiological characteristic, can improve them. We are convinced that as the anaerobic threshold is not a very changeable, involving other characteristics in assessment of aerobic capacity is necessary. **References** Helgerud J, Rodas G, Kemi OJ, Hoff J. (2011). *Int J Sports Med*, 677-82. McMillan K, Helgerud J, Grant SJ, Newell J, Wilson J, Macdonald R, Hoff J. (2005). *Br J Sports Med*, 39:432-436. Sterzing B, Schuster R, Simon P, Striegel H. (2011). *Proc. 16th Ann Cong ECSS*, 28.

## THE INVESTIGATION OF PHYSICAL FITNESS CHARACTERISTICS OF THE IRANIAN ELITE SOCCER REFEREES AND ASSISTANTS

Saremi, A., Shavandi, N., Javidi Athar, A.

*Arak university, Iran*

**Introduction** Despite the importance of referees' role in soccer, very little scientific literature is available on soccer refereeing, especially compared with that available on players (Castagna et al., 2007). The aim of the present study was to investigate the physical fitness characteristics of Iranian professional soccer league referees and their relation with referees' performance. **Methods** 25 main referees ( $36.1 \pm 5.6$  years,  $181 \pm 5.2$  cm, and  $76.4 \pm 7.7$  kg) and 33 assistant referees ( $35.3 \pm 6.8$  years,  $179 \pm 5.6$  cm, and  $75.5 \pm 6.5$  kg) participated in the study (2010-2011 League). To assess the physical fitness levels, all of the referees were tested using the fitness test battery adopted by FIFA (Bartha et al., 2009; Reilly et al., 2006): endurance ability was measured by a 12-minute run, and speed and anaerobic power were measured using 50 and 200 m sprint runs, respectively. The referees' performance was assessed by calculating the average score which each referee obtained during soccer professional league (2010-2011) which was recorded by refereeing supervisors. Pearson correlations were used to assess the relationships between variables. **Results** In the 50-m, 200-m, and 12-minute run tests the referees scored,  $6.88 \pm 0.08$  seconds,  $29.7 \pm 0.63$  seconds, and  $2951 \pm 276$  m, respectively. In the 50-m, and 12-minute run tests the assistant referees scored,  $6.86 \pm 0.03$  seconds, and  $2940 \pm 238$  m, respectively. In referees, significant positive correlation were found between aerobic fitness (12-minute run test) ( $r=0.58$ ,  $p<0.03$ ) with refereeing performance, while in assistant referees speed performance (50-m run test) showed a significant positive correlation with refereeing performance ( $r=0.57$ ,  $p<0.01$ ). **Discussion** These results suggest that the 12-minute run test and 50-m sprint test are suitable predictors of refereeing performance in main referees and assistant referees, respectively. Furthermore, based on FIFA standards (Bartha et al., 2009; Casajus et al., 2006), Iranian elite referees are considered to be in a high level of aerobic capacity and speed. **References** Castagna C, Abt G, D'Ottavio S. (2007). *Sports Med*, 37, 625-646. Bartha C, Petridis L, Hamar P, Puhl S, Castagna C. (2009). *J Strength Cond Res*, 23,121-126. Reilly T, Gregson W. (2006). *J Sports Sci*, 24, 795-801. Casajus JA, Castagna C. (2007). *J Sci Med Sport*, 10, 382-389.

## FATIGUE AND RAPID HAMSTRING/QUADRICEPS FORCE CAPACITY IN ELITE SOCCER PLAYERS

Greco, C., Silva, W.L., Camarda, S.R., Denadai, B.S.

*Human Performance Laboratory - UNESP*

**Introduction** Muscle fatigue, defined as a reduction in the maximal force exerted by a muscle or a muscle group due to central and/or peripheral mechanisms is frequently found during soccer match, especially towards the end of play. Significant changes in the conventional concentric hamstrings:quadriceps ratio (Hcon:Qcon) and functional eccentric hamstrings:concentric quadriceps ratio (Hecc:Qcon) were also found after both exhaustive laboratory-based soccer-specific exercise and a field test representative of soccer specific movements. Zebis et al. (2011) have recently introduced the rate of force development (RFD) hamstrings:quadriceps strength ratio (RFDH:Q) to assess the potential to stabilize the knee joint during explosive movements of elite soccer players. Thus, the aim of this study was to investigate the effect of fatigue induced by an exhaustive laboratory-based soccer-specific exercise on different hamstrings:quadriceps (H:Q) ratios of soccer players. **Methods** Twenty-two male soccer players ( $23.1 \pm 3.4$  yr.) performed maximal eccentric and concentric contractions for knee extensors (KE) and flexors (KF) at  $60^\circ/s$  and  $180^\circ/s$  to assess Hcon:Qcon and Hecc:Qcon ratios. Additionally, they performed maximal voluntary isometric contractions for KE and KF, from which the maximal muscle strength, RFD and RFDH:Q were extracted. Thereafter, subjects performed an exhaustive laboratory-based soccer-specific exercise and a post-test similar to the pre-test. **Results** There was significant reduction of Hcon:Qcon ( $0.60 \pm 0.06$  vs.  $0.58 \pm 0.06$ ) and Hecc:Qcon ( $1.29 \pm 0.2$  vs.  $1.16 \pm 0.2$ ) after the soccer-specific exercise. However, no significant difference between Pre and Post exercise conditions was found for RFDH:Q at 0-50 ( $0.53 \pm 0.23$  vs.  $0.57 \pm 0.24$ ) and 0-100 ms from the onset of muscle contraction ( $0.53 \pm 0.17$  vs.  $0.55 \pm 0.17$ ). **Discussion** The principal original finding of this study was that the H:Q strength ratios based on peak force values are more affected by fatigue induced by a soccer specific intermittent protocol than rapid H:Q force capacity. The reduction of both Hcon:Qcon and Hecc:Qcon is consistent with previous studies (Rahnama et

al., 2003; Delestrat et al., 2010). RFDH:Q obtained during early contraction phase was not modified after exercise. Thus, fatigue induced by soccer specific intermittent protocol seems not reduce the potential for knee joint stabilization during the initial phase of voluntary muscle contraction. References Zebis MK, Andersen LL, Ellingsgaard H, Aagaard P. (2011). Rapid hamstring/quadriceps force capacity in male vs. female elite soccer players. *J Strength Cond Res*, 25: 1989-1993.

### REPEATED HIGH-INTENSITY RUNNING AND SPRINTING IN WOMEN'S FOOTBALL COMPETITION

Spencer, M.1, Wiig, H.1, Gabbett, T.2,3

*Norwegian School of Sports Sciences*

REPEATED HIGH-INTENSITY RUNNING AND SPRINTING IN WOMEN'S FOOTBALL COMPETITION Spencer, M. 1, Wiig, H. 1, Gabbett, T. 2,3 1: Norwegian Research Centre for Training and Performance, Norwegian School of Sports Sciences, Oslo, Norway, 2: School of Exercise Science, Australian Catholic University, Brisbane, Australia, 3: School of Human Movement Studies, The University of Queensland, Brisbane, Australia Introduction Despite the reported importance of high-intensity running (Mohr et al., 2005) and repeated-sprint ability (Gabbett et al., 2008) to competitive success in football, studies investigating the nature of repeated high-intensity activity in games are limited (Gabbett et al., 2008). To our knowledge, no study has investigated the concurrent repeated, high-intensity (RHIA) and repeated-sprint activity (RSA) of intermittent team sport competition. Therefore, the aim of this study is to describe the nature of RSA and RHIA (e.g. striding and sprinting activities) that involve a high energy cost and are associated with short duration (i.e.  $\leq 20$  seconds) recovery periods. Methods Thirteen elite women football players underwent video-based time-motion analysis on 34 occasions during national and international standard matches, in which all players played 90 min. RSA and RHIA were defined as successive (i.e. 2 or more) sprints, or striding and sprinting efforts that occurred with  $\leq 20$  seconds between efforts. Results The number of RSA and RHIA bouts performed was similar between the first and second half of matches, when analysed as sets of 2, 3, 4, 5 or 6 efforts. Sprinting and striding/sprinting durations tended to remain relatively stable irrespective of the number of efforts in a RSA or RHIA bout, or the period of play. However, the mean recovery duration progressively increased with a greater number of efforts per bout; RSA (sets of 2:  $9.94 \pm 4.73$ ; sets of 6:  $16.57 \pm 2.49$ ; Effect Size (ES) = 1.75, large) and RHIA (sets of 2:  $9.49 \pm 2.60$ ; sets of 6:  $14.74 \pm 2.66$ ; ES = 2.00, large). Furthermore, RSA bouts were associated with moderately greater recovery durations between efforts (ES = 0.67-0.93) for sets of 4 and 5 sprints, in the second half compared to the first half of matches. However, only trivial or small differences (ES = 0.01-0.33) were observed between halves for RHIA bouts. Discussion These findings suggest that first to second half reductions in RHIA and RSA do not occur in elite Women's soccer competition. However, players increase the amount of low-intensity recovery performed between RHIA and RSA efforts, most likely in an attempt to maintain RHIA and RSA performance. These findings are novel and emphasize the importance of repeated-effort ability to elite Women's football, and highlight the importance of training this quality to minimise reductions in performance during competitive match-play. References Gabbett, TJ, Mulvey, MJ. (2008). *J Strength Cond Res*, 22, 543-552. Mohr, M, Krstrup, P, Bangsbo, J. (2005) *J Sports Sci*, 23, 593-599.

### EFFECTS OF 16 WEEKS OF STRENGTH AND PLYOMETRIC TRAINING ON PHYSICAL PERFORMANCE IN SEMIPROFESSIONAL SOCCER PLAYERS

Otero-Esquina, C., Pareja-Blanco, F., Rodriguez-Rosell, D., González-Badillo, J.J.

*University Pablo de Olavide*

Effects of 16 weeks of strength and plyometric training on physical performance in semiprofessional soccer players Otero-Esquina, C1. Pareja-Blanco, F1. Rodriguez-Rosell, D1. González-Badillo, JJ1. 1Faculty of Sport, UPO, Seville, Spain Introduction There are several studies which have evaluated the effects of strength training over jump height and acceleration capacity with soccer players using loads  $>85\%$  1RM until failure (1,3). However, to our knowledge there have not been any studies that evaluate the effects of training with lower loads and not to failure in semi-professional soccer players. Therefore, the aim of this study was to analyze the effects of this type of training on physical performance. Method Fifteen soccer players from third Spanish division took part in this study (age  $22.7 \pm 3.4$  years, height  $1.78 \pm 0.06$ m, weight  $75.4 \pm 6.8$ kg). These subjects completed a strength training twice a week for 16 weeks. Subjects performed full squat (4-8 reps 40-60% 1RM), CMJ with and without load, resisted sprint and loaded change of direction. The variables measured were: estimated 1RM full squat (T-Force System), CMJ height and acceleration capacity in 10 and 20m (T10, T20 and T10-20). A related-samples t-test was used to analyse pre-post changes among variables and correlation was determined through Pearson's coefficient correlation. Results Subjects obtained significant improvements in CMJ height (5.5%;  $p < 0.01$ ), T10-20 (0.8%;  $p < 0.05$ ) and estimated 1RM full squat (7.4%;  $p < 0.05$ ) while T10 and T20 showed no significant changes. Pretest values found significant correlations ( $p < 0.05-0.01$ ) between CMJ and T10 ( $r = -0.69$ ), T10-20 ( $r = -0.59$ ), T20 ( $r = -0.74$ ) while RM correlated significantly ( $p < 0.05$ ) with T10 ( $r = -0.53$ ) and T20 ( $r = -0.57$ ). However, post-test showed stronger correlations between CMJ and 1RM ( $r = 0.61$ ), T10 ( $r = -0.75$ ), T10-20 ( $r = -0.72$ ) and T20 ( $r = -0.78$ ). Discussion These results show that plyometric and strength training with light loads (40-60% 1RM) and not to failure (4-8 reps) improve 1RM full squat, CMJ height and T10-20 which are very important for soccer successful (1). These findings show higher gains on performance than other works (3), which did not show changes neither CMJ nor sprint time training with high loads until failure. Therefore, the present study suggests that is not necessary to train with high intensity (% 1RM) to improve soccer players performance. References 1. Hoff, J, and Helgerud, J. Endurance and strength training for soccer players: physiological considerations. *Sports Med* 34: 165-180, 2004. 2. Lopez-Segovia, M, Palao Andres, JM, and Gonzalez-Badillo, JJ. Effect of 4 months of training on aerobic power, strength, and acceleration in two under-19 soccer teams. *J Strength Cond Res* 24: 2705-2714, 2010. 3. Ronnestad, BR, Kvamme, NH, Sunde, A, and Raastad, T. Short-term effects of strength and plyometric training on sprint and jump performance in professional soccer players. *J Strength Cond Res* 22: 773-780, 2008.

### PHYSICAL PERFORMANCE, TECHNICAL ACTIVITY AND INJURY RISK IN A PROFESSIONAL SOCCER TEAM IN MATCH-PLAY OVER A PROLONGED PERIOD OF FIXTURE CONGESTION

Lago-Penas, C.1, Dellal, A.2, Casais, L.1

1: UVIGO (Pontevedra, Spain), 2: Olympique Lyonnais FC and USS (Strasbourg, France)

Introduction Professional soccer players are often required to play competition matches with only 2-3 days' recovery. However, the effect of a prolonged period of fixture congestion on players' performance is still inconclusive. Therefore, the aim of this study was to investigate recovery via analysis of activity profiles in a professional soccer team over an intense period of matches. Methods A computerized player tracking system (AMISCO Pro, Sport-Universal Process, Nice, France) was used to characterize activity profiles in the reference team. A 1-



way repeated measures ANOVA was used to compare outcome measures in each category of physical and skill-related performance across: 1) 6 consecutive games over the 21-day-period, and; 2) games played during 3 different congested fixture periods in the same season. The methodologies and definitions of injury are similar to those employed in other investigations on elite soccer play (Carling, et al., 2011; Dupont, 2010). Results Across the 6 successive matches, no differences were reported for the overall distance covered ( $p=0.072$ ) or that covered in high-intensity ( $p=0.622$ ), moderate-intensity ( $p=0.277$ ), low-intensity ( $p=0.467$ ) or light-intensity ( $p=0.368$ ) running. No differences were found in the analysis of the technical actions. The incidence of injury across the prolonged periods was similar to that reported in matches played outside the study periods; however, injury rate during training time was significantly lower during congested period to those outside the study period (4.6 vs. 14.6 per 1000 h exposure,  $p<0.001$ ). The comparison of physical performance in matches played across the 3 separate periods (August, September and October) revealed significant increases in the overall distance covered. Discussion This study provided a valuable opportunity to study physical performance, injury risk and severity in match-play over a prolonged period of fixture congestion. Physical performance and injury rates were generally unaffected which shows that coaches, support staff and players in high-performance teams in a professional setting can cope with a congested playing calendar. As a whole, these results also lend support to findings observed other studies (Carling et al., 2011; Lago-Peñas et al., 2011; Odetoynbo et al., 2009). References Carling C, Le Gall F, Dupont G. (2011) *Int J Sports Med*, 33(1):36-42. Dupont G, Nedelec M, McCall A, McCormack D, Berthoin S, Wisløff U. (2010). *Am J Sports Med*, 38: 1752-1758 Lago-Peñas C, Rey E, Lago-Ballesteros J, Casais L, Dominguez, E. (2011) . *J Strength Cond Res* 2011; 25: 2111-2117 Odetoynbo K., Wooster B., Lane A. (2009). *Science and Football VI*, 105-110

### SEVEN WEEKS OF COMBINED STRENGTH AND POWER TRAINING DURING THE COMPETITIVE SEASON IN HIGH-LEVEL AMATEUR SOCCER: A RANDOMIZED-CONTROLLED TRIAL

Faude, O., Roth, R., Di Giovine, D., Donath, L., Zahner, L.

*University of Basel*

Introduction Speed and power abilities are considered important prerequisites for match performance in soccer. Scientific studies addressing specific strength and power training methods are scarce so far, particularly when conducted during the competitive season. We therefore investigated the effects of a 7 weeks combined strength and power training program during the competitive season on various fitness parameters in high-level amateur soccer players. Methods Sixteen male soccer players (age: 22.5 (SD 2.5) y, height: 1.79 (5.3) m, weight: 76.8 (6.1) kg) from one team of the third Swiss league were randomly stratified (strata: one-repetition maximum (1-RM), 10 m sprint time) to either a combined strength training (CST, N = 8) or a control (CON, N = 8) group. The intervention was conducted twice per week within an in-season period of 7 weeks. CST comprised strength exercises (uni- and bilateral half squats and calf raises with additional weights) combined with plyometrics and/or sprints (5 to 10 m). CON performed technical and tactical training during the same time period. Before and after the training period, several physical fitness parameters were assessed: 1-RM (half squat), isometric peak strength and rate of force development (RFD), leg press, uni- and bilateral), vertical jump height (countermovement jump, CMJ (uni- and bilateral); drop jump, DJ), 10 and 30 m sprint times, agility testing with the ball, and intermittent endurance performance (yo-yo intermittent recovery test 1). Results Players attended on average 10.9 (1.1) training sessions during the 7 weeks period. Large significant test x group interactions were found for 1-RM ( $p < 0.001$ , effect size (ES, partial eta squared) = 0.76), bilateral CMJ ( $p < 0.001$ , ES = 0.58), CMJ with the left leg ( $p = 0.003$ , ES = 0.51), and drop jump reactivity index ( $p = 0.003$ , ES = 0.57) with increases after CST (+3 to 18%) and similar or decreased values (+0.6 to -7.7%) in CON. Although not significant ( $0.09 \leq p < 0.40$ ) comparable results were observed in several other parameters (isokinetic peak strength and RFD, CMJ with right leg, DJ, 30 m sprint time, and intermittent endurance) with effect sizes indicating at least medium effects ( $0.06 \leq ES < 0.19$ ). No relevant test x group interaction was observed for agility testing and 10 m sprint. Discussion It is concluded that a 7 weeks combined strength and power training can improve relevant physical prerequisites compared to routine technical and tactical training in high-level amateur soccer players during the competitive season. The medium effects in sprint time, jump heights and intermittent endurance need further verification in randomized-controlled trials with more participants.

### LEG DOMINANCES EFFECT ON BALANCE IN ELITE SOCCER PLAYERS

Fletcher, I., Long, S.

*University of Bedfordshire*

LEG DOMINANCES EFFECT ON BALANCE IN ELITE SOCCER PLAYERS Fletcher, I.I, Long, S.I 1: UoB (Bedford, UK) Introduction Soccer has a high prevalence of lower limb injuries (Gstotner et al., 2009); with non-contact ACL injuries more prevalent within the preferred rather than non-preferred kicking leg (Brophy, 2010). This could suggest that leg asymmetry could be an inherent injury risk factor. Importantly, balance asymmetry has yet to be tested in the elite population. Therefore, this study aimed to compare kicking leg dominances effect on balance in elite players. Methods 15 male elite soccer players (age  $24 \pm 7$  yr, height  $183.86 \pm 5.16$  cm, mass  $79.9 \pm 9.13$  kg) drawn from an English League One soccer team were assessed for balance asymmetry using an RSscan pressure plate (RSscan Ltd, Ipswich, United Kingdom). 1 legged static, dynamic (a one metre hop and hold) and passing action balance tests were assessed by measuring the deviation from the centre of pressure (CoP) in millimetres. Results When the balance tests were compared a main effect was found ( $F=63.721$ ,  $p<0.01$ , effect size=0.907), indicating that the static test was 10.5% ( $p=0.037$ ) worse than the dynamic balance task. Leg dominance across all the balance tests was not linked to significant differences in CoP deviation ( $F=0.476$ ,  $p=0.501$ , effect size=0.033). However, when pairwise comparisons were employed, though the static and dynamic balance tests showed leg symmetry ( $p>0.05$ ), the pass test indicated that the dominant leg exhibited significantly worse dynamic balance than the non-dominant leg (33.3%,  $p=0.05$ ). Discussion This study's results indicate that static balance was significantly better than dynamic test results. This could be important in terms of screening players for injury risk factors. Njorai (2010) states that players are always in motion, therefore balance systems are rarely required to maintain a stable base for more than a few moments. If this is the case than it brings into question the efficacy of static balance tests. Interestingly, Lambert et al., (2006) has shown functional discrepancies between dominant and non-dominant legs. The present results on standard static and dynamic balance tasks do not support this supposition; however the specific kicking task test found a decrease in stability within the dominant kicking leg. It may be that in a highly trained soccer population leg inequalities are more apparent in specific balance tasks; this may mean that balance screening does not just have to be dynamic; it also has to incorporate a specific football task to explore leg discrepancies within players. References Brophy R. (2010). *British J Sports Med*, 44, 694-698. Gstotner M, Neher A, Scholtz A, Millonig M, Lambert S, Raschner C. (2009). *Motor Control*, 13, 218-231. Lambert S, Schuepfer N, Raschner C, Platze H, Niederkofler A, Patterson C. (2006). 5th International Conference on Strength Training. Njorai W. (2010). *Soccer J*, 55, 8-13.

### REGULAR PATTERNS OF PLAY IN EFFECTIVENESS OFFENSIVE SEQUENCES OF FC BARCELONA COUNTERATTACK

Sarmiento, H.1,2, Barbosa, A.1, Martins, J.3, Campanico, J.1, Anguera, M.T.2, Leita, J.1

1-UTAD, CIDESD (Vila Real, Portugal); 2-UB (Barcelona, Spain); 3-UTL (Lisboa, Portugal)

While the results of the literature suggest that the increase in transitions (from defense to offence) speed is linked with an increased likelihood of scoring a goal, very few studies have analyzed the transition as a whole. Thus, the aim of the present study is to demonstrate the potential of the software THÈME 5.0, for the detection of behavior temporal patterns (T-pattern) in the football game, more specifically, in the actions of counterattack of the FC Barcelona, accessing to the interaction contexts in which the behaviors are performed. The sample consisted of 12 football games of domestic competitions that were analyzed by systematic observation by using a specific instrument to observe the offensive process (Sarmiento et al., 2010). We used the software THÈME 5.0., and the following criteria were used: the minimum number of events was set at 3 and the level of significance was set at 0.05. The analysis revealed the existence of 787 different T-patterns in the sequences of the counter-attack. The study of these patterns allowed the knowledge of specific regularities in the offensive sequences of this team, particularly regarding the understanding of how these start, develop and end. This analysis helps us to characterize the transitions (defense-attack) that are associated with total effectiveness (goal scored) in this team. In general, in this type of sequences, the recovery of the ball possession is performed through an interception of the ball in zone 6 of the field, in an interaction context characterized by the numerical superiority; then we observe a quick change in the flank of play (right side to the left side), where a player progresses in the field performing short passes and conductions of the ball in situations of numerical equality. These sequences ended in the central zone (zone 11) of the offensive sector, through a shot with goal scored in an interaction context of numerical inferiority. This type of analysis allows us to know and to characterize the regular structures of offensive sequences in football teams. The t-patterns detected in the defense-attack transition of this successful team allowed us to know how that process is developed in an effective way. This information is relevant, on the one hand to the team itself because it makes it possible to conceive training exercises in order to increase this efficiency, on that other hand it allows, for example, that the opposing coaches can develop strategies to prevent that the Barcelona team performed these transitions effectively. Sarmiento, H., Anguera, T.; Campanico, J. & Leita, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. *Medicina (Kaunas)*, 46(6), 401-407.

### RESPONSES OF PEAK OXYGEN UPTAKE, VELOCITY AT LACTATE THRESHOLD AND RUNNING ECONOMY IN PROFESSIONAL SOCCER PLAYERS DURING SEVERAL SEASONS

Krueger, M.1,2, Broich, H.3, Sperlich, B.4, Mester, J.1,2

1:German Sport University Cologne, 2:German Research Center for Elite Sport, Cologne, 3:Bayer 04 Leverkusen Fußball GmbH, Leverkusen, 4:Institute of Training Science, University of Wuppertal

**INTRODUCTION:** Since professional soccer players have to cover distances up to 12 km during a match, endurance performance is one important component of success (di Salvo et al., 2007). VO<sub>2</sub>peak, velocity at lactate threshold (VLT) and running economy (RE) have been described as major factors accounting for variance in aerobic endurance performance (Midgley et al., 2007). Therefore the aims of this case study were 1) to investigate how VO<sub>2</sub>peak, VLT and RE vary within and over several seasons in elite soccer players and 2) to discuss possible practical applications. **METHODS:** VO<sub>2</sub>peak, VLT and RE of 12 professional and international level soccer players (25 ± 3 yrs, 184 ± 7 cm, 79.8 ± 7.5 kg) were measured during eight time points (i.e. July 2006 [0706]; January [0107] and July 2007 [0707]; January [0108], July [0708], September [0908] and December of 2008 [1208] and May 2009 [0509]) before, during and after three soccer seasons using an incremental treadmill protocol (2.8 m/s, increase 0.4 m/s every 5 min). Capillary blood lactate concentration and VO<sub>2</sub> were determined at the end of each stage. RE was defined as VO<sub>2</sub> in mL/kg/min at 3.2 m/s. ACSM-criteria for exertion were met in all tests. **RESULTS:** VO<sub>2</sub>peak expressed as mL/min/kg was significantly elevated in September 08 when compared to the other time points (57.3 ± 2.5 vs. 55.5 ± 3.4 [0706], 55.6 ± 2.7 [0107], 55.4 ± 3.8 [0707], 55.1 ± 3.0 [0108], 55.3 ± 3.6 [0708], 56.3 ± 4.3 [1208], 54.5 ± 4.3 [0509]; best P = .03). VLT expressed as m/s was also significantly elevated in September 08 when compared to the other time points in the same year (3.29 ± 0.12 vs. 3.24 ± 0.07 [0108], 3.24 ± 0.10 [0708], 3.26 ± 0.09 [1208]; best P = .02) while RE remained unaltered from 0706 to 0509 (best P = .17). **CONCLUSION:** This study showed: 1) RE is not influenced by pre- or in-season exercise in elite soccer players. 2) VO<sub>2</sub>peak and VLT elevated from preseason (July 08) to September 08, but declined to December of the same season. This can be explained by an additional endurance block during season preparation, which is no longer possible during the season due to several matches per week. It seems that frequent match play is not sufficient to maintain high levels of VO<sub>2</sub>peak and VLT during an entire season. We therefore suggest 1) to routinely assess all three endurance relevant parameters in professional soccer players and 2) to implement short conditioning blocks (e.g. high intensity interval training) during the season to maintain a high level of physical fitness.

13:45 - 14:45

## Poster presentations

### PP-PM35 Physiology 10

#### 3D RECONSTRUCTIONS OF SKELETAL MUSCLE MITOCHONDRIAL NETWORK AS A TOOL TO ASSESS MITOCHONDRIAL CONTENT AND STRUCTURAL ORGANIZATION

Dahl, R., Larsen, S., Stride, N., Helge, J.W., Dela, F., Prats, C.

University of Copenhagen. Faculty of Health Sciences Center for Healthy Aging

**Introduction** The mitochondria are highly dynamic organelles that continuously adjust to the energetic demands of cells. There is an ongoing debate in the field about the optimal method to assess mitochondrial volume or markers that correlate with mitochondrial volume. Previous studies have shown a strong association between the content of specific mitochondrial proteins and mitochondrial oxidative capacity [1]. However, few studies have validated mitochondrial proteins as markers for mitochondrial volume. The aim of the present study was to develop a technique to assess mitochondrial content and to identify a suitable marker of mitochondrial volume. Furthermore, we use the technique to investigate the structural organization of mitochondria in human muscle fibers. **Methods** Needle

biopsies from the m. vastus lateralis of 7 healthy middle aged subjects were used in this study. Single muscle fibers from each biopsy (n=24 +/-3,8) were co-immunostained against mitochondria and myosin heavy chain type I. Confocal microscopy z-stacks were acquired and 3D reconstructions of mitochondrial networks were performed to measure mitochondrial fractional volume and assess structural complexity. Several biomarkers were measured and their correlation to mitochondrial volume was investigated. Results The mitochondria of the slow-twitch muscle fibers were generally tubular shaped and interconnecting at the I-band of muscle sarcomere as transverse tubular interconnections creating a complex network of mitochondria. Subsarcolemmal and intermyofibrillar interconnected mitochondria were observed. In the fast-twitch fibers the structural organization of mitochondrial network was more diverse; from individual ellipsoid mitochondria to tubular interconnected mitochondrial networks. Interestingly, the different morphological variants could be found within the same muscle fiber. Type I muscle fibers exhibited higher mitochondrial content than type II muscle fibers (p<0,02). Discussion and Conclusions There is extensive debate in the mitochondrial research field whether the subsarcolemmal mitochondria and the intermyofibrillar mitochondria are connected or if they are two structurally distinct populations. Furthermore, there is also extended debate about the optimal marker for mitochondrial volume. We have developed a technique to analyze the 3D structure of mitochondrial networks in human single muscle fibers and measure mitochondrial volume. Using this technique we show evidence that question the existence of these two mitochondria populations, the two pools of mitochondria are physically interconnected. References: 1 - Holloszy et al. JBC1967; 242, 2278.

### EFFECTS OF VOLUNTARY EXERCISE AND CALORIC RESTRICTION ON MRNA EXPRESSIONS OF TLRs IN OBESE ZUCKER RATS

Kitamura, H., Shiroya, Y., Minato, K., Umetsu, Y., Yamauchi, H.

*Wayo Women's University*

EFFECTS OF VOLUNTARY EXERCISE AND CALORIC RESTRICTION ON MRNA EXPRESSIONS OF TLRs IN OBESE ZUCKER RATS Kitamura H.1, Shiroya Y.1, Minato K.1, Umetsu Y.1, Yamauchi H.2 1: Wayo Women's University (Chiba, Japan), 2: Jikei University School of Medicine (Tokyo, Japan) Introduction Regular physical exercise is associated with improvement of obesity. Recently, Toll-like receptor (TLR) 4 has been reported to play an important role in the link among insulin resistance, inflammation, obesity, and type 2 diabetes. Also, TLR2 is a key mediator of insulin resistance. However, it is unclear what effects physical exercise and caloric restriction on TLRs expressions have in obese Zucker rats. In this study, we investigated the effects of voluntary exercise and caloric restriction on mRNA expressions of TLR2 and TLR4 in liver of obese Zucker rats. Methods Obese Zucker rats were divided into three groups (n=7 for each group); ad libitum food intake (OZ), caloric restriction (CR), voluntary exercise plus caloric restriction (CR+Ex). Lean Zucker rats served as controls (n=7, LZ). During 6-week intervention, food intakes in the CR and CR+Ex rats were 70% and 74% of that in the OZ rats. The rats in the CR+Ex group engaged in voluntary wheel running for 6 weeks. Liver tissue sample was collected after the intervention to measure mRNA expression of TLRs by real-time polymerase chain reaction. Results Fasting serum glucose (BG), triglyceride (TG), total cholesterol (TC), insulin, and leptin were higher in the OZ rats, compared with the LZ rats. Caloric restriction reduced body weight and improved insulin resistance, but aggravated fasting serum TC. Voluntary exercise reduced body weight, fasting serum BG and TG, and improved insulin resistance. Suppressed mRNA expression of TLR2 in the OZ rats was observed. In most of CR+Ex rats (n=6), TLR2 mRNA was not detected. OZ and LZ rats had similar mRNA expression of TLR4. TLR4 mRNA tended to be higher in the CR group compared with the LZ group. There was no significant difference between the OZ and CR groups in mRNA expression of TLR4. Discussions Voluntary exercise and caloric restriction improved obesity and insulin resistance. While TLR2 expression blunted in obese Zucker rats, TLR4 was the same as shown in lean Zucker rats. Our results did not correspond to previous studies that TLR4 expression was higher in diet-induced obesity rats than in the controls. Voluntary exercise tended to blunt the expression of TLR2, but not TLR4 in obese Zucker rats. Further studies to evaluate TLRs expression in obesity Zucker rats are required. These results suggest that voluntary exercise and caloric restriction might not affect mRNA expressions of TLRs in liver of obese Zucker rats. References Reyna, SM, et al. (2008), *Diabetes*, 57, 2595-2602. Kuo, LH, et al. (2011), *Diabetologia*, 54, 168-179. Oliveira, AG, et al. (2011), *Diabetes*, 60, 784-796.

### URINE TOXIC TRACE ELEMENTS IN PRE AND POSTMENOPAUSAL WOMEN: EFFECTS OF AEROBIC EXERCISE.

Robles, M.C.1, Llerena, F.2, Crespo, C.1, Palomo, R.3, Grijota, F.1, Maynar, M.1, Caballero, M.J.2

*University of Extremadura*

Aluminum (Al), mercury (Hg) and lead (Pb) are non-essential elements in the environment that can become toxic to humans. Al has a role in neurodegenerative processes and is associated with the etiology of Alzheimer (Duce and Busch 2010). Pb and Hg are classified as carcinogenic affecting human health (Koedrith and Seo 2011). Purpose: To evaluate the effect of 6 months of aerobic exercise on urinary excretion of toxic elements in pre and postmenopausal women Method: 45 premenopausal (PRE) (37.40±8.80 yr) and 30 postmenopausal (POST) (51.70±3.81yr) women, all sedentary and living in the same geographical area, were studied before and after a 6 months exercise program based on aerobic dance (60-70% maximal heart rate, 60 min/day, 3 days/week). Before and after the program, VO2 max was measured and overnight fasting urines samples were collected and analyzed by inductively coupled plasma mass spectrometry (ICP-MS). The normality of the variables was assessed using the Shapiro-Wilks test. The Wilcoxon test was used to assess the significance of the differences between before and after exercise, and Mann-Whitney test was used to assess the differences between PRE and POST women. Results: Both groups improved their VO2 max after the aerobic exercise program from 33.87±6.26 to 38.72±8.24ml/min/kg p<0.01 in PRE and from 32.63±6.29 to 37.71±6.70ml/min/kg p<0.01 in POST. No differences were observed between urinary concentrations (expressed in µg/g creatinine) of Al, Hg and Pb in pre and postmenopausal women in basal values (Al 42.61±30.67 PRE vs 35.67±20.78 POST; Hg 2.24±2.19 PRE vs 1.56±0.93 POST and Pb 4.47±6.44 PRE vs 4.90±7.42 POST). After the exercise program, changes were observed to decreased urinary levels of Al, Hg and Pb in both groups, although the decline in Hg and Pb only were statistically significant in postmenopausal women: Al 9.90±6.38 in PRE p<0.00; 10.35±15.57 in POST p<0.00; Hg 0.79±1.09 in PRE; 1.01±1.45 in POST p<0.01; and Pb 0.67±0.75 in PRE; 1.40±1.26 in POST p<0.00. Conclusions: These results suggest that menopause and age does not seem to affect urinary levels of these toxic elements. However, there is a decrease in urinary excretion of Al, Hg and Pb as a possible adaptation to aerobic exercise (Llerena et al. 2011). References. 1. Duce JA, Bush AI. (2010) *Prog Neurobiol*;92:1-18. 2. Koedrith P, Seo YR. (2011) *Int J Mol Sci*;12:9576-95. 3. Llerena F, Maynar M, Barrientos G, Palomo R, Robles MC, Caballero MJ. (2011) *Eur J Appl Physiol* Published Online First: 2 december 2011. DOI 10.1007/s00421-011-2276-6 Acknowledgements Financial support provided by the European Regional Development Fund (ERDF), the Junta of Extremadura (project PRI08B130) and University of Extremadura (project 18.R8.01).

## COMPARISON OF ESSENTIAL TRACE ELEMENTS CONCENTRATIONS IN SERUM OF ATHLETES AND SEDENTARY SUBJECTS

Crespo Coco, C., Llerena Ruiz, F., Maynar Marino, M., Robles Gil, M.C., Grijoa Pérez, F., Calvo, L., Caballero Loscos, M.J.  
UNIVERSITY OF EXTREMADURA

The quality of human life depends on the chemical composition of food and of the surroundings. Recent improvements and new methods in analytical chemistry and increasing fields of environmental investigations have added substantially to our knowledge of the biochemistry of trace elements (Kabata-Pendias and Mukherjee, 2007). Trace elements (zinc, copper, selenium, etc.) are essential for the correct functioning of an organism (Savarino et al, 2001). Purpose: To assess serum levels of essential trace elements in athletes and sedentary people. Method: 23 elite endurance athletes (21.62±4.27 years) and 30 sedentary (23.57±2.53 years) men, all participants lived in the same geographical area. The development of the method and its application in the analysis of serum samples was carried out in an ICP-MS Nexion model 300D (PerkinElmer, Inc., Shelton, CT). Serum samples were stored in 1 mL eppendorf vials at -80 °C. The validity of the methodology was checked by the biological certified reference material. The normality of the variables was assessed using the Shapiro-Wilks test. Student's T test was used to assess the differences between elite athletes and sedentary men. Results: No differences were observed between serum concentrations of Co, Cu and Se. Significant differences were observed in Zn ( $p < 0.001$ ), being higher serum levels in sedentary men than in athletes (645.70±70.84 vs 993.99±100.32 µg/L). Serum levels of Mn ( $p < 0.05$ ), Mo ( $p < 0.05$ ) and V ( $p < 0.01$ ) were higher in athletes than in sedentary men (Mn: 3.766±1.576 vs 1.269±0.358 µg/L; Mo: 0.479±1.548 vs 0.357±0.146 µg/L and V: 0.689±0.507 vs 0.160±0.024 µg/L). Conclusions: These results suggest that physical activity, in particular the high-level training in long distance, does not produce significant changes in serum levels of Co, Cu, and Se (González-Haro et al., 2011). Zn serum levels are lower in athletes than in sedentary, as a possible consequence of the important role of Zn in metabolic processes that occur during exercise. Mn, Mo and V levels are higher in athletes than sedentary men as possibly adaptive consequences. References 1.Kabata-Pendias A, Mukherjee A. (2007) Springer, New York; pp 25-26. 2.Savarino, L, Granchi, D, Ciapetti, G, Cenni, E, Ravaglia, G, Forti, P, Maioli, F, Mattioli, R. (2001) Exp. Gerontol; 36 (2), 327-339. 3.González-Haro C, Soria M, López-Colón JL, Llorente MT, Escanero JF. (2011) Journal of Trace Elements in Medicine and Biology; S54-S58. Acknowledgements The authors gratefully acknowledge the financial support provided by the European Regional Development Fund (ERDF) the Junta of Extremadura (project PRI08B130) and University of Extremadura (project 18.R8.01).

## COMPARISON OF URINE ESSENTIAL TRACE ELEMENTS CONCENTRATIONS IN ATHLETES AND IN SEDENTARY SUBJECTS LIVING IN THE SAME AREA OF EXTREMADURA .

Llerena, F., Robles, M.C.2, Crespo, C.2, Grijoa, F.2, Munoz, D.2, Palomo, R.1, Maynar, M.2, Caballero, M.J.1  
University of Extremadura

Comparison of urine essential trace elements (Co, Cu, Mn, Mo, Se and Zn) concentrations in athletes and in sedentary subjects living in the same area of Extremadura (Spain). Llerena, F.1, Robles MC.2, Crespo C.2, Grijoa, F.2, Muñoz, D.2, Palomo, R.1, Maynar, M.2, Caballero, M.J.1 1: University of Extremadura (Badajoz, Spain), 2: University of Extremadura (Cáceres, Spain). Introduction Trace elements such as cobalt (Co), copper (Cu), manganese (Mn), molybdenum (Mo), selenium (Se), and zinc (Zn) are integral part of important enzymes or coenzymes involved in vital biologic processes. The data about how physical activity affects element metabolism is rather contradictory. It was emphasized that heavy physical exercise led to a redistribution of elements between body stores, blood, and tissues and that the increased losses by sweat and urine in exercise could cause deficiency in some elements pointing out the importance of dietary intake of them (Lukaski et al., 1990, Savas et al., 2007). The present work reports differences in urinary excretion of Co, Cu, Mn, Mo, Se and Zn between athletes with those of age-matched sedentary subjects living in the same geographical area. Methods Middle-distance runners (n=21; age, 21.62±4.3 yr; BMI, 18.25±1.73) and sedentary men (n= 26; age, 22.65±3.6 yr; BMI, 21.81±3.14) participated in this study. Morning midstream urine samples were collected and acidified with 1% (v/v) HNO<sub>3</sub>. Co, Cu, Mn, Mo, Se, and Zn were determined in urine samples using a Perkin-Elmer Elan 9000 inductively coupled plasma mass spectrometry (ICP-MS) with a quadrupole based collision/reaction cell. Creatinine concentrations were measured in all urine samples to take into account the different degree of dilution (Shi et al. 1995). The Mann-Whitney test was performed for statistical analysis. A p value of <0.05 was used to determine statistical significance. Results Concentrations, expressed in µg/g creatinine, of the six trace elements in urine from athletes versus those from sedentary subjects were as follows: Co (0.038±0.08 vs 0.434±0.65  $p < 0.001$ ); Cu (55.180±18.94 vs 19.66±9.93,  $p < 0.001$ ); Mn (2.84±8.99 vs 5.58±10.28,  $p < 0.001$ ); Mo (41.51±20.57 vs 33.14±22.66, not significant (NS)); Se (22.66±5.92 vs 23.49 ±13.54, NS); and Zn (149.9 ±120.8 vs 261.3±214.9, NS). Discussion Urinary Co and Mn concentrations were lower in runners, consistent with the possibility that body attempts to conserve these elements most likely because of organism requirements. The increased excretion of Cu in athletes may be the reason of reported lower serum Cu levels as a result of physical exercise (Savas et al. 2007). Acknowledgements The authors gratefully acknowledge the financial support provided by the European Regional Development Fund (ERDF) and the Junta of Extremadura (project PRI08B130) References Lukaski HC, Hoverson BS, Gallagher SK, Bolonchuk WW (1990). Am J Clin Nutr, 51(6), 1093-1099. Savas S, Senel O, Okan I, Aksu ML (2007). Neuroendocrinol Lett, 28(5), 675-680. Shi HL, Ma YQ, Ma YF (1995). Anal Chim Acta, 312(1), 79-83

## EFFECTS OF EXERCISE TRAINING ON THE BODY COMPOSITION, LIPID METABOLISM, THYROID HORMONE, AND THYROID STIMULATING HORMONE RECEPTOR MRNA IN RAT HYPOTHYROIDISM

Kim, K.  
Keimyung University

EFFECTS OF EXERCISE TRAINING ON THE BODY COMPOSITION, LIPID METABOLISM, THYROID HORMONE, AND THYROID STIMULATING HORMONE RECEPTOR mRNA IN RAT HYPOTHYROIDISM Kim, K.1, Ko, J.1, Ahn, N.1, Byun, J.1, Park, K.1, Kim, S.1, Kim, H.2, Chang, I.3 1: KMU (Daegu, Korea), 2: KMC (Daegu, Korea), 3: CUD (Daegu, Korea) Introduction Hypothyroidism brings negative effects on energy metabolism. It is reported that possibilities of obesity, diabetes and atherosclerosis increase (Fisher, 1996). This study analyzed the mechanism of the depression of metabolic function through the analysis of blood metabolic markers relation to induced hypothyroidism in rat. And this study examined the effects of treadmill exercise on the changes of blood metabolic markers relation to hypothyroidism in rat. Finally, this study suggested the importance of exercise training for the prevention of hypothyroid induced obesity, diabetes, and atherosclerosis. Methods The markers of hypothyroidism and the effects of exercise interventions on thyroid functions were analyzed to measure the function of hypothyroidism in comparison with pre- and post-results of injections in 6-propyl-2thiouracil (PTU) on rats in the study. Results After injections in PTU, rats showed the negative results of bone mineral contents and body composition. Before exercise intervention,

PTU group showed a significant lower value of serum T4 concentration than control group. and PTU-Ex group showed a significant higher values than PTU-non Ex group. But serum T3 concentration showed no significant difference between PTU-Ex group and PTU-non Ex group. Related blood markers on thyroid function as TC and LDL-C showed a significant elevation after injection of PTU. Especially, PTU group showed significant lower values than control group. Discussion These results imply the hypothyroidism increase the prevalence of metabolic syndrome. Hypothyroidism with 6-propyl-2-thiouracil (PTU) had the negative effects on lipid metabolism and metabolic syndrome. It could be suggested the positive effects of exercise training on hypothyroidism by the changes of serum T4 concentration (Mastorakos & Pavlatou, 2005; Ciloglu et al, 2005). References Mastorakos G, Pavlatou M. (2005). *Hormone and Metabolic Research*, 37, 577-584. Ciloglu F, Peker I, Pehlivan A, Karacabey K, İhan N, Saygin O, Ozmerdivenli R. (2005). *Neuroendocrinology Letters*, 626, 830-834. Fisher DA. (1996). *Clinical Chemistry*, 2, 135-139.

### **HUMAN MUSCLE PROTEIN FRACTIONAL BREAKDOWN RATE DETERMINED BY THE DISAPPEARANCE RATE OF PROTEIN-BOUND ALANINE PRE-LABELLED WITH 2H VIA INTAKE OF A SINGLE BOLUS OF 2H<sub>2</sub>O**

Holm, L., Reitelseder, S., Dideriksen, K.J., Nielsen, R.H., Doessing, S., Kjaer, M.

*Bispebjerg Hospital*

**Introduction** We here validate the fractional breakdown rate (FBR) method in a human setting and further test whether the approach by pre-labelling proteins via infusion of a labelled amino acid complies with the assumptions. **Methods** Thirteen healthy and sedentary males were enrolled and started at day0 (zero) by drinking a dose of 5.25 mL 2H<sub>2</sub>O•kg<sup>-1</sup> lean body mass. Eight subjects had 15N-phenylalanine (phe) infused on day70 and had bilateral biopsies from vastus lateralis muscle taken at day80 and 94 to calculate the FBR over the 14 days period based on both the water-derived 2H<sub>4</sub>-alanine and the pre-infused 15N-phe. At day94 an infusion of ring-13C<sub>6</sub>-phe was given to determine the fractional synthesis rate (FSR). Five other subjects had bilateral biopsies taken at day80 and 90 (to calculate FBR), where in between they resistance trained one leg 6-7 times. On day90 they received an infusion of 1,2-13C<sub>2</sub>-leucine to determine the FSR in the rested and exercised muscles. **Results** The intake of 2H<sub>2</sub>O and the infusion of 15N-phe resulted in immediate and prolonged plasma enrichments of 2H-alanine and 15N-phe, respectively. However, during the FBR-measurement period (from day80-94) only the plasma 2H-alanine had dropped to non-detectable levels, whereas the 15N-phe was still abundant in plasma. The myofibrillar protein FBR based on 2H-alanine disappearance over 2 weeks was 0.017±0.001 %•hr<sup>-1</sup> with no difference between legs (p<0.05). In comparison the myofibrillar protein FSR over 4 hours measured by the incorporation of ring-13C<sub>6</sub>-phe was 0.082±0.014 %•hr<sup>-1</sup>. Frequent resistance training during a 10-days period only minorly increased the myofibrillar protein turnover rate (FSR: change 0.0080±0.0008 %•hr<sup>-1</sup>, p<0.05, measured by 1,2-13C<sub>2</sub>-leu incorporation and FBR: rest 0.0061±0.0062 %•hr<sup>-1</sup>, p>0.05). **Discussion** The presence of FBR-tracer in the precursor pool during the period of FBR determination results in a re-incorporation of the tracer and thus, the infusion of labelled phe cannot be used in the present setting. In comparison, the 2H<sub>2</sub>O approach does not seem to inherit this risk of tracer recirculation. We could determine a similar level of muscle protein FBR under the same conditions in two separate experiments and report a good inter-subject coefficient of variation (FBR: 22.2 vs. FSR: 46.9%). However, the FBR seems lower than the corresponding FSR, which warrants further investigation. Using the present experimental setting, exercise did neither have any major effect on muscle contractile protein FSR nor FBR.

### **EFFECTS OF OREXINS ON WATER INTAKE AND PLASMA ANTIDIURETIC HORMONE LEVEL**

Molnár, A.H.1, Kis, G.K.2, Daruka, L.2, Orbán, K.1, Szablics, P.1, Balogh, L.1, László, F.1,2, László, F.A.2, Varga, C.2

*1Institute of Physical Education and Sport Sciences and 2Department of Physiology, Anatomy and Neuroscience*

**Introduction** Orexin-A (OxA) and orexin-B (OxB) play a significant role in the regulation of food intake, energy balance, sleep-wake cycle and muscle tone. Additionally, these anabolic neuropeptides may cause increased water consumption and urinary output (Heinonen et al., 2008). The antidiuretic hormone (ADH) regulates the water balance of the body. It acts on the kidneys, increasing the water permeability of the renal tubules and collecting ducts, leading to increased water reabsorption of water (Wilmore and Costill, 2004). Thus, ADH and indirectly the orexins take part in the regulation of water homeostasis. **Aims** The effects of the centrally administered OxA and OxB on water intake and ADH secretion were investigated. We studied whether there is an interaction between orexins and the effect of ADH on water balance. **Methods** Different doses of orexins (10-30-90 µg/10 µl) and a specific orexin receptor-1 (OX1) antagonist SB 408124 (30 µg/10 µl) were administered intracerebroventricularly (i.c.v.) in male Wistar rats (200-250 g) under anaesthesia. Water consumption was measured for 6 hours. Plasma ADH level elevation was induced by histamine (10 mg/kg) or 2.5% NaCl (10 ml/kg) administered intraperitoneally 15 minutes after OxA or OxB administration. Plasma ADH levels were measured by radioimmunoassay. **Results** Orexins enhanced the water consumption. Most increased water intake was observed after administration of 30 µg/10 µl OxA (11.4±0.86 ml vs. control: 2.73±0.39 ml). OX1 antagonist decreased polydipsia significantly. There were no changes in basal ADH level (5.8±0.45 pg/ml) after administration of orexins. A significant increase in plasma ADH concentration was detected following histamine administration (59.03±1.98 pg/ml) and moderate enhancement was observed after 2.5% NaCl administration (23.65±2.47 pg/ml). I.c.v. OxA (30 µg/10 µl) reduced the histamine- (25.6±0.36 pg/ml) or hyperosmosis-induced (12.5±1.3 pg/ml) increased ADH level. These inhibitory effects were prevented by the specific OX1 antagonist. **Conclusion** We observed that there is an interaction between orexins and the ADH-system. Our results suggest that the effects of the orexins on water consumption or blockade of the histamine and osmotic-induced ADH level increase are mediated by the OX1 receptor. **References** Heinonen MV, Purhonen AK, Makela KA, Herzig KH. (2008). *Acta Physiol (Oxf)*, 192(4), 471-485. Wilmore JH and Costill DL. (2004). *Physiology of Sport and Exercise*, 71-77. (Human Kinetics, Champaign) Support SROP 4.2.2.-08/1-2008-0006, SROP 4.2.1./B-09-1/KNOV-210-0005, János Bolyai Research Scholarship of the Hungarian Academy of Sciences (A.H.M)

### **INFLUENCE OF PERCEIVED STRESS IN HUMAN LYMPHOCYTES DNA DAMAGE: THE ROLE OF HABITUAL PHYSICAL ACTIVITY IN ATTENUATING STRESS AND/OR REDUCING DNA DAMAGE**

Cortinhas, A.1, Bento, T.2, Joao, P.1, Gaivao, I.3, Leitao, J.C.1, Mota, M.P.1

*Universidade de Trás-os-Montes e Alto Douro*

1 UTAD, CIDESD, Vila Real – Portugal; 2 ESDRAM, Rio Maior – Portugal; 3 UTAD, CECAV, Vila Real - Portugal Study financed by FCT (PTDC/DES/121575/2010) **INTRODUCTION** Stress is the result of several factors, such as work demands, fatigue, sleep, diet and others. Psychological stress depends not only on the magnitude and density of the stress factors, but also from subject's perception of his/her own capacities to deal with each situations. Psychological stress has been proposed as an important factor in the pathogenesis and

development of several diseases, and in cancer (1). Oxidative DNA damage has been used to estimate cancer risk, once it causes mutagenesis and carcinogenesis (2). A few studies tried to establish the link between psychological stress, biochemical changes, oxidative stress and DNA oxidative damage. On the other hand, it has been proposed that an active lifestyle is associated with an increased organism protection to oxidative stress, and an increase in the ability to develop psychological strategies of coping with stress events. The aim of the present study was to analyze the influence of daily perceived stress on DNA damage and to verify the possible role of physical activity in reduction of DNA damage and perceived stress. METHODS Thirty healthy men, nonsmokers, above 40 years old, integrated this study. 15 of these subjects had a moderate to vigorous daily physical activity and the remaining ones had sedentary to lower daily physical activity, according to the levels proposed by the ACSM (3). Psychological stress was measured through Perceived stress scale (PSS). Daily physical activity was measured during at least 4 days to 7 days with an accelerometer (ActiGraph). Oxidative DNA damage was quantified by comet assay with FPG enzyme (4). T-test for independent samples were used to analyze differences between groups, and significant level was set at  $p < 0.05$ . RESULTS/DISCUSSION Our results revealed that the most active subjects exhibited lower perception of stress and oxidative damage to DNA. Habitual physical activity induces an increase in endurance capacity, increasing capacity to deal with higher daily workloads and induce hormonal changes associated with an increase in sleep quality and general relaxed state; we believe that higher physical activity contributes to enhance coping abilities to deal with stress events. Moreover, regular physical activity is also related with a decrease of oxidative damage to DNA, possible due to an decrease in oxidant state, but also to the reduction of biochemical changes associated with hormonal changes. References 1. Choen, S. and Herbert, T. (1996). *Annu. Rev. Psychol.* 47:113–42 2. Kasai H. (1997). *Mutation research.* 387(3):147-163. 3. Haskell, W.L., et al. (2007). *Med Sci Sports Exerc.* 39, 1423-1434. 4. Collins AR, et al. (2001). *Mutagenesis.* 16(4):297-301.w

### THE REPRODUCIBILITY OF VO<sub>2</sub> KINETICS DURING WALKING IN PRESCHOOL CHILDREN

Stasiulis, A., Stasiule, L., Capkauskiene, S.

*Lithuanian Academy of Physical Education*

**Introduction** The pulmonary oxygen uptake (pVO<sub>2</sub>) kinetic response at the onset of exercise provides a non invasive method of evaluating aerobic metabolism in muscles during growth and maturation (Armstrong and Barker, 2009). However, to date only limited research has been devoted to investigating the pVO<sub>2</sub> kinetics during exercise in children. Therefore, the aim of this study was to evaluate the reliability of pVO<sub>2</sub> kinetics during six minutes walking on treadmill in preschool children. **Methods** 34 preschool children (19 girls and 15 boys) participated in 2 consecutive treadmill exercise sessions separated by one hour. Their age was 6.7±0.5 years. During each session, pVO<sub>2</sub> was collected at rest and during walking at 6 km per hour and a 4% grade for 6 minutes. The pVO<sub>2</sub> kinetics during exercise was analysed by applying mono exponential function. **Results** No slow component of pVO<sub>2</sub> kinetics was found in any group of children during this mode of exercise. For the two walking sessions VO<sub>2</sub>baseline value was 0,266 ± 0.057 and 0.266± 0.045 L/min., amplitude of pVO<sub>2</sub> response was 0.588 ± 0.072 and 0.577 ± 0.063 L/min., time constant of pVO<sub>2</sub> kinetics was 15.6 ± 3.1 and 16.1 ± 4.2 s, respectively (in all cases  $p > 0.05$ ). **Conclusion** The results of the present study indicate that at least mean values of pVO<sub>2</sub> uptake kinetics may be accurately estimated using two treadmill walking sessions in groups of young preschool children of both genders. **References** Armstrong N, Barker AR. (2009). Oxygen uptake kinetics in children and adolescents: a review. *Pediatr Exerc Sci*, 21(2),130-147.

**13:45 - 14:45**

## Poster presentations

### PP-PM36 Biochemistry

#### PPAR $\alpha$ GENE VARIANTS AS PREDICTED PERFORMANCE ENHANCING POLYMORPHISMS IN PROFESSIONAL ITALIAN SOCCER PLAYERS

Proia, P.

*University*

Proia, P.I, Saladino, P.I, Schiera, G.I, Contro', V.I, Bianco, A.I, Traina, M.I, Palma, A.I 1: UNIPA (Palermo, Italy) **INTRODUCTION** One of the genes of the health-related fitness phenotype is a PPAR $\alpha$  coding for peroxisome proliferator activator receptor alpha, a central regulator of expression of genes involved in fatty acid metabolism. Several polymorphic sites have been identified within the PPAR $\alpha$  gene; most of them are very uncommon or where functionally silent. **METHODS** Sixty professional soccer players and thirty sedentary volunteers were enrolled in the study. Samples of venous blood were obtained at rest in the morning by conventional clinical procedures and allowed to clot at room temperature for 30 minutes and centrifuges. Serum was collected and total cholesterol, high density lipoprotein cholesterol, low density lipoprotein cholesterol and triglycerides were measured by using a kit in a chintic enzyme analyzer. An aliquote of anticoagulant-treated blood was used to prepare total RNA from mononuclear cells. The polymorphic site in PPAR $\alpha$  intron 7 was scanned by using PCR-RFLP protocol with Taq I enzyme. **RESULTS** We found variations among genotype distribution of PPAR $\alpha$ , lipidic profile variation and professional soccer players versus sedentary volunteers. To enphatized this correlation, we also investigated mRNA levels of PPAR $\alpha$  in mononucleate cells. **DISCUSSION** The aim of this study was analyzed the role of polymorphism of PPAR $\alpha$  gene in performance enhancing in italian soccer players, compare with the results obtained by Maciejewska et al 2011 in polish rowers. Our results evidenced a variation of genotype distribution of PPAR $\alpha$  in accordance with previously studies showing that intron 7 G allele as well as GG genotype, are associated with endurance performance (Ahmetov et al, 2006; Eynon et al, 2009). However, our study shows that PPAR $\alpha$  genotype distribution change among analyzed population with varying genetic background. So PPAR $\alpha$  G allele may be considered an endurance relates allele. We can explain this one because PPAR $\alpha$  is an important factor that regulate the balance between fatty acid and glucose metabolism. Moreover, we analyzed the correlation between PPAR $\alpha$  mRNA expression and athletes lipid profile (Proia et al., 2012; Horowitz et al., 2000). **REFERENCES** Maciejewska A, Sawczuk M, Cieszczyk P. (2011). *Journal of Science and Medicine in Sport*, 14, 58-64. Ahmetov II, Mozhayskaya IA, Flavell DM. (2006). *Eur J Appl Physiol*, 97, 103-108 Eynon N, Meckel Y, Sagiv M. (2009). *Scand J Med Sci Sports* doi:10.1111/j.1600-0838.2009.00930 Proia P, Bianco A, Schiera G, Saladino P, Pomara F, Petrucci M, Traina M, Palma A. (2012). *J Sports Med Phys Fitness*, 52, 102-106

## THE TIME COURSE FOR CHANGES IN OXIDATIVE STRESS AND DNA IN RESPONSE TO EXERCISING IN A HOT ENVIRONMENT: THE RELATIONSHIP WITH VO2MAX

Knez, W.L., Kelly, K.B.

*Aspetar, Qatar Orthopaedic and Sport Medicine Hospital*

**Introduction** Exercising in a hot environment is associated with cardiovascular alterations such as an increase in core temperature, dehydration and cardiac drift. However, there is minimal research investigating the time course of changes in oxidative stress and DNA in response to exercise and thermal stress. Additionally, it is not known whether there is a critical point in core temperature for the production of oxidative stress or DNA modification, and whether this relationship is associated with an individual's maximal oxygen consumption (VO2max). Therefore, the first aim of this study was to investigate the time course of changes in indirect markers of oxidative stress and DNA modification during and after an aerobic bout of exercise in a hot environment. Secondly, we sought to determine whether there is a relationship between VO2max and the changes in markers of oxidative stress and DNA modification. **Methods** Eight recreational cyclists (age=30.9±2.2yrs; height=177.9±4.1cm; mass=74.5±4.5kg) completed a cycling VO2max in hot conditions (35°C, 70%RH) to determine 60% of peak power output. One week later the participants returned to the laboratory and cycled at this intensity until they reached a core temperature of 38.5°C. Blood was sampled before, during, and after (0, 10, 25, 35, post 10 and post 20 mins) exercise to determine indirect markers of oxidative stress (malondialdehyde; MDA) and DNA (8-hydroxy-2'-deoxyguanosine oxidation; 8-OHdG) modification. Statistical analysis was completed using linear mixed models with a level of significance set at p≤0.05. **Results** Cycling at 60% of peak power output until core temperature reached 38.5°C resulted in an inverse relationship between VO2max and the production of MDA and 8-OHdG (p<0.047; p<0.001). Additionally, after adjusting for VO2max there was a significant increase in oxidative stress over the exercise bout. Data showed that MDA increased during exercise (0-10, 25, 35 min [0 min post]) and decreased from 0-post to post 20 min recovery. After correcting for multiple comparisons there was a tendency towards significance from 0 mins to the completion of the exercise bout. However, no changes were observed in the modification of DNA during exercise or recovery. No relationship was observed between changes in blood markers and core temperature. **Discussion** Research shows that regular exercise protects against exercise-induced changes in oxidative stress and DNA. This research has also shown that this relationship extends to exercising in a hot environment. In this investigation, higher VO2max was associated with a decrease in both oxidative stress and DNA modification. Changes in oxidative stress appeared to be more sensitive to exercise duration than core temperature. Furthermore, these data showed that there was no critical core temperature for the development of oxidative stress. However, the current project was limited to a maximum core temperature of 38.50C. Future research should continue exercise beyond this point with a larger sample to develop a clearer understanding.

## COMPARISON BETWEEN YOUNG AND ADULT TRACK AND FIELD ATHLETES ON OXIDATIVE STRESS MARKERS

Zalavras, A.

*University of Thessaly*

**COMPARISON BETWEEN YOUNG AND ADULT TRACK AND FIELD ATHLETES ON OXIDATIVE STRESS MARKERS** Zalavras, A.1, Theodorou, AA.1, Nikolaidis, MG.2, Paschalis, V.1, Karatrantou, K.1, Oikonomou, D.1, Fatouros, IG. 3, Koutedakis, Y. 1, Jamurtas, AZ.1 1: UTH (Greece) 2: AUTH (Greece) 3: DUTH (Greece). **Introduction** Reports in the literature suggest that glutathione levels might be different between children and adults (Michelet et al. 1995). Furthermore, glutathione levels were positively correlated with regular physical exercise (Michelet et al. 1995). However, studies comparing the redox status between young and adult individuals are scarce. Therefore, the aim of this study was to compare the antioxidant defense system between young and adult track and field athletes and assess whether it responds differently following an acute bout of aerobic exercise. **Methods** Thirteen young athletes (age: 14.2±1.1; weight: 54.2±8.5; height: 165.6±7.4) and 12 adult athletes (age: 25.2±6.9; weight: 66.9±6.1; height: 175.2±4.5) participated in this study. Blood was collected prior to, immediately post and 1h post an acute exercise bout (45 minutes at 70% VO2max). Blood was analyzed for indices of oxidative stress (reduced glutathione) and the antioxidant defense system (total antioxidant capacity). **Results** A 2X3 (group X time) repeated measures ANOVA did not reveal significant differences between groups nor an interaction effect. However there was a significant difference across time. Glutathione levels were significantly lower (p<0.05) for both groups immediately post exercise and total antioxidant capacity was significantly elevated (p<0.05) immediately post and 1h post exercise. **Discussion** These results indicate that there are no differences in the antioxidant defense system between young and adult track and field athletes. Furthermore, the response to an acute stressor as exercise is similar between the two aged groups. **References** Michelet F, Gueguen R, Leroy P, Wellman M, Nicolas A, Siest G. (1995). Blood and plasma glutathione measured in healthy subjects by HPLC: relation to sex, aging, biological variables, and life habits. *Clin Chem.* 41(10):1509-17.

## CREATINE SUPPLEMENTATION IN FIBROMYALGIA: PRELIMINARY DATA FROM A DOUBLE-BLIND RANDOMIZED CONTROLLED TRIAL

Alves, C.R.R., Santiago, B.M., Benatti, F.B., Tritto, A.C., Campos-Ferraz, P.L., Lancha, J.A.H., Otaduy, M.C., Lima, F.R., de Sá Pinto, A.L., Gualano, B.

*University of Sao Paulo*

**Introduction** Recent evidence has suggested that low muscle phosphocreatine (PCr) content could be implicated in pain and muscle weakness seen in fibromyalgia (FM). Moreover, non-controlled studies have suggested a beneficial effect of creatine (Cr) supplementation in this syndrome. However, no randomized controlled trial has been conducted so far. **Purpose** To explore the possible therapeutic effects of Cr supplementation on muscle function, muscle strength and renal function in FM patients. **Methods** This was a 16-week randomized double-blind placebo-controlled trial. Twenty women diagnosed with fibromyalgia were randomly assigned into two groups: i) placebo (Pl; n = 10), and ii) Cr (Cr; n =10). The Cr group received 20 g/day of Cr for 5 days followed by 5g/day for 16 weeks. The Pl group received the same dose of dextrose. At baseline (PRE) and after 16 weeks (POST 16), we assessed: i) PCr concentration in gastrocnemius by in vivo magnetic resonance spectroscopy (MRS); ii) muscle strength by 1-repetition maximum (1-RM) test in the bench press and leg press; iii) muscle function by Timed-Up-and-Go test. Data were expressed as absolute changes (delta) from POST 16 to PRE and tested by Unpaired Student's T test. Effect Sizes (cohen's d) were also calculated. **Results** After 16-weeks of supplementation, PCr concentration was higher in the Cr group versus the Pl group (p = 0.05). Performance in the Bench press and leg press 1-RM and in the Timed-Up-and-Go test were also greater in the Cr group when compared to the Pl group (bench press: Pl = -2.6 ± 1.8, ES = -0.22 vs. Cr = 0.5 ± 2.6, ES = 0.09; p = 0.005; leg Press: Pl = -0.6 ± 7.5 Kg, ES = -0.21 vs. Cr = 4.6 ± 4.9 Kg, ES = 0.31; p = 0.05 and Timed-Up-and-Go test: Pl = 1.0 ±

2.2, ES = -0.69 vs. Cr = -0.12 ± 0.56, ES = 0.11; p = 0.07). Furthermore, albuminuria, proteinuria, serum and urinary creatinine, serum urea, serum and urinary sodium and potassium were not altered following the intervention (p>0.05). Conclusion In a small cohort of FM patients, Cr supplementation increased muscle PCR concentration, resulting in improvements muscle function and muscle strength. No adverse effect of Cr upon renal function was noted. This study will be expanded with a longer-term follow-up, larger sample and additional measurements related to FM symptoms (e.g., pain and quality of life) in order to confirm or not the therapeutic value of Cr in such a condition.

### THE ANABOLIC-ANDROGENIC STEROIDS EXERT DIRECT TOXIC EFFECTS ON NEURON-LIKE CELLS

Proia, P.

*University*

Basile, JR.1,2, Binmadi, NO.3, Zhou, H.1, Yang, Y.1, Proia, P.1,4 1: UMB (Baltimore, USA), 2: GCC (Baltimore, USA), 3: KAU (Saudi Arabia), 4: UNIPA (Palermo, Italy). **INTRODUCTION** Intake of AAS by athletes and others in an attempt to gain muscle strength and improve performance is often associated with toxic effects on the liver, the cardiovascular system, the male and female reproductive systems, and the central nervous system (Trifunovic et al., 1995). In vivo administration of high doses of androgens has been linked to neurobehavioral changes that could be the outward manifestation of neuronal damage. **METHODS** PC12 cells are a cell line that have been widely used as a model in neurobiological investigations (Fujita et al., 1989; Vaudry et al., 2002). Following exposure to nerve growth factor (NGF), PC12 cells differentiate into a sympathetic-like neuron and develop extensive neuritic processes. Differentiated PC12 cultures, were treated with steroid hormones, methandienone and 17- $\alpha$ -methyltestosterone at final concentrations of 75  $\mu$ M in complete medium, for 24 h. After treatment several analysis were performed on total proteins and RNA samples, as well as immunofluorescence analysis and vitality assay. **RESULTS** Genomic effects of AAS treatment, was found. The experimental procedures described above showed that anabolic steroid hormones induced cell death by activation of the apoptotic pathway that include caspase-3 activation, HSP90 cleaved as well as PARP (Santamarina RD et al., 2008). **DISCUSSION** These preliminary experiments demonstrate that AAS cause an alteration of cellular pathways that control cell survival and differentiation. Particularly, we showed that cell extracts prepared from anabolic steroid hormones-treated PC12 cells showed caspase-3 activity and the PARP (the main substrate of protease activity) is cleaved during this death process. In our studies, we also confirmed the cleavage of HSP90 after 24 hours PC12 cells treatment with methandienone and 17- $\alpha$ -methyltestosterone, when we used a suprapharmacological concentrations, that means an activation of the apoptotic pathway. However, we saw a neuritin increases correlated with a loss of neurites. This protein is an important effector of androgen in enhancing peripheral nerve regeneration following injur. This discrepancy could be attributable to the high concentrations of AAS used in our study, which were an attempt to approximate the excessive amounts of steroids used by athletes to enhance performance. **REFERENCES** Trifunovic B, Norton GR, Duffield MJ, Avraam P, Woodiwiss AJ. (1995) *Am. J. Physiol*, 268, 1096–1105. Fujita K, Lazarovici P, Guroff G. (1989) *Environ. Health Perspect*, 80, 127-142. Vaudry D, Stork PJ, Lazarovici P, Eiden LE. (2002) *Science*, 296, 1648-1649. Santamarina RD, Besocke AG, Romano LM, Ioli PL, Gonorazky SE. (2008) *Clin Neuropharmacol*, 31, 80–85.

### THE EXPRESSION OF FGF21 BY MECHANICAL STRETCHING IN C2C12 MUSCLE CELLS

Tanimura, Y.1, Aoi, W.2, Mizushima, K.1, Naito, Y.1, Yoshikawa, T.1

*1: Kyoto prefectural University of Medicine (Kyoto, Japan), 2: Kyoto prefectural University (Kyoto, Japan)*

**Introduction** Fibroblast growth factor 21 (FGF21) is a novel metabolic regulator and controls glucose and lipid metabolisms (Kharitononkov et al., 2005). We reported that the expression of FGF21 in skeletal muscle is elevated by exercise in mice, and this elevation is associated with phosphorylation of Akt (p-Akt) (ECSS 2011, Liverpool). In this study, we investigated whether mechanical stretching in mouse C2C12 cells induces the expression of FGF21 using an in vitro experimental model. **Methods** Mouse C2C12 myoblasts were cultured in high glucose Dulbecco's modified Eagle's medium (DMEM) supplemented with 10% fetal bovine serum in a 10-cm<sup>2</sup> elastic silicone chamber precoated with 0.05% porcine type I collagen at 37°C. To induce cell differentiation, the medium was changed to low glucose DMEM supplemented with 2% horse serum for 96 h. To determine the effects of mechanical stretching, the cells were stretched using an NS-200 apparatus driven by a computer-controlled stepping motor. Then, an 8% uniaxial sinusoidal stretch was applied at 1 Hz for 60 min (Nakai et al., 2010). Immediately after the treatments, C2C12 were then scraped and lysed. Cell lysates were prepared for quantitative analysis of FGF21, p-Akt, and Akt. **Results** Mechanical stretching increased the expression of FGF21 in C2C12. Additionally, we could identify the increase of p-Akt in C2C12 by the stretching, although total Akt was not changed. **Discussion** We investigated the effect of mechanical stretching on the expression of FGF21 in C2C12. This treatment increased the expression of FGF21 along with phosphorylation of Akt. These observations supported our previous study, which the increase of p-Akt by acute exercise induced FGF21 in skeletal muscle. In conclusion, the expression of FGF21 in C2C12 depends on the increase of p-Akt via mechanical stretching. **References** Kharitononkov, A., Shiyanova, T. L., Koester, A., Ford, A. M., Micanovic, R., Galbreath, E. J., Sandusky, G. E., et al. (2005). FGF-21 as a novel metabolic regulator. *The Journal of clinical investigation*, 115(6), 1627-35. Nakai, N., Kawano, F., Oke, Y., Nomura, S., Ohira, T., Fujita, R., & Ohira, Y. (2010). Mechanical stretch activates signaling events for protein translation initiation and elongation in C2C12 myoblasts. *Molecules and cells*, 30(6), 513-8.

### REGENERATIVE POTENTIAL OF SKELETAL MUSCLE IN ELITE GRECO-ROMAN WRESTLERS

Kasperska, A.1, Ostapiuk-Karolczuk, J.1, Zurek, P.1, Wolny, R.2, Hubner-Wozniak, E.3, Zembron-Lacny, A.1

*1: FPC Gorzow Wilkp. USPE (Poznan, Poland), 2: PWF (Poland), 3: UPE (Warsaw, Poland).*

**Introduction** The process of skeletal muscle regeneration is due to the activation of satellite cells, which proliferate and differentiate to form new myotubes. In regeneration the key role play hydrogen peroxide, nitric oxide, cytokines and growth factors which may come from many sources like, muscles and/or motor nerves and inflammatory cells. During recovery, most of these molecules have been released and could be useful in assessment of muscle regeneration in athletes (Hawke and Garry, 2001). The purpose of the study was to estimate the regenerative potential of skeletal muscle in elite Greco-Roman wrestlers compared to non-athletes. **Methods** Greco-Roman wrestlers, members of national team were observed during preparatory training period (pre-season January). In blood were measured concentrations of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), nitric oxide (NO), pro-inflammatory cytokines (IL-1 $\beta$ , TNF $\alpha$ ), hepatocyte growth factor (HGF), insulin-like growth factor (IGF-I), platelet-derived growth factor (PDGF-BB) and brain-derived neurotrophic factor (BDNF). Total creatine kinase (CK) activity was determined as a marker of muscle damage. Body composition were estimated using a bioelectrical impedance (Tanita, Japan). Healthy and untrained men made a reference group. **Results** The H<sub>2</sub>O<sub>2</sub> concentration was higher in non-athletes, oppo-



site to NO that was higher in wrestlers. The positive correlations was observed between NO and BDNF ( $r=0.641$ ,  $P<0.001$ ). The level of TNF $\alpha$  was 7-fold higher in wrestlers. Athletes with very high values of IL-1 $\beta$  and TNF $\alpha$  demonstrated the low level of growth factors and delay in regeneration of damaged muscles. IGF-I, PDGF-BB and BDNF was increased in wrestlers, in opposite to HGF that was lower in wrestlers compared to non-athletes. Individual analysis of IGF-I, PDGF-BB and BDNF revealed significant changes in highly qualified wrestlers. The activity of CK in wrestlers was measured for three days after strenuous training. The negative correlation was between percentage changes of CK and IGF-I ( $r=-0.755$ ,  $P<0.001$ ). CK activity was even 4-9-fold elevated in wrestlers. Analysis of body mass showed that wrestlers have lower fat mass (FM) but free fat mass (FFM) was higher than in non-athletes. Discussion We have concluded that wrestling training at high intensity has significant influence on growth factors and increase of hydrogen peroxide and nitric oxide. The release of pro-inflammatory cytokines and growth factors is related to athlete's fitness level, and effects on skeletal muscle regeneration. References Hawke TJ, Garry DJ. (2001). *J Appl Physiol* 91, 534-551. Acknowledgments This study was supported by a grant from National Science Centre Poland: 2011/01/N/NZ7/05282.

### STRESS PROTEIN AND GLUTATHIONE RESPONSES TO 90-MIN INTERMITTENT CYCLING FOLLOWING ALKALOSIS

Peart, D., Kirk, R., Siegler, J., Vince, R.

*University of Hull*

Introduction Inducing a pre-exercise alkalosis with sodium bicarbonate (NaHCO<sub>3</sub>) has been shown to attenuate intra-cellular heat shock protein 72 (HSP72) and lipid peroxidation (TBARS) following a single 4-min bout of anaerobic exercise (Peart et al. 2011). The response of HSP72 is said to be related to exercise duration (Fehrenbach et al. 2005), and the validity of TBARS to examine oxidative stress has been questioned (Powers et al. 2010). Therefore the aim of this study was twofold, firstly to examine whether NaHCO<sub>3</sub> attenuates a more pronounced expression of HSP72 following a longer exercise protocol, and secondly to further examine the effect of NaHCO<sub>3</sub> on oxidative stress by observing glutathione activity and the expression of heme oxygenase-1 (HO-1). Methods Six physically active males ( $23.2 \pm 2.9$  years,  $179.5 \pm 5.5$  cm,  $76.5 \pm 6.8$  kg, and PPO  $315 \pm 36$  W) performed 90-min of intermittent cycling on three occasions. Visit 1 was a familiarisation to the exercise and the following visits were the experimental (SB = 0.3 g.kg.BW<sup>-1</sup> sodium bicarbonate) and placebo (PL = 0.045 g.kg.BW<sup>-1</sup> sodium chloride) trials completed in a blinded and randomised manner. Venous blood for the analysis of HSP72 and HO-1 were taken pre-exercise and the 0-, 45-, 90- and 180-min post-exercise. Both HSP72 and HO-1 were analysed in monocytes via flow cytometry. The percentage of oxidised to total glutathione (GSSG/TGSH) was analysed pre-exercise, and then 0-, 45- and 90-min post-exercise using a commercially available assay kit. Results HSP72 and the percentage of GSSG/TGSH were significantly increased in both conditions from 45-min post-exercise ( $p \leq 0.014$ ), with no differences between trials. HO-1 was also significantly increased in both trials from 45-min post-exercise ( $p \leq 0.016$ ), and the increase was significantly higher in PL compared to SB ( $p = 0.036$ , 183 and 66% respectively). Discussion NaHCO<sub>3</sub> had no effect upon HSP72, contrary to previous research reporting an attenuation following 4-min of high intensity cycling (Peart et al. 2011). Discrepancies between these studies are likely to be due to the differing exercise intensity and duration, and these results may suggest that alkalosis only attenuates HSP72 when there is a sufficient disruption to acid-base balance. Both GSSG/TGSH and HO-1 indicated the presence of oxidative stress, however only HO-1 was attenuated by NaHCO<sub>3</sub>. Differences may be due to the fact that HO-1 has previously been shown to be sensitive to changes in acid-base status (Christou et al. 2005). References Christou et al. (2005) *Am J Heart Circ Physiol*, 288, 2647-52 Fehrenbach et al. (2005) *Int J Sports Med*, 26, 552-57 Peart et al. (2011) *J Sci Med Sport*, 14, 435-440 Powers et al. (2010) *Int J Sport Nutr Exerc Metab*, 20, 2-14

### MUSCLE ATROPHY OCCURS HETEROGENEOUSLY AFTER CAST IMMOBILIZATION IN MOUSE SOLEUS MUSCLE

Sudo, M., Tsubuko, T., Tomiga, Y., Eshima, H., Ando, S., Tanaka, H., Higaki, Y.

*Fukuoka Univ.*

Introduction Skeletal muscle is a highly plastic tissue, and its physiological responses are dependent upon the amount of mechanical load on the tissue. A number of studies have found that physical inactivity induces significant muscle atrophy (e.g., Frimel et al., 2005). However, whether muscle atrophy occurs heterogeneously in a muscle remains to be elucidated. The purpose of this study was to examine the heterogeneity of muscle atrophy induced by cast immobilization for 1 week. Methods Male C57BL/6J mice aged 10 weeks were subjected to unilateral hind limb cast immobilization for 1 week. This study involved three groups ( $n = 5-6$  for each condition): (1) cast immobilization group (Cast), (2) non-cast immobilization in the contralateral hind limb group (N-Cast), and (3) untreated control group (CON). In the Cast group, unilateral ankle joints were stabilized with plaster casts under anesthesia. Ankle joints were fixed in full plantar flexion, and the soleus muscle was immobilized in a shortened position. The soleus muscle was dissected after cast immobilization. Muscle sections were histochemically stained. We measured the cross-sectional area to assess muscle atrophy from the proximal, middle, and distal sections of the soleus muscle. Muscle damage was evaluated from stained cross-sections as the relative number of damaged fibers in relation to intact fibers. Results After 1 week of cast immobilization, the soleus muscle weights were significantly lower in the Cast ( $0.28 \pm 0.04$  mg/body weight) compared with the CON group ( $0.36 \pm 0.03$  mg/body weight) ( $p < 0.01$ ). Muscle atrophy was severe in the middle myofibers ( $693 \pm 182 \mu\text{m}^2$ ) compared with the proximal ( $1127 \pm 336 \mu\text{m}^2$ ) and distal ( $1235 \pm 300 \mu\text{m}^2$ ) portions of the soleus muscle. Myofiber damage frequently occurred in the immobilized mice (Cast,  $2.45\% \pm 3.12\%$ ; N-Cast,  $2.81\% \pm 3.66\%$ ) compared with the CON mice ( $0.18\% \pm 0.18\%$ ). The occurrence of myofiber damage did not differ among the proximal, middle, and distal portions in all groups. Discussion The present findings suggest that the middle portion of the soleus muscle may be more vulnerable to physical inactivity than the proximal and distal portions. A decrease in mechanical load by cast immobilization may heterogeneously lead to muscle atrophy. We conclude that after 1 week of cast immobilization, muscle atrophy was greater in the middle than in the proximal and distal portions of the soleus muscle. Reference Frimel TN, Kapadia F, Gaidosh GS, Li Y, Walter GA, Vandenborne K. (2005). *Muscle Nerve*, 32, 672-674.

### IN VIVO MUSCLE VOLUME AND PHYSIOLOGICAL CROSS\_SECTIONAL AREA OF HUMAN TRUNK MUSCLES

Ikegawa, S., Okazaki, H., Suzuki, Y., Okabe, N., Kumagawa, D., Takahashi, Y., Tanaka, S., Tsunoda, N.

*Jumoni University*

IN VIVO MUSCLE VOLUME AND PHYSIOLOGICAL CROSS\_SECTIONAL AREA OF HUMAN TRUNK MUSCLES Shigeki Ikegawa 1, Hitomi Okazaki 1, Yukari Susuki 1, Naoko Okabe 1, Daisuke Kumagawa 2, Yusuke Takahashi 3, Shigeharu Tanaka 3, Naoya Tsunoda 3 1:Jumoni University, 2:Japan Institute of Sports Science, 3:Kokushikan University Introduction The structure of muscle is a important factor of its function. Fascicle length determine the excursion of muscle and physiological cross-sectional area(PCSA) determin the force-generating

capacity. Such studies were mainly in the upper and lower limbs. Trunk muscles have valuable task for control of body posture, protect the abdominal area, and suspend the spine. Therefore, the aim of the present study is to determine the muscle volume and physiological cross-sectional area of trunk flexors and extensors using magnetic resonance imaging (MRI). Methods Serial cross-sectional images of the trunk were obtained for nine healthy females by MRI. From the obtained images, anatomical cross-sectional area (ACSA) of Rectus Abdominis (RA), Psoas Major (PM), Quadratus Lumborum (QL, proximal and distal) and Erector Spinae + Multifidus (ST: Spinal Thoracis, LT: Longissimus Thoracis, IL: Iliocostalis Lumborum, M: Multifidus) were measured. Muscle volume of each muscle and muscle group were calculated as sum of ACSA between most proximal to distal images. PCSA was calculated from the muscle volume divided by muscle fiber/muscle length ratio reported by former cadaver studies. Result Mean muscle volume of trunk flexors indicated 165.4 cm<sup>3</sup> for RA and 147.2 cm<sup>3</sup> for SM. Trunk extensor muscle volume were 23.9, 13.1, 18.6, 134.1, 113.8, 133.7 for the QLprox and QLdist and ST and LT and IL and M. Mean fiber length of RA was 29.2 cm. This fiber length was four to eight times longer than other muscles. Mean PCSA of M indicated 23.6 cm<sup>2</sup>, from two to six times larger than other muscles. Discussion Comparing the PCSA data of present study and Delp et al (1991), all the data of present study is larger than previous study. It is considered that shrinkage of the cadaver affect this difference. As reported by Ward et al (2009), the greater PCSA and shorter fiber length suggest that M is structurally designed to generate large forces over narrow range of muscle length. This is due to the valuable task of M to stabilize the spine. On the contrary, RA have longer muscle fiber and smaller PCSA. Comparing the trunk extension, trunk flexion is wide range of motion of body. It is considered that trunk flexor and extensor muscles are purposely-designed structures. References Delp S, Suryanarayanan S, Murray W, Uhlir J, Trillo R. (1991). *J Biomech*, 34, 371-375 Regev G, Kim C, Tomiya A, Lee P, Ghofrani H, Garfin S, Lieber R. (2011). *Spine* Ward S, Kim C, Eng C, Gotshalk L, Tomiya A, Garfin S, Lieber R. (2009). *J Bone Joint Surg Am*, 91, 76-85

**13:45 - 14:45**

## Poster presentations

### PP-BN08 Sport Biomechanics 5

#### EFFECT OF HOME EXERCISE PROGRAM ON ISOMETRIC LEG EXTENSOR STRENGTH, POSTURAL STABILITY AND PLANTAR PRESSURE IN WOMEN WITH GONARTHROSIS

Rätsepsoo, M.1,2, Gapeyeva, H.1,2, Sökk, J.1,2, Ereline, J.1,2, Haviko, T.3, Märtson, A.3, Päsuke, M.1,2

*University of Tartu*

Introduction: It has been found that patients with gonarthrosis experience decreased postural stability and muscle strength (Hurley et al., 1997; Hassan et al., 2001) and present weight bearing asymmetry (Christiansen & Stevens-Lapsley, 2010). Aim of this study was to investigate the effect of resistance exercises on isometric strength of leg extensors, postural stability and plantar pressure in women with late stage gonarthrosis. Methods: Ten women with gonarthrosis aged 46-72 years who were scheduled for unilateral total knee arthroplasty (TKA) participated in this study. All patients performed home exercise program (HEP) which included resistance and balance exercises during 2 months. Isometric maximum voluntary contraction (MVC) of leg extensors was measured with custom made leg bench. Postural stability characteristics (30 s bipedal standing, eyes open) were recorded on a dynamographic force plate. Plantar pressure distribution characteristics were measured with a digital biometric images scanning system (Italy). Results: Significant improvement ( $p < 0.01$ ) in unilateral maximum peak torque (MPT) of the involved leg and bilateral MPT ( $p < 0.001$ ) was found after 2 months of HEP. Patients had an increase ( $p < 0.05$ ) in peak torque:body mass (MPT:BM) ratio of the involved leg and bilateral MPT:BM ( $p < 0.001$ ) ratio after 2 months of HEP. MPT and MPT: BM ratio of the involved leg were significantly lower compared to uninvolved leg ( $p < 0.05$ ) before HEP, but not after HEP. Plantar pressure distribution and center of pressure sway characteristics (anteroposterior and mediolateral displacement, trace length and area) did not differ significantly 2 months after HEP. Discussion: After two months of home exercise program isometric strength of leg extensors remarkably increased in women with late stage gonarthrosis; therewith no changes were found in postural stability and plantar pressure distribution characteristics. References: 1. Hassan BS, Mockett S, Doherty M. *Ann Rheum Dis* 2001; 60: 612-618. 2. Hurley MV, Scott DL, Rees J, Newman DJ. *Ann Rheum Dis* 1997; 56: 641-648. 3. Christiansen CL, Stevens-Lapsley JE. *Arch Phys Med Rehabil* 2010; 91(10): 1524-1528. Acknowledgements: This study was partly supported by the Estonian Ministry of Education and Research project SF0180030s07, Estonian Science Foundation project 7939 and EU FP7 project GA-223576.

#### MOVEMENT PATTERN OF THROWING DRAG-FLICK OF THE U-21 FIELD HOCKEY

Antonio, R., López de Subijana, C., Navarro, E.

*Sport Sciences Faculty- Technical University of Madrid- Madrid-Spain*

Introduction In field hockey, the drag-flick is one of the most effective throwing in penalty corner (McLaughlin, 2007; Piñero, 2008). The objectives of this study were to describe the sequence of linear velocities of the kinematic chain during the drag-flick and to determine the throwing patterns of sample players. Methods The sample were three men (19,8 ± 0,9 years-old; 69,9 ± 7,2 Kg.; 177,4 ± 6,8 cm and 5 ± 1 years of experience in the skill) and a woman (18,8 years-old; 71,6 Kg.; 171,3 cm and 6 years of experience in the skill) participated in this study. They were all drag-flickers and members of the under-21 Spanish national team. Each player executed 20 drag-flicks. Six automatic capture Vicon cameras sampling at 250 Hz were used to capture the positions of the reflective markers. For the normality of the distribution a Kolmogorov-Smirnov test was made. Not all variables meet the criteria of normality and a Kruskal-Wallis and Mann-Whitney test were done to determine and to quantify the differences between variables ( $\alpha = 0,05$ ). Later the Bonferroni's correction was applied which placed the significant level at  $\alpha/6 = 0,00833$ . Results and Discussion The results confirmed the existence of a proximal-distal sequence of movements of the kinematics chain of the body segments (Brétigny, Seifert, Leroy & Chollet, 2008; López de Subijana, Juárez, Mallo & Navarro, 2010). The relative timing (TRel) of movement was determined by the instants when the maximal speeds were reached. They provided relevant information about the coordination of this skill. Based on the TRel it has been described different patterns of drag-flick. Conclusions It has been established ranges of time to describe the most effective pattern for these throwers. Acknowledge This study was funded by the Spanish Sport Council (Ref n= P08-1110-338) References Brétigny, P., Seifert, L., Leroy, D., & Chollet, D. (2008). Upper-Limb Kinematics and Coordination of Short Grip and Classic Drives in Field Hockey. *Journal of Applied Biomechanics*, 24 (3), 215-223. López de Subijana, C., Juárez, D., Mallo, J. & Navarro, E. (2010). Biomechanical analysis of the penalty-corner-drag-flick of elite male and female

hockey players. *Sports Biomechanics*, 9, 72-78. McLaughlin, P. (1997). Three-dimensional biomechanical analysis of the hockey drag flick: full report. Belconnen, A.C.T.; Australia: Australian Sports Commission. Piñeiro, R. (2008). Observación y análisis de la acción de gol en hockey hierba. Sevilla: Wanceulen.

### DYNAMICS OF CG DURING ACCELERATION OF MAXIMAL SPRINT

Nagahara, R.1,2, Matsuo, A.3, Matsubayashi, T.3, Zushi, K.1

1: University of Tsukuba (Tsukuba, Japan), 2: JSPS Research Fellow, 3: Japan Institute of Sports Sciences (Tokyo, Japan)

DYNAMICS OF CG DURING ACCELERATION OF MAXIMAL SPRINT Nagahara, R.1,2, Matsuo, A.3, Matsubayashi, T.3, Zushi, K.1 1: University of Tsukuba (Tsukuba, Japan), 2: JSPS Research Fellow, 3: Japan Institute of Sports Sciences (Tokyo, Japan) Introduction Running speed of maximal sprint is usually approximated by exponential equation (Chelly and Denis, 2001; Volkov and Lapin, 1979). This approximation is based on the idea which the acceleration of sprinters gradually becomes small. On the other hand, it is generally thought that the height of whole body centre of gravity (CG) during acceleration of maximal sprint becomes high with increasing running speed. However, a previous study showed that the increasing running speed during maximal sprint changed like a cubic curve (Nagahara, 2009). Moreover, in practical side, the acceleration of maximal sprint is divided into two or three sections. Thus, the purpose of this study was to clarify whether the running speed and height of CG during acceleration of maximal sprint gradually increase or not. Methods Twelve male sprinters (age  $21.6 \pm 2.6$  yr, stature  $1.74 \pm 0.04$  m, body mass  $68.1 \pm 4.1$  kg and the best time of 100 m race  $10.71 \pm 0.33$  s) participated in this study. The subjects performed 60 m sprint twice with maximal effort started by crouch position as used in 100 m race. The time of 60 m sprint was measured using photocell connected starting gun and VICON motion-capture system. Whole running motion from start to 50 m mark was recorded using VICON system consisted by sixty cameras (250Hz). The coordinates of segment endpoints were obtained by filtering and CG were calculated. Results and Discussion Time of 60 m sprint was  $7.24 \pm 0.16$  s. As a typical result, the height of CG increased to the 11th step, and then leveled off to the 18th step, and gradually decreased thereafter while the running speed still increased. At the same spot, the 11th step, the acceleration shifted to constant and decreased again thereafter. These are novel and unexpected results and suggest that the sprinters accelerate with unsteady change of running speed and height of CG. References Chelly SM, Denis C. (2001). *Med. Sci. in Sports*, 33, 326-333. Nagahara R, Ae M, Tanigawa S, Koyama H. (2009). In: *Proceedings of ISB 22nd Congress*. Volkov NI, Lapin VI. (1979). *Med. Sci. in Sports*, 11, 332-337.

### EFFECT OF PROPHYLACTIC TRAINING ON A POTENTIAL RISK FACTOR FOR FUTURE ACL INJURY; A RANDOMIZED CONTROLLED TRIAL

Petersen, M.B.1, Bencke, J.1, Lauridsen, H.B.1, Curtis, D.1, Bandholm, T.1, Thorborg, K.2, Hölmich, P.2, Andersen, L.L.3, Myklebust, G.4, Aagaard, P.5, Zebis, M.K.5,1

1 Copenhagen University Hospital, Hvidovre, Denmark, 2 Copenhagen University Hospital, Amager, Denmark, 3 NRCWE, Denmark, 4 Oslo Sport Trauma Research Center, Norway, 5 University of Southern Denmark

Introduction Young female soccer and handball players are at highest risk of sustaining an ACL-injury (Lind et al. 2009). Most non-contact ACL-injuries occur during sidecut manoeuvres (Olsen et al. 2004). A potential risk factor during sidecutting is a high vastus lateralis (VL) and low semitendinosus (ST) neuromuscular activity just before foot strike (Zebis et al. 2009). The present study examined the effect of 12 weeks of prophylactic training on the VL-ST pre-activity difference in young female athletes. Methods Forty young female soccer and handball players (age  $15.7 \pm 0.5$  years, weight  $63.7 \pm 10.8$  kg, height  $168 \pm 5.6$  cm) were randomized to prophylactic neuromuscular training (NMT, n=20) or control group (Con, n=20). In the NMT-group, 12 weeks of prophylactic training (Olsen et al. 2005) was implemented 3/week while the Con-group continued their regular warm up exercises. VL and ST muscle activity (EMG) was measured during a sidecutting manoeuvre in the 50 ms time interval prior to foot strike on a force plate (AMTI). EMG activity was normalized to peak EMG amplitude recorded during MVC. A per protocol analysis was performed on players who remained uninjured and who had undergone at least 10 weeks of full training and match play, (NMT, n=15) and (Con, n=10). Results In the Con-group neuromuscular pre-activity of the ST was significantly lowered ( $P=0.011$ ) and the VL-ST pre-activity difference significantly increased ( $P=0.046$ ) compared with the NMT-group. In the Con-group, seven players suffered an injury in the lower extremity compared to one player in the NMT-group ( $P=0.04$ ). Discussion Twelve weeks of prophylactic training prevented a decrease in the neuromuscular activity of the ACL-agonist ST in young female soccer and handball players. Further, the increase in VL-ST pre-activity difference in the Con-group implies a reduced capacity for knee joint stabilization during high-risk movements like the sidecut manoeuvre. References 1. Lind et al. 2009, *Knee.Surg.Sports Traumatol.Arthrosc.* 17, 117-124 2. Olsen et al. 2004, *Am.J.Sports Med.* 32, 1002-1012. 3. Zebis et al. 2009, *Am.J.Sports Med.* 37, 1967-1973. 4. Olsen et al. 2005, *BMJ* 330, 449.

### ANKLE SPRAINS ON SOCCERS AND BIOMECHANICAL REPERCUSSIONS

Leiras, J., Villas-Boas, J.P., Sousa, F.

FADEUP

ANKLE SPRAINS ON SOCCERS AND BIOMECHANICAL REPERCUSSIONS Leiras, J.1, Villas-Boas, J. P.1,2, Sousa, F.1,2 1 CIF2D, Faculty of Sports, University of Porto, Porto, Portugal 2 Porto Biomechanics Laboratory (LABIOMEPI), University of Porto, Porto, Portugal Soccer is considered by F.I.F.A. the most popular sport in the world. Increasing the volume and intensity of games and practices the incidence of the injuries also increases. The ankle injuries are very common, since takes several functions of mobility and stability associated with jumping, running and sudden changes in movement direction. The ankle sprain is an acute effect of soft tissue, and occurs more often in the ligaments of the ankle joint complex. Regarding the mechanism of injury, most ankle sprains occur in inversion movements (Giza et al. 2003), many of which prove highly disabling for sports and conditioning of the load support. The main objective of this study was to determine the incidence, severity and biomechanical effects of ankle sprains in soccer players of the Portuguese League. Forty six soccer players aged  $27.1 (\pm 4.3)$  years, of  $178.8$  cm ( $\pm 5.4$ ) height and  $79.0$  kg ( $\pm 6.42$ ) body mass, were evaluated. A first observational and exploratory podiatric analysis was conducted, which included a static evaluation of body composition, morphology of the foot and lower extremity alignment. A Podoscope, a Goniometer, a Perthes ruler, a Pelvimeter, a Pedigraph, and Footscan plate, was used. The registration of all injuries occurred during two sportive seasons was done, including: type of injury, mechanism and treatment. Of the players assessed, twelve (26%) suffered ankle sprains by inversion, predominantly in the support foot, mainly of grade II, with an average duration of treatment of 2-4 weeks. About 40% of subjects had two or more sprains, which shows a high recurrence rate, occurring more commonly in the competitive period (65%). The gait of the individuals who suffered sprains had specific features to highlight: less time of total contact of

the foot, and difficulty in sustaining balance. A larger pressure displacement from lateral to medial was found at the initial contact stage and at the support phase of the forefoot, and lower lateral displacement of the pressure at the digital elevation stage. They was also decreased the range of motion of extension of the 1st metatarso-phalangeal joint, which hinders the ability to accommodate the load and motion control, and the contact on the 1st metatarsal was anticipated. However, the maximum peak pressure occurred in the 1st ray, which is related to a radius hypermobile in individuals with sprains by inversion. It should also be noted that the sprains occur mostly in the mid-field players. This study allowed us to conclude that sprains trigger specific biomechanical changes, both at the time of full contact of the foot, and on the ability to maintain balance and a proper distribution of plantar pressures. Giza E, Fuller C, Junge A, Dvorak J. (2003). *Am J Sports Med*, 31, 550-4.

## BIOMECHANICAL ANALYSIS OF THE BASIC BODY MOVEMENT IN AIKIDO

furutani, o., horita, t.

*Univ. of kokushikan.*

Biomechanical analysis of the basic body movement (irimi) in Aikido O.Furutani<sup>1</sup>, T.Horita<sup>2</sup>, <sup>1</sup>Kokushikan University, Tokyo, Japan, <sup>2</sup>University of Toyama, Toyama, Japan INTRODUCTION Aikido is one of the martial system derived from the many martial arts traditions of Japan (M.Ueshiba.2005). Aikido practice is performed by barefoot using a sliding step (suri ashi). The basic movement in Aikido is called "irimi" (entering). The motion of irimi is characterized as follows, the performer moves laterally using a sliding step against the opponent's attack, and then moves closely to the opponent's "dead (blind) angle". The aim of irimi is to render the opponent's attack ineffectively. This entering to the side of an attack with a sliding step and placing oneself in the opponent's dead angle is called "one step irimi" (M.Ueshiba.2005). Irimi represents the characteristics of budo as manifested in martial technique (K.Ueshiba.1984). The motion of Irimi is based on the circular rotation of the body in keeping with a stable position of the center of gravity (K.Ueshiba.1984). The purpose of the present study was to investigate the biomechanical characteristic of the basic body movement (irimi) in Aikido. METHODS Eight skilled(5-6 grade) male experts (61.4±11.5yr;63.8±6.5kg;169.5±4.2cm) and 5 unskilled male (19.6±1.5yr;61.3±5.6kg;168.1±2.5cm) subjects participated in this study. The subjects performed irimi on the two force plates (KISTLER, Type2986A). The motion of the subjects was recorded by two video cameras (30 f.p.s.). Three-dimensional (3D) analysis was performed by a computerized motion analysis system (FRAME DIASIV, DKH, JAPAN). Center of gravity of the body (CG) and lower limb joint kinematic variables were analyzed. RESULTS AND DISCUSSION The differences were found in the path of CG and lower limb joint kinematics between skilled and unskilled subjects in irimi. The skilled subjects showed small change (92.4±0.9cm) in horizontally frontal displacement of CG during movement as compared to unskilled subjects (98.8±2.2cm). The skilled subjects showed small change (11.5±0.3cm) in horizontally lateral displacement of CG during movement as compared to unskilled subjects (16.8±0.7cm). Skilled subjects showed shorter movement time (1.36±0.04s) as compared to the unskilled subjects (1.66±0.08s, P<0.05). In addition, force impulse of the skilled subjects were lower (9.93±0.27Ns/Kg) than the unskilled subjects (10.89±0.98Ns/kg, P<0.05). Therefore it has been considered that Aikido experts possess well-coordinated and economical movement. REFERENCES K. Ueshiba, *The Spirit of Aikido*, 41, 1984, Kodansha, Tokyo, Japan. M. Ueshiba, *PROGRESSIVE AIKIDO*, 12, 18, 44-47, 2005, Kodansha, Tokyo, Japan.

## POWER PRODUCTION DURING THE INITIAL PHASES IN LUGING: A PRELIMINARY STUDY

Fedotova, V.1, Pilipiv, V.2

*1: Riga Technical University (Riga, Latvia), 2: Latvian Olympic Team (Riga, Latvia)*

Introduction In winter sport of lugging the first phases of the start are known to have a leading role for the successful start performance (Lembert et al., 2011). Kinetics of this highly demanding sport is seldom evaluated. The aim of this study was to assess power output of lugers during the initial start phases, as a possible performance predictor. Methods Experienced lugers (4 female and 4 male) gave an informed consent for their routine training start attempts on the ramp to be videotaped and analysed. For each athlete the best out of 3 attempts was processed. Average power output during the start spurt phase (Ps), average power to reach maximal positive velocity in the spurt phase (Pmax), and average power to reach maximal backward velocity (Pback) were calculated as in (Bezodis et al., 2008). Sled velocity was estimated from 100 fps video records using Simi Motion analysis software. 2 start interval times – time to clear 3 m (t1) and 15 m (t2) distance on the slope – were used as performance criteria. Results For all athletes Pmax had the largest values among all power parameters; it ranged from 3104 to 3875 W in male group, and from 1584 to 2458 W in female group. Other power parameters showed larger relative differences within groups: Ps ranged from 334 to 867 in male, and from 187 to 394 W in female group; Pback 505 to 1293 for male, and 295 to 600 W in female group. From all measured variables only maximal velocity (Vmax) during the start spurt correlated with performance criteria (in male group only). Discussion From the preliminary study all calculated power parameters appear to be poor performance predictors. This is also true for values normalized to body mass. Vmax correlation with start time in male group is in accordance with Platzer et al. (2009) data; however, in female group correlation was not obvious. Average Pmax values normalized to body mass for both groups are comparable to values in snatch pull in weightlifting according to previously published data; absolute values tend to exceed the ones reported for weightlifters (Garhanner, 1991; Zebas et al., 2000). Given an emphasis is put on strength training in lugging, power output assessment might provide additional information for coaches and athletes. Nevertheless, using power output as a performance predictor is not justified so far. References Bezodis NE, Trewartha G, Salo A. (2008). 26th ISBS Conf Proc, 498-501. Garhanner J. (1991). *Int J Sport Biomech*, 7, 3-11. Lembert S, Schachner O, Raschner C. (2011). *J Sports Sci*, 29(15), 593-601. Platzer HP, Raschner C, Patterson C. (2009). *J Sports Sci*, 27(3), 221-226. Zebas C., Carlson K., Christensen B., Daniel G., Hayes M. (2000). 18th ISBS Conf Proc, 387-388.

## PROPOSAL OF A NEW EVALUATION INDEX OF BICYCLE PEDALING SKILL. - USING WIRELESS MULTI-AXIS ACCELERATION AND ANGULAR VELOCITY SENSORS -

KITAWAKI, T., OKA, H.

*Okayama University*

Introduction: In order to evaluate bicycle pedaling skills, it is important to know how bicycle crank are rotate. Several previous studies, crank angle were measured on a road cycle via a potentiometer (Hull and Davis, 1981) or photo encoder (Chapman et al., 2006). Alternatively, it is possible to use a motion capture device to measure the rotation state of the crank (Trumbower and Faghri, 2004); however, this necessitates the use of a large-scale system in order to measure angles precisely. In this study, we propose a simple measurement system for the technical evaluation of bicycle pedaling for beginner or novice class cyclists. The system consists of small wireless sensor

units, and can simultaneously record the rotational state of the bicycle crank. Method: A wireless multi-axis sensor unit (9-axis motion sensor: Logical Products) was used for data acquisition. This unit was fixed to the bicycle crank in order to obtain the rotational state of the bicycle crank's acceleration and angular velocity data. Twenty-four male test subjects pedaled the road cycle which was attached to a bicycle trainer (Power Beam Pro: CycleOps) with a fixed rear-axis at 70, 100 rpm and preferred revolution. Wireless multi-axis sensor data was acquired for 25 seconds at a sampling rate of 1 kHz, and data recording was controlled by a soft-ware application (Logical Products). Results: In this study, several results have been obtained as follows: (1) Using wireless multi-axis acceleration and angular velocity sensors, the rotational state of the bicycle crank can be measured at a high accuracy and frequency. By averaging, the angular velocity for each crank angle is provided more precisely. (2) We propose an 'Angular Velocity Irregularity Index (AVII)' that is averaged root-mean-square error of the crank angular velocity per revolution. AVII depends on power and the number of revolutions. Additionally, the AVII has a tendency to be lower for an expert cyclist, and to be higher for beginners. (3) However, there are several beginner or intermediate cyclists having a low AVII. This shows the possibility that the AVII can become an evaluation index of the pedaling skill from the viewpoint of pedaling efficiency. Acknowledgments: This study was subsidized by JKA through its promotion funds from KEIRIN RACE. References: Chapman AR, Vicenzino B, Blanch P, Knox JJ, Hodges PW (2006). *J Sport Sci*, 24, 115-124. Hull ML, Davis RR (1981). *J Biomech*, 14, 843-856. Trumbower RD, Faghri PD (2004). *IEEE Eng Med Biol Mag*, 23, 62-71.

## THE RELATIONSHIP BETWEEN THE KICK START AND LOWER-LIMBS MUSCLE STRENGTH IN SWIMMING

Suito, H.1, Nunome, H.2, Ikegami, Y.2

1:Aich Gakuin University (Nisshin, Japan), 2:Nagoya University(Nagoya, Japan)

Introduction Recently, the competing swimming was introduced the new start block with starting block. The start is one of the most important factors for swimming performance. The kick start using the new start block was reported significant improves start time than the traditional start (Ozeki et al., 2011). The kick start is like track start but uses a starting block by backward leg. The purpose of this study was to investigate the relationship between the start time and maximal isometric strengths of forward and backward legs. Methods Subjects in this study were 5 males Japanese competitive swimmers (Age = 20.4 ± 0.5 years, Height = 175.6 ± 7.0 cm, Weight = 65.7 ± 6.1 kg, freestyle(n=3), breaststroke(n=1), butterfly(n=1)). The start time of the subjects was measured by digital camera operating at 30 Hz in the transit time of head of 5 m from takeoff of foot during race of the national intercollege competition swimming. Maximal isometric strengths of knee extension were determined as peak torques using an isokinetic dynamometer. Results The average time of start at 5 m was 0.75 ± 0.04 s. The average maximal isometric strength of forward leg was 196.0 ± 42.1 Nm. The average maximal isometric strength of backward leg was 202.6 ± 67.4 Nm. Moreover, a significant correlation was obtained between the start time to 5 m and maximal isometric strength of forward leg ( $r = -0.911$ ,  $P < 0.05$ ). However, there was no significant correlation between the maximal isometric strength of backward leg and the start time to 5 m. Discussion From these results, it is suggested that isometric maximal strength of the forward knee extension influence the kick start. On the other hand, isometric maximal strength of the backward knee extension has an insignificant effect on the kick start. Therefore, it is possible that develop muscle strength of the forward knee extension was effective to improve of the kick start performance in competitive swimming. References Ozeki K, Sakurai S, Taguchi M, Takise S. (2011) Does Start method with back-plate reduce 15 m Time? -Collegiate elite female swimmers- (In Japanese)., 2011 Japanese Society of Sciences in Swimming and Water Exercise Program & Book of Abstracts : 74-75.

## DIFFERENCES IN EMG ACTIVITY WHEN EXERCISING ON A STATIC AND MOVING ROWING MACHINE

Baca, A., Schöllauf, V., Kornfeind, P.

Institute of Sports Science, University of Vienna

Introduction Rowing machines are used for land-based training in periods of bad weather conditions. Two main modes of operation can be distinguished. In the static mode, the foot stretcher is stationary and the rower moves relative to the static rowing simulator. If the simulator itself rolls back and forth during the rowing stroke, a motion more similar to outdoor rowing may be expected (Elliott et al., 2002). Whereas comparisons of kinematics and reaction forces between the two modes have been reported (Kleshnev, 2005; Baca et al., 2006; Colloud et al., 2006), no such studies for EMG activity can be found. Methods Seven Austrian female and male subjects (21.0 ± 2.5 yr) with international competition experience participated in the study. A Concept2 (Concept2, Vermont, USA) rowing machine was operated both in the static mode and on slides (a construction that is attached to the legs), enabling rolling back and forth. The subjects exercised with 18 and 30 strokes per minute (SR18, SR30). EMG signals were derived from the m. biceps brachii (BB), m. triceps brachii (TB), m. deltoideus posterior (DP), m. teres major (TM), m. erector spinae (ES), m. vastus lateralis (VL), m. biceps femoris (BF) and m. gastrocnemius medialis (GM) with a wireless Delsys system (Bagnoli DesktopEMG) on the right side of the body. Results Significant differences (Wilcoxon,  $p < 0.05$ ) could be found for the pre-activation (ratio of the EMG amplitude at the beginning of the pulling phase and the maximum amplitude) of VL (SR18), BF (SR18) and GM (SR18, SR30), the maximum of the EMG-signals of BB (SR18, SR30), TB (SR30), DP (SR18, SR30), TM (SR18, SR30), ES (SR30) and VL (SR18, SR30), which was normalized to the average power during the pulling phase, the integral of the thus normalized EMG-data during the pulling phase of BB (SR18, SR30), DP (SR18, SR30), ES (SR30) and VL (SR18, SR30) as well as the duration from the beginning of the pulling phase until the maximum EMG-amplitude for DP (SR 30), TM (SR30) and GM (SR30). Discussion The present study suggests that the choice of the rowing machine influences muscular adaptation and affects the rowers' motor control pattern. Differences (in particular between pre-activation and the maximum amplitudes) are supposed due to different masses (rowing machine vs. body mass of subject) having to be accelerated/decelerated at the beginning of the pulling phase. Comparative studies in on-water rowing are required in order to draw further conclusions regarding the advantage of a specific rowing simulator modality. References Baca A, Kornfeind P, Heller M (2006). *Proc. XXIV Int. Symp. Biomechanics in Sports*, 347-350. Colloud F, Bahuaud P, Doriot N, Champely S, Chèze L (2006). *J Sports Sci*, 24 (5), 479-493. Elliott B, Lyttle A, Birkett O (2002). *Sports Biom*, 1 (2), 123-134. Kleshnev V (2005). *Proc. XXIII Int. Symp. Biomechanics in Sports*, 130-133.

13:45 - 14:45

## Poster presentations

## PP-BN09 Motor Learning and Coaching 2

**EFFECTS OF WEIGHT TRAINING AND MARTIAL ARTS IN ANTHROPOMETRIC AND STRENGTH CHARACTERISTICS IN ADOLESCENT BOYS**

Ferunaj, P., Mara, F., Kavaĳa, G., Kuvarati, S., Skenderi, D.H., Erindi, A.

*University of Sports of Tirana*

**Introduction** Many adolescent boys are highly concerned about their body image perception and combined martial arts and weight training are preferred by them to improve muscle strength. Pubescent boys have presented a higher arm and thigh circumference in relation to prepubescent boys, and this fact may be explained due to the higher increase on the muscular mass in this maturational stage(1). However, there are controversial data determining the ratio of predominant factor for this change, growth age or physical training. **Methods** In the study 9 volunteer adolescents (mean age  $17 \pm 0.23$ ) undertook the 3 days per week, 1.5 hour per session, 16 weeks of mixed training, combination of taekwondo (45 minutes) and progressive weight training (45 minutes). We have measured the body mass, anthropometric traits (Chest, biceps, leg girth) and body fat percentage (%BF) via skinfold thickness (SKF) method (2). The maximal and endurance strength for major muscle groups was measured before and after training using 1 RM and 75% of 1RM, respectively. **Results** Body mass was increased from  $73.77 \pm 13.28$  kg to  $77.43 \pm 13.98$  kg and interestingly, body fat decreased from 18.43 % to 16.75 %. The decrease in body fat was parallel combined with anthropometric changes. Thus, pectoralis girth increased from  $87.8 \pm 4.32$  cm to  $90.35 \pm 5.82$  cm, biceps girth from  $30.2 \pm 2.45$  cm to  $32.17 \pm 2.61$  cm, leg girth from  $56.92 \pm 7.07$  cm to  $59.25 \pm 7.86$  cm. Maximal strength in back squat, dead lift and bench press was increased 23 %, 26 % and 18 %, respectively, whereas endurance strength 19 %, 22 % and 17 %. **Discussion** The major finding of this study was that martial arts and weight training was effective to improve maximal strength and anthropometric traits in adolescent boys. However, data from our study suggest that body weight status is not influenced by concurrent training. But despite of high intensity training, there was no decrease in body mass. Although we did not measure muscle mass, considering the increase in body mass and other anthropometric traits let us conclude that dominant factor for this change is the physical training and not age status. Furthermore, strength is clearly more closed to muscle size (3). However, the weak point of our study is the lack of control group. **References** 1. Hansen L, Bangsbo J, Twisk J, Klausen K. 1999. Development of muscle strength in relation to training level and testosterone in young male soccer players. *J Appl Physiol*;87:1141-7. 2. Jackson, A. S., and Pollock, M. L. 1985. Practical assessment of body composition. *Physician and Sportmedicine* 13(5) : 76 – 90. 3. Thomas Rowland. (2004). *Children's Exercise Physiology*, Second Edition, 4,34 - 35.

**THE EFFECT OF THROWING MOVEMENT IN VARIOUS RUN-UP SPEEDS FOR JAVELIN THROWERS**

Aoyama, S.1, Kanazawa, N.1, Aoyama, T.2, Tsunoda, N.2

*1: Kokushikan University. 2: Graduate School of Sport System, Kokushikan University.*

**Introduction** The javelin throw involves complex movements that run-up and throwing also run-up is an integral part of the javelin throw. Most studies of javelin throwing performance are final phase such as release parameters. However, no study has focused on between run-up and movement speed of javelin throw. Therefore the purpose of this study was to clarify the effect of throwing movement speeds in various run-up speeds for javelin throw. **Methods** The subjects were seven male right-handed javelin throwers (age:  $21.3 \pm 2.1$  yrs, height:  $174.9 \pm 5.9$  cm, body weight:  $80.6 \pm 6.0$  kg, PB:  $66.97 \pm 3.95$  m). All the subjects performed for total 6 throws. Details were two throw which same run-up speed as competition (CT), two 80% of CT (80%) and two 60% of CT (60%) for recorded best throw from each throw. The run-up speed was measured using by Speed meter (VINE, Japan) with attached to the waist. Throwing movement velocities of during the run-up were measured from the front and right side of the throwing area by video cameras operating at 60 frames per seconds and set at 1/250s shutter speed. It was used in DLT to 3-D coordinates of the digitized body and javelin parts (movement velocity of javelin: JV, movement velocity of right wrist: WV, movement velocity of right elbow: EV, movement velocity of right shoulder: SV). **Results** The results of this study were: CT was significantly higher than 80% and 60%. A significant correlation was observed between various run-up speed and javelin throw performance in all the throws ( $r=0.534$ ,  $p<0.05$ ). Also, CT of javelin throw performance was significantly higher than 60% of javelin throw performance. However, no significant differences in JV were observed between CT and 80% and 60%. Moreover, there were no significant differences between various run-up speed and WV, EV, SV. **Discussion** The run-up speed is one of the important contributions to javelin throw. In this study, there were no differences between movement velocity of JV, WV, EV and SV in various run-up speeds. In addition, there were no significant between various run-up speed and JV, WV, EV, SV. This means that it does not need to throw run-up of maximum speed to daily training of javelin throw technique. Therefore, run-up speed of 80% and 60% are good way to develop the correct movement and skill of javelin throw training. From these results, it was suggested that it is important factor to consideration for prevented injury of shoulder, elbow and wrist that can be expectation of better javelin throw technique and performance. **References** Mero A, Komi P.V., Korjus T, Navarro E, Gregor R.G. (1994) *J Applied Biomechanics* 10, 166-177 Best.RJ, Bartlett RM, Morriss CJ. (1993) *J Sports Sci* 11, 315-328

**BIOLOGICAL MATURITY INFLUENCES MATCH RUNNING PERFORMANCE IN JUNIOR FOOTBALL**

Gastin, P., Bennett, G.

*Deakin University*

**Introduction** Children and adolescents mature at different rates (Jackowski et al. 2011) such that individuals competing in the same competition may differ in physical and biological maturity despite being of similar chronological age. Despite the attempt to provide equitable junior competition through age group categories, early maturing adolescents are likely to have an advantage over their late maturing peers (Armstrong & Welsman 2005). Outcomes related to differences in physical and biological maturity may include selection bias, physical fitness, skill, drop-out and injury (Burgess & Naughton 2010). Whether differences translate into on-field performance in competition is relatively unknown. The purpose of this study was to investigate the influence of biological maturity on match running performance

in junior Australian football (AF). Methods Eighty seven players from an under 15 AF junior competition were categorised into early ( $n = 20$ ), average ( $n = 45$ ) and late ( $n = 22$ ) maturity groups based on self-reported assessment of biological maturity (Tanner 1978). Biological development was also assessed objectively from anthropometric measurements to estimate years from peak height velocity (PHV) (Mirwald et al. 2002). Running movements during competition were collected using GPS technology (SPI Pro, 5 Hz, GPSports, Australia), including measures of total distance, peak speed, high-intensity running distance (HIR;  $>14.4$  km/h), number of high-intensity efforts (HIE;  $>14.4$  km/h) and number of sprints ( $> 23$  km/h). Results On average, there was a 0.9 year difference in the timing of PHV between the early and late maturers, although the range spanned a period of 2.7 years. Early maturers were significantly ( $p < 0.05$ ) heavier and taller than all other boys, with longer upper and lower bodies. Running distance, HIR and HIE were significantly greater in the early maturers compared to both average and late maturers. No differences were observed between groups in the number of sprints or the peak speed obtained during competition. Discussion Individuals within the same chronological age group varying considerably in physical and biological maturity. This translates into enhanced running performance during match competition in early maturing boys, placing them at a performance advantage to their less mature peers. Holistic models of talent development that acknowledge these differences and in particular cater for late developing players should be encouraged. References Armstrong N, Welsman J. (2005). *Lancet* 366(Suppl 1):S44-S45. Burgess D, Naughton G. (2010). *Int J Sports Physiol Perf* 5(1), 103-116. Jackowski S. et al. (2011). *Bone* 48(5), 1178-1185. Mirwald R et al. (2002). *Med Sci Sports Exerc* 34(4):689-694. Tanner J. (1978). *Foetus into man*. Harvard University Press.

### 'ON YOUR MARKS': LAST CHANCE FOR NEUROMUSCULAR ACTIVATION

Smirniotou, A., Katsikas, C., Zacharogiannis, E., Dallas, G., Paradisis, G.

*Kapodistrian University of Athens*

Introduction Starting action in sprinting, as this is defined by RT and initial acceleration after block clearance, is a complex motor action which critically affects sprint performance. It requires high neuromuscular activation and explosive force production exerted on the blocks. The purpose of this study was to explore the effectiveness of specific dynamic actions usually performed by athletes using their body weight as well as mechanical stimuli - vibration, in order to produce neuromuscular activation the 'very last moment' just behind the blocks. Methods 16 male PE students with no starting experience participated in this preliminary study. After the 'On your marks' signal, all subjects, replicating the usual dynamic actions executed by athletes behind the blocks as supplementary 'last moment' neuromuscular activation, underwent the following conditions, in a random order, for 3 sec each : 1. No action behind the block 2. Tuck jumps 3. Power lunges. 4. Activation on vibration platform (Power Plate – 30Hz, 2.5mm). Before testing, all subjects followed a 30 min specific warm up protocol comprised of sub maximal running, dynamic stretching and sprint specific dynamic activities (Behm and Chaouachi, 2011). Afterwards, they performed three 5 m sprints from blocks for each condition. Each condition was tested in a separate day. Reaction times (RT) were recorded (ReacTime-Lynx) as well as times at 2.5m and 5m from the blocks (photocells - Polifemo, Microgate). The best 5m performance was used in the statistical analysis. Results ANOVA with repeated measures was used to compare performance after each condition. Where appropriate, post hoc analysis was carried out (Bonferroni). The level of significance was set at  $P < 0.05$ . Significantly better performance was found in RT ( $P = 0.01$ ) and 2.5m ( $P = 0.027$ ) only for the vibration condition. Discussion In the present study, the 'last moment' very short duration dynamic stretches (lunges) and activities (tuck jumps) did not enhance performance. The vibration condition though did have a positive effect in block clearance. A possible explanation could be that the mechanical stimuli caused by vibration enhances motor neural activation leading to powerful muscle contractions (Bosco, 1998). Since practically is not possible to use vibration platform before starting, further research could explore if acute and 'quick' stimulating activities just behind blocks (e.g quick feet skipping) could possibly be more effective than lunges or jumps. References Behm DG & Chaouachi A (2011). *Eur J Appl Physiol* 111:2633-51. Bosco C, Cardinale M, Colli R, Tihanyi J, Duvillard, S, Viru A (1998). *Biol Sport* 153:157-164

### THE EFFECT OF DIFFERENT FREQUENCY OF WHOLE BODY VIBRATION IN DIVERS' FLEXIBILITY AND EXPLOSIVE STRENGTH OF LOWER LIMBS

Dallas, G., Paradisis, G., Tsiganos, G., Argeitaki, P., Smirniotou, A.

*KAPODISTRIAN UNIVERSITY OF ATHENS*

Introduction Flexibility and explosive strength of lower limbs are significant factors in diving. The purpose of this study was to examine the acute effect of different Whole Body Vibration (WBV) frequencies on diver's flexibility and explosive strength of lower limb. Methods Eighteen male and female competitive divers (Mage  $15.00 \pm 4.47$  years, body mass  $48.61 \pm 14.97$  Kg, Height  $159.38 \pm 13.36$  cm and Body fat %  $14.15 \pm 5.31$ ) volunteered to participate in this study. The sample was assessed under different intervention programs a) vibration program with low frequency (30 Hz) and amplitude (2 mm) (LFA) b) vibration program with high frequency (50 Hz) and amplitude (4 mm) (HFA) and c) Non Vibration program (NVP). Each intervention program consisted of a single repeated bouts session lasting for 2 minutes. The following tests were done before-pre and after-post each intervention program: a) flexibility (sit & reach test), and b) explosive strength of lower limbs under 3 different tests a) Squat Jump (SJ), b) Counter Movement Jump (CMJ), c) Single Leg Jump for the Right (RL) and Left Leg (LL). Results A two-way ANOVA (day\*trials) with repeated measures on both factors was used. Univariate analysis with Bonferroni adjustments (.05/3) were selected as post hoc tests. There was significant interaction between day \* trials with respect to: a) sit & reach ( $p = .001$ ), b) SJ ( $p = .004$ ), c) RL ( $p = .017$ ). However, no interaction effect between day \* trials was found with respect to a) CMJ and LL ( $p > .05$ ). Discussion The results support that both vibration intervention programs showed a great percentage of improvement on flexibility compared to NVP. Further, vibration programs is an effective method to maintain the gain in explosive strength of lower limbs immediately after, whereas NVP failed to maintain the initial values in this test. The athletes underwent the vibration programs showed an improvement on flexibility and explosive strength, while the athletes of NVP showed no significant effect between pre and post sessions. Further, the improvement through vibration programs was significant higher than the NVP. References Bazett-Jones DM, Finch HW, Dugan EL. (2008). Comparing the effects of various whole-body vibration accelerations on counter-movement jump performance. *J Sports Sci Med* 7(1):144-50. Jacobs PL, Burns P. (2009). Acute enhancement of lower-extremity dynamic strength and flexibility with whole-body vibration. *J Strength Cond Res*; 23 (1):51-57. Van Den Tillaar, R. (2006). Will whole-body vibration training help increase the range of motion of the hamstrings? *J Strength Cond Res*; 20: 192-196.

## THE EFFECT OF NAP ON MOTOR LEARNING: DOES AN ADVANTAGE OF NAP AFTER MOTOR LEARNING CONTINUE IN THE FOLLOWING DAY?

Morita, Y.1,2, Ogawa, K.3,4, Uchida, S.1,4

1 Waseda University, 2 Research Fellow of Japan Society for the Promotion of Science, 3 Hiroshima University, 4 Future Institute for Sport Sciences

**INTRODUCTION:** Past studies have presented that beneficial role of sleep in motor memory consolidation. In our previous study, we revealed that motor performance was improved by 2-hour nap after motor learning compared to staying awake. However, a question arises whether the effect of nap reflects on the following day's performance after a nocturnal sleep. Regardless of taking a nap after motor learning or not, if following day's performance could be improved equally, it is useless to use a nap in a practical sense. The purpose of this study is to examine whether an advantage of nap after motor learning continues in the following day. An additional purpose of this study is to examine whether the less than 2 hour nap facilitate performance. **METHODS:** Subjects were 12 college students. They were divided into nap group and control group. All subject practiced three-ball cascade juggling for 15min, and juggling technique was evaluated at 1030h (test). After the test, nap group took a 70min nap from 1400h while control group stayed awake. Both groups retested juggling at 1730h (retest 1). The following day, both groups retested again at 1030h (retest 2). Juggling performance was quantified as the catching number. Analysis carried out using two-way ANOVA (group: nap, control  $\times$  time: test, retest). **RESULTS:** The mean number of catches in nap group was  $4.76 \pm 1.43$  (mean  $\pm$  SD), and in control group was  $4.01 \pm 2.48$ . There were no differences of juggling performance between nap group and control group in the test. In the retest 1, mean number of catches in nap group was  $8.39 \pm 2.20$ , whereas in control group was  $5.23 \pm 3.49$ . In the retest 2, mean number of catches in nap group was  $14.52 \pm 6.57$ , whereas in control group was  $7.24 \pm 4.44$ . There was a main effect of test time ( $p < 0.001$ ), and significant group  $\times$  time interaction ( $p < 0.05$ ). The result of simple main effect test, in nap group, the mean number of catches was significantly increased from test to retest 1 ( $p < .001$ ). Similarly, the mean number of catches increased significant from test to retest 2 ( $p < .001$ ), and from retest 1 to retest 2 ( $p < .005$ ) in nap group. Furthermore, in the retest 2, the mean number of catches in nap group was significantly large compared to the control group ( $p < .05$ ). **DISCUSSION:** Data from juggling performance, when it took a nap after motor learning, it was shown that the performance in the following day improved more greatly. This result indicated that an advantage of nap after motor learning continued in the following day through the nocturnal sleep. It showed that performance was facilitated by 70min nap shorter than 2 hours.

## ARE PHYSICAL ACTIVITY AND FUNDAMENTAL MOTOR SKILLS RELATED AT THE AGE OF FOUR?

Iivonen, S.1, Mehtälä, A.2, Sääkslahti, A.1, Tammelin, T.3, Kulmala, J.3, Villberg, J.2, Poskiparta, M.2

1:University of Jyväskylä, 2:University of Jyväskylä, 3: LIKES Research Center for Sport and Health Sciences

**ARE PHYSICAL ACTIVITY AND FUNDAMENTAL MOTOR SKILLS RELATED AT AGE FOUR?** Iivonen, S.1, Mehtälä, A.2, Sääkslahti, A.1, Tammelin, T.3, Kulmala, J.3, Villberg, J.2, Poskiparta, M.2 1: Department of Sport Sciences, 2: Research Centre for Health Promotion, University of Jyväskylä, 3: LIKES Research Center for Sport and Health Sciences, Jyväskylä, Finland **INTRODUCTION** Research lacks knowledge regarding the intensity of physical activity (PA) that preschool children need for the sufficient fundamental motor skills (FMS) necessary to be physically active (Stodden et al. 2008). This study aims at determining if different intensities of PA and FMS are related at the age of four. **METHODS** The data was collected during autumn 2011 from 26 boys and 32 girls (mean age  $4.12 \pm 0.33$  years). PA was measured objectively for 5 consecutive days (for at least 2 weekdays and 1 weekend day) using the ActiGraph GT3X accelerometer and FMS by APM Inventory (Numminen 1995). The FMS measures were 1) right- and left- foot static balance, 2) dynamic balance, 3) standing broad jump, 4) sliding and galloping, 5) throwing and catching combination, 6) throwing at a 2m target, 7) kicking a ball at a target and 8) sum score of manipulative skills (5–7). PA was classified by intensity cut-points established by Van Cauwenberghe et al. (2010). The Mann-Whitney U-test and the Pearson correlation coefficients analyzed the differences between the two genders and the relationships between average weekday and weekend-day PA and FMS. PA was categorized as total (counts per min.), light (373–584), moderate (585–880) and vigorous ( $\geq 881$ ) and combined categories of LMVPA ( $\geq 373$ ) and MVPA ( $\geq 585$ ). **RESULTS** Boys had more moderate PA during weekdays than girls ( $p = 0.035$ ). Among girls, several significant ( $p \leq 0.05$ ) positive correlations ( $R = 0.42$ – $0.48$ ) were observed between PA and FMS. The significant relationship was observed between throwing and the 2 categories of moderate and LMVPA for weekdays, and the 5 categories of light, moderate, vigorous, LMVPA and MVPA for weekend days. The similar correlations were found between manipulative skills and light PA for weekdays, and light and moderate PA for weekend days. The highest correlations were observed between throwing and light PA for weekdays ( $R = 0.52$ ), manipulative skills and light PA for weekend days ( $R = 0.55$ ) and manipulative skills and MVPA for weekend days ( $R = 0.53$ ). PA was not related to FMS among boys. **DISCUSSION** Boys were more physically active than girls during weekdays at the age of four. PA was related to FMS among girls, but not among boys. Even light PA was positively related to girls' manipulative skills, both during weekdays and weekend days. One reason for this might be that the nervous system in girls developed earlier than in boys. **REFERENCES** Numminen, P. 1995. APM-Inventory. Jyväskylä: LIKES. Stodden, D.F. et al. 2008. *Quest* 60, 290–306. Van Cauwenberghe, E. et al. *International Journal of Pediatric Obesity*, 2010; Early Online, 1–8

## EFFECT OF PHYSICAL EXERCISE ON ATTENTIONAL FUNCTIONING IN YOUNG ADULTS

Moratal, C., López-Ramón, M.F., Monleón, C., Pablos, A., Blasco, E., Lupiáñez, J., Huertas, F.

Universidad Católica de Valencia

**Introduction** Many authors have shown the benefits of regular physical exercise on physical and psychological abilities in all ages (Bouchard et al., 1990; McMorris et al., 2009). According to Posner and Petersen (1990), attention modulates perception and action by three different attentional networks: alertness, orienting and executive control. The ANTI-Vigilance (ANTI-V) is a new version of the ANTI (Callejas et al., 2004) that measures vigilance in addition to the above mentioned attentional functions and their interactions. In other previous studies performed by our group, we described the influence of physical exercise and sports practice on children's cognitive functioning. The present research aims to study whether practice of physical exercise (systematic or unsystematic) improves perceptual-motor performance in general, and more specifically, in young adults attentional networks functioning. **Methods** A sample of university students performed the ANTI-V. Reaction Time (RT) and accuracy were registered. Moreover, participants completed a questionnaire to collect data about their physical activity profile (systematic practice / unsystematic practice / no practice, and modality: open vs. close tasks, and hours of practice /week). **Results** Results showed a reduction in alertness and an increased in orienting on practitioners of systematic physical activity compared to non-practitioners or practitioners of unsystematic physical activity. Also, those participants who exercised regularly for more hours a week had a positive impact on attentional performance compared to those who less exercised. No interaction between



executive control functioning and physical exercise related variables were found. Discussion Results seems to indicate that systematic practice of physical activity improves cognitive processing as demonstrated by previous studies (BrainWork, 2002). The practice of physical exercise is associated with segregation of IGF-1 by muscle that stimulates the production of BDNF (Brain-derived neurotrophic factor), a neurotrophin related to nerve growth factor, located mainly in the hippocampus and in the cerebral cortex. This might be the mechanism by which physical exercise helps to improve cognitive and sensory functioning of the brain. These evidences would justify the need of promoting physical activity programs in young adults who are one of the populations that usually abandon the practice of sports and physical activity. References Bouchard, C.; Shephard, R.; Stephens, T.; Sutton, J., y McPherson, B. (1990). Exercise Fitness and Health. Champaign: Human Kinetics. BrainWork (2002). The Neuroscience Newsletter, Vol 12.No.1. Callejas, A., Lupiáñez, J. & Tudela, P. (2004). The three attentional networks: On their independence and interactions. *Brain and Cognition*, 54(3): 225-227. McMorris, T., Tomporowski, P. & Audiffren, M. (2009). Exercise and cognitive function. Michigan: Wiley-Blackwell. Posner, M.I. & Petersen, S.E. (1990). The attention system of the human brain. *Annual Review of Neuroscience*, 13, 25-42.

### THE EFFECT OF WATER IMMERSION ON SHORT AND LONG AFFERENT INHIBITION, SHORT INTRA CORTICAL INHIBITION AND INTRA CORTICAL FACILITATION IN HUMAN

Sato, D., Yamashiro, K., Yoshida, T., Onishi, H., Shimoyama, Y., Maruyama, A.

*Niigata University of Health and Welfare*

**Introduction** Water immersion can alter numerous physiological parameters depending on physical characteristics like buoyancy, hydrostatic pressure, and temperature. We have examined the effects of water immersion on cerebral cortical activities, and proposed that water immersion influences the cortical processing of somatosensory inputs (Sato et al., 2012). This result might imply that water immersion affect the sensorimotor processing. Therefore, the aim of the present study was to investigate the effect of water immersion on short and long afferent inhibition (SAI and LAI), short intra cortical inhibition and intra cortical facilitation (SICI and ICF). **Methods** Motor evoked potentials (MEPs), SAI, LAI, SICI and ICF were measured for seven healthy males at rest before, during and after the 15-minute water immersion. SAI and LAI were evaluated by transcranial magnetic stimulation (TMS) protocol based on coupling peripheral nerve stimulus with TMS of the motor cortex. MEPs induced with TMS were conditioned by painless electrical stimuli applied to right median nerve at interstimulus intervals (ISIs) of 20 and 200ms. The intensity of the stimulus was fixed at about three times the sensory threshold. SICI and ICF were tested using the paired-pulse TMS paradigm. MEP was recorded from first dorsal interosseous (FDI) muscle. The water level was allowed to reach the axillary level, and during the experiment, room and water temperatures were maintained at 30°C. **Results** SAI and LAI were reduced during water immersion (101.4±12.9% and 64.4±10.1%) compared with before and after water immersion (before: 67.5±9.7% and 41.2±14.9%, after: 63.4±10.0% and 40.4±13.1%). SICI and ICF were not significantly different among three conditions (before, during and after water immersion). **Discussion** Water immersion decrease short and long afferent inhibition in human. Tamburin et al. (2001) have suggested that increased sensory receptive field might induce summation of the SAI due to 'centripetal gating' mechanism or a 'floor effect'. Our previous research have clarified that water immersion to the axillary level has a centripetal gating effect on short-latency somatosensory evoked potentials (SEPs) (Sato et al., 2012) and increases the amplitudes of long-latency SEPs. Therefore, the present data suggested that the change in sensory input induced decreasing SAI and LAI during water immersion. **References** Tamburin S, Manganotti P, Zanette G, Fiaschi A. (2001). *Exp Brain Res*, 141, 232-41. Sato D, Yamashiro K, Onishi H, Shimoyama Y, Yoshida T, Maruyama A. (2012). *BMC Neurosci*, 13, 13.

13:45 - 14:45

## Poster presentations

### PP-SH08 Physical Education and Pedagogics 2

#### THE SUPPORT OF PARENTS WHEN CHILDREN CHOOSE THE SPORT DURING THEIR LEISURE TIME. CASE STUDY IN SCHOOL PIA BALMES

Franco-Sola, M., Sebastiani, E.M., Figueras, S., Guerra, M.

*Universitat Ramon Llull*

**INTRODUCTION** The aim of this study was to identify the influence of parents in decision making when children from 8 to 12 years old choose a sport. This study is part of a single case study conducted during 2010-2011 school year, in the School Pia Balmes (Barcelona, Spain), about the perceptions of school sports activities for students. **METHODOLOGY** Case Study of School Pia Balmes. The study sample was 204 children, 111 boys and 93 girls, aged 8-12 years and, therefore, corresponds to 3rd until 6th Primary. The instrument was a questionnaire related to the amount of sport played and motivation to practice these sports in school. We used SPSS (v15.0.1) for data processing. A descriptive statistical analysis was prepared by knowing the frequency of the different variables raised. **RESULTS** Our results show that as children grow, there is less influence of parents in deciding which sports they will practice. The 46.5% in 3rd Primary ensure their chose sport with the help of their parents. And when they get to 6th grades, the 80% of children says that they chose the sport alone, without the help of their parents. **DISCUSSIONS AND CONCLUSIONS** The autonomy of children in the choice of sport is increasing in size as they get older. Parents also advise the younger students. Therefore, we conclude that it is important that the families should not be separated from their child meanwhile practicing sport, in order not to crash the motivation and, consequently, the sport during adolescence. **REFERENCES** - Blázquez, D. (1995). *La iniciación deportiva y el deporte escolar*. Barcelona: INDE. - Coller, X. (2000). *Estudio de casos*. Madrid: Centro de Investigaciones Sociológicas. - Guba, E. & Lincoln, Y. (1994). *Competing paradigms in qualitative research*. In Denzin, N. & Lincoln, Y. (coords.) *Handbook of qualitative research*. London: Sage (pp. 105-117). - Institut Barcelona Esports - Ajuntament de Barcelona (2007). *Estudi dels Hàbits Esportius de la població en edat escolar a la ciutat de Barcelona*. Barcelona: Ajuntament de Barcelona. - Piéron, Delfosse, Lendent & Cloes (2001). *Las percepciones al final de la sesión de educación física*. IV Congreso internacional sobre enseñanza de la educación física y el deporte escolar. Santander (Spain): ADEF Cantabria. - Stake, R. (2010). *Qualitative Research. Studying how things work*. New York: Guilford Press. - Vila, I. (1998). *L'ús del temps de la població infantil i juvenil: Els hàbits esportius*. Invited symposia in the Congress of Physical Education and sport's school of Barcelona, on 21th may 1998.

**SELF-ESTEEM AND POSTURE: AN INNOVATIVE PROGRAM OF PEDAGOGIC AND POSTURAL TRAINING**

Bellafiore, M., Battaglia, G., Caramazza, G., Storniolo, F., Costantino, D., Bianco, A., Palma, A.

*University of Palermo*

SELF-ESTEEM AND POSTURE: AN INNOVATIVE PROGRAM OF PEDAGOGIC AND POSTURAL TRAINING Bellafiore, M.1,3, Battaglia, G.1,3, Caramazza, G.2,3, Storniolo, F.1, Costantino, D.3, Bianco, A.1,3, Palma, A.1,3. 1: DISMOT (Palermo, Italy), 2: PhD in "Human Diet and Nutrition" (Palermo, Italy), 3: Regional Sport School of Sicily CONI (Olympic National Italian Committee, Italy). Introduction It is known that exists a strong interaction between psycho-emotional aspects and postural system. A deficit in self-esteem can be associated with an altered conception of own body image which reflects itself in the behavior and posture of the person. The aim of this study was to evaluate the influence of a program of body pedagogy and postural recovery on thoracic hyperciphosis and low level of self-esteem in adolescents. Methods Ten female subjects (age:  $15.5 \pm 1.4$  years; weight:  $56.0 \pm 5.1$  kg; height:  $160 \pm 3.0$  cm; BMI:  $21.9 \pm 1.8$ ) and ten male subjects (age:  $15.3 \pm 1.8$  years; weight:  $67.3 \pm 5.8$  kg; height:  $170 \pm 4.0$  cm; BMI:  $21.9 \pm 1.8$ ) with thoracic hyperciphosis (Cobb angle:  $45-55^\circ$ ) and low level of self-esteem (PSDQ index  $< 2$ ) were selected from a center of global postural re-education and recruited to participate in a 6-month training program for 1 hour 6 times per week. In particular, 3 hours/week were addressed to treatment of postural alteration through the application of Pilates, Mezieres and RPG methods; while the other 3 hours/week were aimed at the body education using Feldenkrais and Gendlin methods. Before, during (3 months) and after 6 months of training program, ciphotic curve and self-esteem level were assessed measuring Cobb angle and with Physical Self-Description Questionnaire (PSDQ) respectively (Marsh, 1996). One-way ANOVA test with Bonferroni's correction was used to analyze significant differences ( $p < 0.05$ ). Results After 3 and 6 months of body education and postural recovery, we found a significant reduction in Cobb angle in both genders ( $p < 0.001$ ), who did not show any difference between them ( $p > 0.05$ ). This structural modification was associated with an increase in the self-esteem level in both groups; however, the growth trend was significantly different between the two genders. In particular, we noticed that self-esteem was higher in female than male adolescents after 3 months ( $p < 0.001$ ); while in men increased more in the 3-6 month period ( $p < 0.05$ ). Discussion The results of our study indicate that there is a similar response to our program of body pedagogy and postural recovery by two genders as concern to the morphological features but different in the psycho-emotional aspects. This program can be a helpful method for reducing either postural alterations in brief time and the risk of relapses in adolescents because it has positive effects on self-esteem, one of the factors contributing to postural habits. References Marsh H.W. (1996) Res Q Exerc Sport, 67, 249-64.

**CONTEXTUAL INFLUENCES ON YOUTH ATHLETES' DEVELOPMENT AND ENJOYMENT**

Santos, A.1, Diogo, F.1, Goncalves, C.E.1

*University of Coimbra - NIF 501617582*

Introduction The youth in development suffer influences from the context were is inserted (Bronfenbrenner, 1999), having the sport programs a potential to promote positive youth development (Urban, Lewin-Bizan, & Lerner, 2009). For adhesion and maintenance in sport the enjoyment is consider a major factor (Scanlan, Carpenter, Lobel, & Simons, 1993). The purpose of this study is to verify the influences of different contexts, type of organization and demographic, in youth sport enjoyment and positive development. Method Three Portuguese soccer clubs of different contexts (one professional club (PC) and two amateur – one of rural area (RAC), other of urban area (UAC) were selected. And the athletes ( $n=225$ ), with ages between 12 and 18 ( $15.06 \pm 1.64$ ), respond to the Sources of Enjoyment in Youth Sport Questionnaire, Sport Attitudes Questionnaire and Development Assets Profile. To select the professional club it was used the criteria of being on the Portuguese Professional Soccer League. For the amateur ones, it was a district competition level, and the case of urban and rural, the demography, accessibilities and local economy base. For the data analyses it was performed a MANOVA and LSD post-hoc test. Results The dependent variables are influenced by club context (25%,  $p=.000$ ) and the age echelon (15%,  $p=.001$ ). The groups showed significant differences by club and echelon in the peers affiliation ( $p=.009$ ;  $p=.001$ ), convention ( $p=.000$ ), effort ( $p=.000$ ,  $p=.002$ ), support ( $p=.002$ ,  $p=.034$ ), learning commitment ( $p=.010$ ,  $p=.045$ ) and familiar ( $p=.006$ ,  $p=.008$ ), having the RAC athletes register the lower scores. Conclusions This shows that the athletes practice context influences some variables of the sports attitudes, the sources of enjoyment and the development assets. Also, the PC and UAC athletes' characteristics are more similar between themselves than with RAC. The RAC context appears a disadvantage factor for positive developmental, maybe due to organizational or local context. References Bronfenbrenner, U. (1999). Environments in developmental perspective: Theoretical and operational models. In S. L. Friedman & T. D. Wachs (Eds.), *Measuring, environment*, pp3-28. Scanlan, T. K., Carpenter, P. J., Lobel, M., & Simons, J. P. (1993). Sources of enjoyment for youth sport athletes. *Pediatric Exercise Science*, 5, 275-285. Urban, J. B., Lewin-Bizan, S., & Lerner, R. M. (2009). The role of neighborhood ecological assets and activity involvement in youth developmental outcomes: Differential impacts of asset poor and asset rich neighborhoods. *Journal of Applied Developmental Psychology*, 30(5), 601-614.

**THE EFFECT OF THE SOCCER CLASS TAKING INTO ACCOUNT IMPROVEMENT IN PHYSICAL FITNESS : FOCUSING ON THE GAMES WITH CHANGING PITCH AREA PER PLAYER**

Tsuda, R., Inoue, A., Suzuki, K., Marutani, Y.

*Kanazawa Medical University*

THE EFFECT OF THE SOCCER CLASS TAKING INTO ACCOUNT IMPROVEMENT IN PHYSICAL FITNESS : FOCUSING ON THE GAMES WITH CHANGING PITCH AREA PER PLAYER Ryosuke T. 1, Akihiro I. 2, Koya S. 3 and Yasuhiko M. 4 1 : KMU (Ishikawa, Japan), 2 : KSU (Ishikawa, Japan), 3 : TGU (Miyagi, Japan), 4 : UJH (Ishikawa, Japan) Introduction It has been suggested that small-sided games in football enable players to improve their physical fitness if conditions for the games, such as the court area per player and player number, are adjusted appropriately (Hill-Hass et al., 2011). However, no study based on this knowledge has yet been conducted in PE classes. The purpose of this study was to examine the effect of playing small-sided games of soccer with changing pitch area per player in PE classes. Methods Two types of small-sided games, "pitch area per player was smaller", and "pitch area per player was larger", were played by two first year junior high school PE classes. 20 students participated in the game with pitch area per player was smaller (S group), and 20 students participated in the game with pitch area per player was larger (L group). Before and after classes, a skill test (ball lifting), a fitness test (150m sprint with changing direction ;  $25m \times 6$ times, rest interval 30s), and a test game were conducted. In addition, students' formative evaluation was conducted after each class. Results and Discussion The result of the first set of 150m sprint with changing direction was improved significantly after class in the S group. This result suggests that improvement of anaerobic power could be obtained in use of small-sided game, pitch area per player was smaller. On the other hand, the mean time for 6 sprints was improved significantly after class in both groups. This result suggests that improvement of aerobic capacity could be obtained regardless of whether they played the

game with pitch area per player was smaller or larger. The distance covered and heart rate during the game were increased significantly after classes in L group. In addition, the score in students' formative evaluation tended to increase as class progressed in L group. Conclusion These results suggest that improvement of energy-related physical fitness could be obtained without compromising students' interest and volition in use of small-sided game, pitch area per player was larger. Reference Hill-Hass, Stephen V. ; Dawson, Brian ; Impellizzeri, Franco M. ; Coutts, Aaron J. (2011) Physiology of Small-Sided Games Training in Football : A Systematic Review. *Sports Medicine*, 41 : 199 - 220.

### **MOTIVATIONAL CLIMATE IN PHYSICAL EDUCATION: A COMPARISON BETWEEN THE PERCEPTIONS OF STUDENTS FROM CLASSES OF BEGINNING TEACHERS AND EXPERIENCED TEACHERS.**

Martins, J.1, Marques, A.1, Sarmiento, H.2, Carreiro da Costa, F.1,3

1: CIPER, Faculty of Human Kinetics, Technical University of Lisbon; 2: University of Trás-os-Montes and Alto Douro; 3: Lusophone University of Humanities and Technologies

Introduction: Motivational climate (MC) plays an important role on students' physical activity (PA) participation. Therefore, it is important to investigate whether beginning teachers were trained in promoting a proper MC. This study aimed to examine the MC prevailing in physical education (PE) classes as well as to compare the perceptions on MC between students of beginning teachers and those of experienced teachers. Methods: A total of 423 students, aged from 15 to 18, participated in the study. They attended 8 public schools, from 10th to 12th grade. One hundred and eighty nine beginning teachers' students (44.7%, age 15.9±1.1, 98 boys, 91 girls) and 234 experienced teachers' students (55.3%, age 16.3±0.9, 92 boys, 142 girls) were assessed using Papaioannou et al.'s questionnaire (2007), validated for the Portuguese population. The students' perceptions were measured with emphasis on mastery, performance-approach and performance-avoidance goals. Individual (and not class) was considered as the unit of analysis. Experienced teachers had more than five years of teaching. Results were compared by using student's t-test. Results: Ranging on a scale from 1 to 5, the mean levels of beginning teachers' students perceptions of mastery-involving climate were high (3.8±1) and did not differ significantly (p=0.259) from those reported by experienced teachers' students (3.7±0.9). However, these results suggest that a mastery climate could be even more emphasized by both types of teachers. According to student's views, beginning teachers emphasized significantly higher values of performance-approach goals than experienced teachers (3±1 vs. 2.8±1; p<0.05). Finally, beginning teachers' students also perceived a higher performance-avoidance environment (2.1±1) than experienced teachers' students (1.79±0.8), and significant differences were observed (p<0.05). A tight control of all aspects of decision-making by beginning teachers, as well as interventions emphasizing normative comparison, might explain these results. Discussion: Beginning PE teachers emphasised performance-approach and performance-avoidance goals more than experienced teachers. More challenging tasks and a positive evaluation for personal improvement should be delivered to all PE participants. Future research concerning affective, behavioral, and cognitive learning outcomes is needed to provide a holistic perspective to help teachers implement methods that will enhance student participation in lifetime PA. References: Papaioannou et al. (2007). *JTPE*, 26, 236-259. Acknowledgments: This study was supported by FCT.

### **PRELIMINARY STUDY AIMING TO IDENTIFY THE CONDITIONS OF IMPLEMENTATION OF A PROJECT INTEGRATING PHYSICAL ACTIVITY FOR 10-16 YEAR-OLD CHILDREN WITH CANCER IN A HOSPITAL CONTEXT**

Cloes, M.1, Del Guidice, A.2

University of Liege

Introduction Today, it is considered that, in children with serious illnesses such as cancer, physical activity during treatment has beneficial effects (physical and mental well-being, self-confidence and self-esteem ...)(INSERM, 2008). However, it is important to notice that physical activity has to be appropriate according to the circumstances (Herbinet, 2002). If some programs begin now to be offered in some hospitals, a lack of resources suitable for children and adolescents appears to be the norm. This study aimed to identify needs and resources for the implementation of a project like this in the department of Hematology Oncology at a hospital in the region of Wallonia, Belgium). Methods In this perspective, we interviewed various members of the medical and paramedical staff (n = 20), young patients (n = 8) and their parents (n = 5). This triangulation process aimed to guarantee the validity of the data. The semi-structured interviews were focused on the representations of these subjects about physical activity at the hospital in young people with cancer (definition of physical activity, opportunities and habits of the young patients to exercise, benefits and risks of being active) as well as about their opinions about the characteristics of the actions to implement (type of activities, recommendations, needed resources and conditions). Respecting the principles of the qualitative research, a content analysis of the answers has been conducted. Results Most of the subjects supported this type of project. Five categories of activities have been identified (adapted ball games, soft gymnastics, group fitness classes, relaxation activities, outdoor activities). A daily medical monitoring has been emphasized while precautionary measures have been listed, as well as the resources of the human, material, organizational and financial aspects that would be needed. Discussion Our findings show that hospitalized children no longer practice physical activity and that availability of specialized physical educators would encourage them to meet their expectations to be more active. Adults recognize that the implementation of these activities would have many physical and psychological benefits for children. They emphasize that individualization is at the center of the intervention. This would require the development of multidisciplinary collaboration. The funds seem less relevant than the presence of a promoter. References Herbinet, A. (2002). *L'expérience des pratiques corporelles auprès d'enfants et d'adolescents hospitalisés atteints d'un cancer : du corps malade au corps vécu*, Recherches & Educations . Retrieved from the Internet on January 2012 : <http://rechercheseducations.revues.org/index165.html>. Institut National de la Santé et de la Recherche Médicale (INSERM)(2008). *Activité physique. Contextes et effets sur la santé*. Expertise collective. Paris : Les Editions INSERM.

### **MOTIVATION TO GO INTO SPORTS OF LATVIA YOUNG PEOPLE**

Porozovs, J., Porozova, D.

Riga Teacher Training and Educational Management Academy

Introduction Sport pedagogues must turn great attention for rousing interest of young people to physical activities. Perceived competence, self-determination and self-motivation are important factors in promoting of lifelong physical activity and development of talent in children (Collins et al, 2010). Methods The questionnaire of 15-18 years old Latvia young people actively participating in sport exercises was carried out. 289 young people were questionnaire. Results The results of investigation showed that 33% of questionnaire young people attend sport exercises in order to reach high results in competitions and become high-class sportsmen, 28% - in order to rise physical condition

and keep good health, 24% in order to acquire new skills, 9% to enjoy sport exercises, 3% in order to meet friends, 2% to keep family traditions etc. 94% of questionnaire young people are fond of sport exercises. As negative factors which hamper participating in sport exercises young people mention lack of time (28%), bad level of sport equipment (10%), difficulties in training process (9%), disagreements with coach (7%), disagreements with other sportsmen (7%), problems with health (6%), etc. The motivation to go into sports is very closely connected with the fact that majority of questionnaire young people have accepted sports as part of their life and also with motivation to reach high results. The main reasons for leaving sports of Latvia young people are following: other interests not connected with sports (16%), injuries and traumas (13%), inability to reach high results in sports (12%), interest about other branches of sports (11%), high level of competition (11%), disagreements with coach (7%), disagreements with other sportsmen from group (6%), hard training exercises (4%) etc. The majority of young people started their sport activities by their own decision (62%) or by advice of parents (14%). Only 7% of young people started to attend sport exercises as a result of suggestion of sport pedagogues. 61% of questionnaire young people consider that they train during sport exercises accordingly their abilities but 39% admit that they could do it harder. Discussion Sport pedagogues must pay more attention to problem of motivation of young people to go into sports. The personality of sport pedagogue has great role in forming motivation to go into sports and reaching high results of young people. If coach knows the main motivations of sportsmen he or she could use it for reaching of the goals. Instead of early specialization all-round sport activities are suitable for children moreover pleasure and enjoyment are especially important. References 1. Collins, D., Martindale, R., Button, A., Sowerby, K. Building a physically active and talent rich culture: An educationally sound approach. In: European Physical Education Review, Vol. 16, Issue 1, 2010, p. 7-28.

### **RUN TEST AFTER FIVE YEARS: DATA ON A POPULATION OF URBAN SEDENTARY STUDENTS**

Frattini, G., Vago, P., Casolo, F., Bruseghini, P., Merati, M., Lovecchio, N.

*Catholic University of Milan, Italy*

Introduction Urban environment may effect the physical practice, of the student population. Many sporting facilities are present in a city but sedentary approach is more typical in a city than in a rural environment. Often, in a large city (like Milano) students play sport or engage in physical activity only during physical education classes (1). The purpose of this study was to compare the same physical performance after five years: during the first and last years of high school course. Material and methods During the first month of high school (September 2005) the Physical Education teacher assessed the 1000m run test to their student. After five years (September 2011) 196 students (108 male and 88 female) repeated the test. All phases of the test were carried-out by the same teacher in the same path (out-door). All students were sedentary and lived in the city since their birth. Results In the first session boys spent 5min ( $\pm 28$ s) to cover the path while girls used 42s ( $\pm 43$ sec) more than male (340 s). No girls used less than 300 sec while only one boy run 1000m more than 360sec. After 5 years the 70% of boys increase the performance using, on average, 42s less to cover the run distance. The girls showed a poor improvement: only 55% of them decrease the time. Mean speed of the girls was 2,96m/sec. Both boys and girls decrease the mean variation: boys from 37 to 34sec; girls from 43 to 30sec. The best gaps between the two tests were 60sec and 94sec for females and males respectively. No significant correlations were found between time spent and anthropometric characteristics. Also, after five years, the performance did not correlate with weight and height:  $r=0,006$ ;  $r=0,21$  and  $r=0,28$ ;  $r=0,19$  within male and female respectively. Discussion The current data show population's characteristics that seem specific of a city environment. Indeed only the sedentary students who play games and perform physical activity during Physical Education classes showed improved running performance (2). The boys obtained better results than the girls both in terms of the number of students showing an improved performance as well as in the magnitude of the improvement. Therefore the Physical Education courses, in an urban context, are a precious element to contrast the sedentary life style (3) and to reduce the drop-out. References 1. Ozdirenç et al. Pediatrics International, 47 (1):26-31; 2005 2. Serbescu et al. Acta Paediatrica, 95 (10):1258-65; 2006 3. Verstraete et al. Public Health Nutrition, 10 (5):477-84; 2007

### **SPORTS AND EXERCISE SAFETY IN FINLAND : A NATIONWIDE IMPLEMENTATION CASE TO TEACHERS AND COACHES**

Jussila, A.M., Oksanen, R., Pasanen, K., Parkkari, J.

*UKK Institute for Health Promotion Research*

Introduction Sports activities are considered to be beneficial to health. On the other hand, participating in sports can also be dangerous by increasing the risk of acute and overuse injuries. Number of sports injuries has increased considerably in Finland during the past decades. Today sports injuries are the most common injury type in our country. Treating of these injuries is often difficult, expensive, and time consuming. The purpose of The Sports and Exercise Safety in Finland program (LiVE) is to increase physical activity in general and safety of sports and exercise in a nationwide setting. Methods LiVE research projects focus on sports-specific injury incidence, risk factors, mechanisms and prevention strategies. Study findings are delivered to the field by communication and education. Implementation of injury prevention is conducted in two nationwide campaigns, Healthy Athlete (2006-) and Safety in School Sports (2010-). The main target groups are young athletes (age 12-20) and their coaches and parents but also elementary school pupils (grades 7 to 9) and their teachers. LiVE programs main communication and education channels are websites: [www.terveurheilija.fi](http://www.terveurheilija.fi) and [www.tervekoululainen.fi](http://www.tervekoululainen.fi). Results Two large randomized controlled studies have been carried out, one among female athletes (Pasanen et al. 2008) and another among army recruits (Parkkari et al. 2011). Also, numerous original studies of injury epidemiology in different sports have been published. The findings of these studies have indicated that sports injuries are true public health problem in Finland. However, a remarkable part of these injuries can be prevented by enhancing awareness of injury risks, increasing quality and contents of training and drills, and taking care of safety environment and equipment in sports. During 2006-2011 LiVE program has educated 70 LiVE-tutors (LiVE education lasts for 1-year) who work in different organisations (e.g. Finnish Ice Hockey Association, Finnish Gymnastic Federation and Judo Federation). In addition, LiVE program has appeared annually in about 30 different events (e.g. European Youth Olympic Summer Festival 2009, Power Mover 2011, Floorball World Championship 2010, PE teachers seminars 2010, 2011 and 2012) and organized several education sessions to improve safety in sports. LiVE websites (in Finnish) have attracted 3000-6000 visitors and 50 000-80 000 hits per month. Discussion Successful development and implementation of preventive strategies against sports and exercise related injuries are likely to result in large reduction in the absolute number of health problems, a reduction in work and school absenteeism, and decrease in medical costs. The true effects of the preventive measures and programmes of the LiVE will be seen within five to ten years. Program is financially supported by the Finnish Ministry of Social Affairs and Health and the Finnish Ministry of Education and Culture. References Pasanen K et al. BMJ 2008;337:96-102, Parkkari J et al. BMC Medicine 2011;9:35.

## STATUS LABOUR OF TEACHERS OF EXTRACURRICULAR SPORTS ACTIVITIES IN SCHOOLS ACCORDING TO HIS INITIAL QUALIFICATION

González, M.D.1, Campos, A.2, Pablos, C.3, Pablos, A.3

1: Alcalá University (Alcalá de Henares, Spain), 2: Polytechnic University of Madrid (Madrid, España), 3: Catholic University of Valencia (Valencia, Spain)

**Introduction** Most people working in sport and physical activity in Spain have unstable employment and low income according to the jobs (Campos, 2010). Specifically, in the extracurricular sports activities in schools there are few studies about the employment situation of these teachers in Spain. Therefore, the objective of this study is to analyse the status labour of teachers of extracurricular sport activities in the Primary schools of the Autonomous Community of Madrid according to his initial training. **Methods** We have used a quantitative methodology of descriptive cut. For this target the sectional survey through personal interview have been applied to people who is working teaching extracurricular sports activities in Primary Centers of Madrid (300 teachers). To catch the relevant information for the study we have used a structured interview. **Results** The results showed that 93% of the teachers who have a sports qualification have a temporary contract and part-time, only 7% of them do have permanent contracts. The teachers who have not a sports qualification have a percentage between 45% and 88%. According hours worked, earnings are highly diversified, the teachers who have sports qualification earn between 9.01 and 18 euros per hour. The monitors that have not sports qualification show more diversification in their earnings. According to monthly earnings, 48% the teachers who have not sports qualification earn less than 150 euros a month and 38% between 150 and 300 euros. The teachers that have a sports qualification, the monthly income are very diverse, between 150 euros and 1953 euros a month, although this income is not more than 10%. **Discussion** Most teachers, regardless of their sport qualification, have temporary contracts and part-time and there is no logical connection between the incomes and training. Comparing these results with other studies of people working in the labor market of physical activity and sport (Augustin, 2003; Campos, 2010), in this job there are higher situations of precarious employment. It is therefore necessary to improve the employment status of teachers of extracurricular sport activities, to ensure adequate education of students and practice healthy physical sports. **References** Augustin, J.P. (2003). *Le sport et ses métiers – nouvelles pratiques et enjeux d’une professionnalisation*. Paris, La Découverte. Campos, A. (2010). *Dirección de recursos humanos en las organizaciones de la actividad física y del deporte*. Síntesis, Madrid.

13:45 - 14:45

## Poster presentations

### PP-SH09 Sociology

#### EFFECTS OF GENDER AND SPORT ON DUAL CAREER OF ITALIAN STUDENT ATHLETES

Guidotti, F., Minganti, C., Cortis, C., Piacentini, M.F., Tessitore, A., Capranica, L.

*University of Rome Foro Italico*

**Introduction** This study aimed to examine the effects of gender, competition level (i.e., county, regional, national), and type of sport (i.e., Individual sports and team sports) on motivations toward academic, athletic and sport careers in Italian student athletes enrolled in Sport Science degree. **Methods** Italian Sport Science student athletes (n=293; gender: 35.49% female and 64.51% male; age: 21.36±2.55 yrs; competition level: 24.91% county, 41.98% regional and 33.11% national; type of sport: 29% individual sports and 71% team sports) completed the Harmonized Italian version of the SAMSAQ (H-SAMSAQ; Guidotti et al., 2012). A multivariate analysis of variance (MANOVA) was applied (p<0.05) to Academic Motivation (AM), Sport Motivation (SM), Sport Career as Athlete (SCA), and Sport Career as Operator (SCO) scores in relation to gender (male and female), competition level (county, regional, and national), and type of sport (Individual and Team). **Results** No difference emerged for gender, AM and CSA. For CSA a main effect emerged for competition level (p<0.0001; National=5.4±1.2pt, Regional=4.6±1.2pt, County= 4.1±1.1pt) and for type of sport (p<0.0187; Team=5.0±1.4pt, Individual=4.6±1.2pt). For SM, a difference (p=0.0134) emerged only for competition level, with National athletes showing a higher value (5.9±0.8pt) with respect to Regional (5.6±0.7pt) and County (5.5±0.7pt) levels. **Discussion** As expected, competition level and type of sport affect CSA, being national athletes are more motivated to be professional sportspersons, and team-sport athletes having more opportunities to emerge in professional sport. The lack of gender differences should encourage the cooperation between Education and Sport Bodies to promote equal opportunities for athletes in sport careers. **References** Gaston-Gayles J. (2005). *JCSJ*, 46(3), 317-327. Guidotti, F., et al. (2012). *eass Conference*, Berne (Switzerland).

#### MEDIA DISCOURSE ABOUT DOPING IN SPORT – CONTENT ANALYSIS OF THE COVERAGE IN DIFFERENT GERMAN NEWSPAPERS

Schirm, J.

*German Sport University Cologne*

**Introduction** Based on the assumption that everything we know about our society – and, for that matter, about the world we live in – we know through mass media, coverage plays a great role in the education and the formation of culture. Particularly the discourses about doping in sport give reason to think about the responsibilities and the ethic standards in media coverage. There is almost no theoretically informed empirical data about the coverage of doping in mass media. The focus of this paper is the doping discourse in mass media, i.e. the way in which doping is presented as a phenomenon of elite sport and the kind of interpretative frames that inform the discourses. The research is based on assumptions derived from the theoretical work on elite sports as a social system and from concepts of framing in media. **Main questions and theoretical background** The general questions that are put forward in the paper are what kind of interpretative schemes are referred to in the media discourses about doping and are there any differences between the discourses in different German newspapers? The main assumption in this paper will be the proposition of individualised coverage. It is expected that there is no discerning media coverage about doping, i.e. that there is no broad view on the causal factors of doping but on the contrary, that journalists are likely to support individualisation of the (mass) phenomenon of doping, thus focusing on individual cases, individual offenders

or victims. This proposition is derived from the fact that sport, mass media and economy are highly interconnected and have a common interest that 'the show must go on' and should not be irritated by reports on responsibilities and liabilities of diverse agents. These (and further) national peculiarities (e.g. political/financial support of elite sport; anti-doping law; national (identity) sports) are expected to have an impact on the mass media system and their way to observe, select, process and disseminate information to the public. Methods The media discourses is analysed on the basis of a content analysis of a representative sample of articles on doping during the year 2012 in six broad sheet papers in Germany (Frankfurter Allgemeine Zeitung, Süddeutsche Zeitung, Die Welt, Frankfurter Rundschau, Die Tageszeitung, Bild). The content analysis includes formalities (e.g. placement, size, author of articles) and qualitative aspects about the discourses (e.g. frame of reference, foci of report). Findings The findings will be discussed within the theoretical frame of agency based action theory. References Philipp M. (2002). Die Konstruktion des medialen Dopingdiskurses. Wiesbaden: Universitätsverlag. Schirm J, Hartmann-Tews I. (2011). Impulse – scientific magazine of the German Sport University Cologne. 02/ 2011, 36-43.

### **BODY CONSTRUCTION AND ANABOLIC STEROIDS USE: 'A MAD THING TO TAKE!'**

Santos, A.M., Serejo, O., Hoenisch, J.

*Universidade Federal da Bahia, Instituto de Saúde Coletiva*

Introduction: Anabolic androgenic steroids (AAS) and other drugs are used to enhance athletic performance and appearance (Bahrke & Yesalis, 2004). However, a comparable synthesis of nonclinical studies has not been made (Clark & Henderson, 2003). The aim of the present study was to investigate the body construction and appearance and performance enhancing drugs (APEDs) use among young male Brazilian bodybuilders. Methods: Employing an ethnographic approach, with in-depth interviews, we qualitatively investigated body image construction among 7 bodybuilders (20-30 yrs of age) in a gym Northeast of Brazil. We used the Discourse of the Collective Subject (DCS) (Lefèvre and Lefèvre, 2003) in order to tabulate and organize the qualitative data obtained during the semi-structured interviews. Adhering to the Theory of Social Representation, this technique permits synthesis of individual narratives – written in the singular, first person – into "one voice" in order to express 'community thought'. In other words, the discourse of seven individuals becomes one. Results: The DCS interpretations for these themes are: 'I saw the guys 'very big' in the gym and I began to take as a mad; I take this (ASS) very hard; I take many kinds of things as testosterone cypionate, nandrolone decanoate, ADE, stanazolol, Greek Deca Durabolin, ADE (injection source of vitamins A, D, and E for animals); I did not get big naturally; I take so much creatine'. Discussion: Men's body image problems may manifest as an unhealthy drive for muscularity and propensity to use anabolic-androgenic steroids (AAS). Based on our results, this group of bodybuilders – with the apparent purpose just 'to look big' (Santos, da Rocha & da Silva, 2011). Conversely, stereotypically male body image disturbance is anchored in a "drive for muscularity". Body image importance and sociocultural pressures predicted increasing muscle bulk for normal and overweight young male (McCabe, Ricciardelli & Holt 2010). And the most commonly cited behavior associated with body image disturbance (BID) in men is illegal APED (Hildebrandt, Alfano & Langenbucher, 2010). Future research on male BID should account for this structure in order to better define relevant diagnostic categories and evaluate the nonclinical significance of BID. References Bahrke MS, Yesalis CE. (2004). Current Opinion in Pharmacology 4:614–620 Clark AS, Henderson LP. (2003). Neuroscience and Biobehavioral Reviews 27,413–436 Hildebrandt T, Alfano L, Langenbucher JW. (2010) Journal of Psychiatric Research 44,841–846. Lefèvre F, Lefèvre, AMC. Caxias do Sul: Educ, 2003. McCabe MP, Ricciardelli LA., Holt K. (2010). Eating Behaviors 11,156–163. Santos AM, da Rocha MSP & da Silva MF. (2011). Journal of Substance Use & Misuse Volume (46): 6, 742-748.

### **DESIGNING EVIDENCE POLICIES FOR ENHANCING SPORT PARTICIPATION**

Breedveld, K.

*WJH Mulier Institute*

Designing evidence based sportspolicies in the Netherlands: lessons learnt Breedveld, K. 1; Van der Poel 1; Collard, D 1; De Jong, M. 1 1 Mulier Institute Introduction In the Netherlands, in 2005 the national government issued a new policy program called A new policy, 'Time for Sports'. The program had three main objectives: enhancing health through sports, enhancing participation in and through sports, and improving performance in elite sports. On all three policy-areas, concrete goals (quantitative indicators) were formulated and policy-programs were issued. Time for sports were a major effort to develop a transparent sportpolicy, that would allow for in depth monitoring and evaluation. Method In this paper, we will go into the results of the Time for Sports program. For this, we draw on an intensive study of policy documents, interview with 20 experts, secondary analyses of the most relevant sportstatistics, and membership data for 500 sportclubs for over 4 years. Results The outcome of the evaluation are that the program largely reached its 'throughput' and 'output', yet failed to reach many of its 'outcome goals': physical activity levels did not rise that much in the 2005-2010 period, and the program failed to reach many other of the other goals that were set out at the start of the program. Yet the program can not be labeled unsuccessful, though it is hard to proof the effectiveness of the program by merely looking at 'objective' outcome measures. Discussion Taking all this in consideration, and taking into account how the policy was first formed in 2005 and how its goals came into being, we will deliver a theory on why the Time for Sports program did not deliver fully what it set out to do at the beginning. The theory has important implications for sportspolicies, but also for sportsresearch aiming to support such policies with data and research-findings.

### **THE OLYMPIC GAMES IN LONDON 2012 FROM A SWEDISH MEDIA PERSPECTIVE**

Hedenborg, S.

*Malmö University*

The aim of this paper is to map out and study Swedish media coverage of the Olympic Games in London 2012 from 6th July 2012 (when London was chosen as the host of the Olympic Games 2012) up until the Games are finished (Olympic games 27 July to 12 August and Paralympics 29 August to 9 September ) in order to discuss how the Olympic Games are presented for the Swedish audience. Four themes will be focused: sustainability, gender, body and ethnicity/nationality. One daily newspaper (Dagens Nyheter) and one tabloid (Aftonbladet) will be used as source material. This study will be published together with other studies with similar aims in an international anthology.

**MEASURING QUALITY OF LIFE IN HANDBALL PLAYERS: A DESCRIPTIVE STUDY.**

Santos, A.

*University of São Paulo and FAPESP*

**INTRODUCTION:** There are few data on quality of life in sports. Studies that measure quality of life can map several factors that make up the index of quality of life and allow the analysis of satisfaction and importance regarding aspects of the lives of athletes related to health and functioning, family, socioeconomic conditions, the psychological and spiritual. **OBJECTIVE:** The purpose of this research is to investigate the quality of life in handball athletes through a descriptive study. **SUBJECT & METHOD:** The instrument used to investigate the quality of life of the athletes was the Quality of Life Index created by Ferrans and Powers. The instrument consists of two parts with thirty four factors each part. The first part measures the satisfaction with various aspects of life, and the second part measures the importance of these aspects for the individual life. The instrument results in values between 0 (worst QLI) and 30 (best QLI). Study participants were members of the handball federation. The athletes had over 18 years of both genders, and they participated in official competitions. This research respected all the ethical procedures. The sample comprised 67 subjects, 25 men and 42 women, mean age 23.6 years (SD=4.3). **RESULT:** The sample presented total QLI with a minimum of 4.3 and maximum 28.8, mean 22.2 (SD=4.2). The QLI health and functioning domain reached the minimum value of 4.5 and maximum 28.5, mean 21.7 (SD=4.6). The family domain got minimum value of 6.6 and the maximum value of 30, average 20.7 (SD=4.4). The socioeconomic domain reached minimum value of 5.6 and maximum 23.6, mean 16.1 (SD=3.5). The spiritual and psychological domain obtained minimum value of 0 and maximum of 30.0, average 23.7 (SD=5.6). Among the factors that resulted in lower values are the intensity of pain, stress and worry. Among the factors that present higher values are satisfaction with their children and faith in God. **DISCUSSION:** High levels of quality of life for athletes can have a positive impact on the efficiency of training and athletic performance. On the other hand, problems outside of sports can take the focus on work and disrupt the dedication of the athletes in daily training. The study presents evidence of the need to improve the quality of life for athletes, especially in the socioeconomic field. In addition to data on quality of life, the results indicate the areas of the lives of athletes in need of further investigation and possible interventions. **REFERENCES** Ferrans CE, Powers MJ. Quality of Life Index: development and psychometric properties. *Adv Nurs Sci.* 1985; 8(1), 15-24. Kimura M. Translation into Portuguese and validation of the Quality of Life Index, Ferrans and Powers. São Paulo: University of São Paulo, [1999]. UNIVERSITY OF SÃO PAULO – Physical Education and Sport School FINANCIAL SUPPORT: FAPESP

**NEGLIGENCE, CHILDREN AND SPORT 2: AVOIDING LIABILITY.**

Greenfield, S., Osborn, G.

*University of Westminster*

This paper considers how Governing Bodies in sport have reacted to avoid being held liable in negligence. There are two aspects to this strategy. First the construction of the rules under which youth sport is played and how individual differences in size and ability can be encompassed. Both Rugby Union and Cricket have introduced protective measures to ensure children are not exposed to undue risk. The three areas cover; the requirement for protective equipment, protecting the child from 'over playing', and from 'unfair' or 'unequal' competition. Different sports require specific protective equipment and there is the question as to whether the wearing of such equipment is voluntary, compulsory or subject to parental waiver. Overplaying acts to limit what a child may do in terms of playing time or activity such as a restriction on the number of overs a young cricketer may bowl. Similarly scrummages in Rugby Union are subject to strict regulation with the potential for uncontested scrums. Such regulations are primarily based around age groups with a progressive increase in physical activity according to date of birth. The application and effectiveness of these measures is reviewed. Secondly the judgment exercised by the organizers, coaches and referees and how potentially dangerous situations are prevented. The essence of this is both the interpretation of the rules under which the game is played and how reasonable care is exercised. This encompasses the identification and application of professional practices and guidance in the selection and management of teams and the adjudication of matches. The paper analyses how such judgment interacts with liability for negligence

**APPLYING THE DEVELOPMENTAL MODEL IN INVESTIGATING THE CAREER DEVELOPMENT OF FLEMISH FORMER ELITE ATHLETES**

Reints, A.

*Vrije Universiteit Brussel*

**Introduction** While the athletic career may seem continuous in nature, sport psychology research has revealed that it consisted of within-career transitions. Wylleman and Lavallee (2004) developed a developmental model reflecting the developmental and interactive nature of transitions at athletic, psychological, psychosocial and academic/vocational level. The aim of this study was to explore athletes' career development, career experiences and challenges as perceived by former elite athletes in their (post-) athletic career. Methods Face-to-face interviews were performed with 24 Flemish former elite athletes (M = 36.79 years old, SD = 5.19), including 12 female athletes (M = 34.25, SD = 5.55) and 12 male athletes (M = 39.33, SD = 3.39); 13 former athletes from individual sports (M = 35.92, SD = 4.48) (e.g., cycling, track and field, triathlon, sailing, swimming, fencing, judo), and 11 participants from team sports (M = 38.18, SD = 5.42) (e.g., soccer, basketball, korfbal, volleyball). The participants retired from elite sport between 1 and 6 years ago, on average 2.9 years ago. Directed content analysis combining a deductive and inductive approach, was used. Results Participants clearly described their athletic career as having experienced several different stages and transitions. Results confirmed the existence of the four levels within the developmental model (i.e., athletic, psychological, psychosocial, academic/vocational level) and also revealed the presence of several within-career transitions not included in the model (e.g., during the mastery and discontinuation stage). Second, data analysis led to the identification of two developmental levels, which were not included in the model, namely the (a) financial level of development, and (b) physical level of development. Discussion By suggesting two stages within the mastery stage, five stages within the discontinuation stage, and stages, transitions and experiences at physical and financial level, current study results broadens the conceptualisation of the normative transitions (former) athletes may face. In this way, it enables to envisage transitions which might overlap and lead athletes to more and/or extensive coping. More specifically, this study leads to a better understanding of the developmental model's capacities and more fully describes athletes' career development. References Wylleman, P, Lavallee D (2004). Developmental sport and exercise psychology: A lifespan perspective, 507-527. FIT, Morgantown.

13:45 - 14:45

## Poster presentations

## PP-SH10 Psychology 2

**INCREASING PHYSICAL ACTIVITY USING Pedometer AND WEB-BASED INCENTIVES**

Allen, M.

*London South Bank University*

Introduction There is now compelling evidence that at least 30 minutes of moderate intensity physical activity five times a week has beneficial outcomes. Despite this consistent finding it is often difficult to motivate people to incorporate physical activity into their daily lives. Pedometers which provide daily step counts have recently been shown to help people increase their levels of physical activity. This study explores how effective a new web based service called Activity4Charity is at increasing physical activity levels. It combines using pedometers and downloading the data onto a web based system with the incentive of raising money for charity. Methods 72 healthy adults (24 men, 48 women) participated in the study. They had a mean age of 41.71 years (sd = 11.87) and a mean Body Mass Index of 26.77 (sd = 7.37). Participants were randomly assigned to one of four groups: 1) collecting money for charity and participating alone, 2) collecting money for charity and participating in a group, 3) not collecting money for charity and participating alone, 4) not collecting money for charity and participating in a group. Following a two week baseline, participants completed a 6 week trial. They were required to wear their pedometer at all times during the day, and they were required to regularly download their data onto the Activity4Charity website. Before and after the 6 week trial participants completed questionnaire measures of health and wellbeing. Performance data (average daily steps and total steps) were downloaded from the Activity4Charity website and compared across conditions. Health data were also compared before and after the trial and between conditions. Results There was a significant difference in the daily average steps taken between baseline (mean = 8,987.73) and trial (mean = 9,832.39) conditions,  $t(61) = 2.88, p = .005$ . Also, participants in the charity condition performed better than those in the non-charity condition, with greater daily average steps,  $t(48) = 2.36, p = .022$ , and total steps,  $t(48) = 2.60, p = .012$ . There was no significant difference for daily average steps,  $t(70) = 1.15, p = .255$ , or total steps,  $t(70) = 1.52, p = .132$ , between those taking part in groups and those taking part individually. There was also some evidence that levels of depression were lower after the intervention than before the intervention,  $t(18) = 1.84, p = .083$ . Conclusion This study demonstrates that a 6 week web-based physical activity (pedometer) intervention can increase physical activity levels and benefit mental health particularly when raising money for charity.

**COMPARISON BETWEEN SELF-PERCEPTION AND ACCELEROMETER MEASURED PHYSICAL ACTIVITY PATTERNS IN COLLEGE STUDENTS.**

Van Hoomissen, J., Downs, A., Julka, D., Lafrenz, A.

*University of Portland*

Participation in physical activity on a regular basis is important for maintaining health, yet many people do not meet the levels recommended by scientific and health organizations. Physical activity behavior during the late adolescence/early college period in life is of particular importance as behaviors adopted during this time frame may carry over into adulthood. Previous research indicates that between 40-50% of college students are physically inactive, thus putting their health at risk (1,2,3). The purpose of this study, therefore, was to measure physical activity levels in college students, utilizing both objective, quantitative data (accelerometers) as well as more traditional self-report measures (International Physical Activity Questionnaire). In addition, we examined the relationship between these two different forms of measurement and common mental health constructs associated with physical activity levels such as depression, anxiety, stress, self-efficacy, self-esteem, and happiness. Forty nine male and female college aged subjects were recruited from a private, liberal arts university during both the fall and spring semesters. Students completed a series of mental health questionnaires and fitness tests prior to measurement of physical activity behavior, which was assessed over a two week period using two different forms of measurement: 1) IPAQ and 2) Accelerometer (Actigraph). Subjects tended to overestimate their time spent in all categories of physical activity (light, moderate, and vigorous), and underestimate their time spent in sedentary behavior indicating a discrepancy in self-perception of actual physical activity behavior. There were significant positive correlations between average minutes per day spent in moderate/vigorous activity and happiness, self-efficacy, and self-esteem. In addition, higher physical activity levels were associated with lower levels of anxiety and stress. These results are consistent with previous research showing significant correlations between physical activity and aspects of mental health. This study remains one of the more extensive college population studies that matches objectively measured physical activity using accelerometers and mediators of mental health. One of the major findings is the discrepancy in perceived time spent in moderate and vigorous activity and the actual time spent in moderate and vigorous activity. The benefits of exercise are well known to this population but there remains a low level of participation. Further research will focus on interventional studies based on feedback to individuals in the college population with regards to what constitutes moderate and vigorous physical activity. References 1.Buckworth, J, Nigg, C. (2004). J American College Health, 53 (1), 28-34. 2.Ferrara, C. (2009) J Exer Physiol Online, 12(1), 23-35. 3.Keating, X, Guan, J, Pinerio, JC, Bridges. (2005). J American College Health, 54 (2), 116-125.

**COMMUNICATION AND PHYSICAL ACTIVITY BEHAVIOR**

Pfeffer, I.

*University of Leipzig*

Introduction Effective health communication is an important aspect of health behavior change (Noar et al., 2007). Based on the Regulatory Focus Theory (RFT; Higgins, 2000) it was examined whether the regulatory fit between the chronic regulatory focus of a person (promotion vs. prevention) and the arguments used in a physical activity promotion message (promotion-goals vs. prevention-goals) enhances physical activity motivation in contrast to non-fit messages. Method In a randomized design with two experimental conditions chronic regulatory focus (promotion vs. prevention) was measured of N = 98 participants (44 female; age M = 41.2 years, SD = 10.18; physical activity M = 157.20 minutes/week, SD = 162.30). Subsequently, participants were allocated at random to one of two conditions (message



with promotion-goals vs. prevention-goals). Participants were asked to read the respective message and to fill in a standardized questionnaire including measures of the value derived from fit variables (Latimer et al., 2008). Internal consistencies of the scales were satisfactory to good. Results Hierarchical multiple regression analyses controlling for physical activity behavior re-vealed significant interaction effects Condition x Regulatory Focus for intention to perform the behavior,  $\Delta R^2 = .043$ ,  $\Delta F(1,93) = 4.81$ ,  $p < .05$ ;  $f^2 = .04$ , prospective feelings,  $\Delta R^2 = .061$ ,  $\Delta F(1,93) = 7.45$ ,  $p < .01$ ;  $f^2 = .06$ , and retrospective feelings associated with the behavior,  $\Delta R^2 = .043$ ,  $\Delta F(1,93) = 5.32$ ,  $p < .05$ ,  $f^2 = .05$ . No effects were found for inclination towards the message and perceived goal value. Mediation analyses revealed prospective and retrospective feelings to mediate the effect of regulatory fit on intention to perform the behavior. Discussion Creating regulatory fit between the chronic regulatory focus of a person and the arguments used in a physical activity promotion message produces more positive feelings associated with the behavior and enhances physical activity motivation in contrast to non-fit conditions. It is therefore an effective strategy to improve message persuasiveness. However, it is not clear if regulatory fit also would have influenced physical activity behavior itself. References Higgins, E. T. (2000). Making a good decision: value from fit. *American Psychologist*, 55, 1217-1230. Latimer, A. E., Rivers, S. E., Rench, T. A., Katulak, N. A., Hicks, A., Hodorowski, J. K., Higgins, T., & Salovey, P. (2008). A field experiment testing the utility of regulatory fit messages for promoting physical activity. *Journal of Experimental Social Psychology*, 44, 826-832. Noar, S. M., Benac, C. N., & Harris, M. S. (2007). Does tailoring matter? Meta-Analytic review of tailored print health behavior change interventions. *Psychological Bulletin*, 133, 673-693.

### MOTIVATIONAL PREDICTORS OF PHYSICAL SELF-CONCEPT AND PHYSICAL ACTIVITY IN SCHOOL AND LEISURE-TIME ACROSS THE PRIMARY-SECONDARY SCHOOL TRANSITION

Taylor, I.M., Spray, C.M., Pearson, N.

*Loughborough University*

Introduction: A significant life-event that occurs at the onset of developmental declines in physical activity (PA) is the transition from primary to secondary school physical education. With this in mind, we adopted self-determination theory (Deci & Ryan, 2000) to longitudinally explore children's motivation in primary school PE as a predictor of change in physical activity behaviour in school and leisure time across this transition. In addition, children's physical self-concept was explored as an important component of their global sense of well-being which may be vulnerable to potential declines across the primary-secondary school transition. Methods: 348 10- and 11-year old school children (52% male) took part in the study by completing a multi-section questionnaire exploring the study variables at the end of primary school and three months into secondary school (approximately five months later due to the summer vacation). Results: Paired samples t-tests revealed that children's physical self-concept, school PA, and leisure-time PA significantly declined over the primary-secondary school transition (all  $p < .05$ ). Further, intrinsic motivation in primary school PE positively predicted change in physical self-concept and school PA ( $\beta = .12$  and  $\beta = .13$ , respectively; both  $p < .05$ ), whereas external regulation in primary school PE negatively predicted change in leisure-time PA ( $\beta = -.10$ ,  $p < .05$ ). Children's identified regulation and introjected regulation did not predict change in the outcome variables. Conclusions: Evidence is provided that children's physical activity and physical self-concept decline over the transition from primary to secondary school. Moreover, children's enjoyment and interest (i.e., intrinsic motivation) in primary school PE, as well as their experiences of pressure and coercion (i.e., external regulation) may partially explain these worrying declines. References Deci, E.L., & Ryan, R.M. (2000). *Psychological Inquiry*, 11, 227-268.

### VALIDATION OF THE GREEK VERSION OF THE EXERCISE SELF-EFFICACY SCALE

Theodoropoulou, E., Karteroliotis, K.

*National and Kapodistrian University of Athens*

Introduction The exercise self-efficacy scale has been established to have sound psychometric properties (Marcus et al., 1992). However, no validity or reliability data of this scale are available in the Greek language, hence prompting the present study. Therefore, the aims of the current study were to examine the factorial validity and reliability of the Greek version of the exercise self-efficacy scale (Marcus et al., 1992). Methods Participants were 340 volunteers that attended the physical education classes at the University of Athens. To test the factorial validity, two samples were used. The first sample (N=150) were 77 men and 73 women (24.28±6.32 yrs), whereas the second sample consisted of 86 men and 64 women (22.85±5.64 yrs). An Exploratory Factor Analysis (EFA) was conducted with the first sample. The extraction method employed was principal axis factor followed by promax rotation (Russell, 2002). A Confirmatory Factor Analysis (CFA) (maximum likelihood method) was performed with the second sample to confirm the goodness of fit of the model found in EFA. The CFA was conducted using the AMOS 16.0 statistical software (Arbuckle, 2007). Assessment of model fit was based on  $\chi^2$ ,  $\chi^2/df$ , CFI, GFI, IFI, TLI and RMSEA indices (Kline, 2005). To test the internal consistency, the Cronbach's alpha ( $\alpha$ ) coefficient was used. To examine the test-retest reliability, 40 students, 21 men and 19 women (28.78±5.647 yrs), completed this scale twice with an interval of 15 days between the two assessments. Results The Kaiser-Meyer-Olkin (KMO) was 0.831 and the Bartlett Test of Sphericity was statistically significant ( $\chi^2=263.56$ ,  $df=10$ ,  $p=0.00$ ). EFA yielded one factor accounted for 59.54% of the variance of the model. The item factor loadings ranged from 0.48 to 0.82 ( $\alpha=0.83$ ). Similarly, CFA showed that this model presented a good fit ( $\chi^2=9.487$ ,  $df=5$ ,  $p=0.091$ ,  $\chi^2/df=1.897$ , CFI=0.988, GFI=0.974, IFI=0.988, TLI=0.976, RMSEA=0.078,  $\alpha=0.87$ ). The item factor loadings ranged from 0.56 to 0.84. The test-retest reliability coefficient was 0.92. Discussion The results indicated that the exercise self-efficacy scale was a valid and reliable instrument. These findings show that it is a useful tool for studies focusing on exercise and self-efficacy topics. Future studies are proposed in other Greek samples in order to increase the knowledge about the validity and reliability of the exercise self-efficacy scale. References Arbuckle JL. (2007). *Amos 16 user's guide*. Amos Development Corporation, USA. Kline RB. (2005). *Principles and practice of structural equation modeling*. The Guilford press, USA. Marcus BH, Selby VC, Niaura RS, Rossi JS. (1992). *Res Q Exerc Sport*, 63(1), 60-66. Russell DW. (2002). *Pers Soc Psychol Bull*, 28(12), 1629-1646.

### SATISFACTION WITH LIFE IN UNIVERSITY STUDENTS: THE ROLE OF SPORT PRACTICE

Figueiras, T., Martins, C., Santana, P.

*Instituto Superior da Maia*

Introduction The most recent researches on Positive Psychology show the increasing importance of subjective well-being (SWB) as one of the main indicators of well-being in western societies. SWB concerns each individual's judgment of his own life, considering personal experiences and the general assessment of such experiences. Satisfaction with life (LS) is the SWB cognitive component and is considered crucial for assessing the individual's quality of life. SWB is understood as the outcome of the personality and the experiences and life

circumstances (like gender and age), but also as the result of the voluntary control of individuals, through intentional activities such as practicing sports, that can cause lasting changes in SWB and LS. We wonder if, as a vehicle of positive psychology, a close relationship with sport can be assumed as able to promote and contribute to sustainable increase in individuals SWB and LS. In this sense, the objective of this study was: i) to assess the level of LS of university students, and ii) determine whether there were gender differences and between practitioners and non-practitioners and also between physical education and sport students (PES) and other courses students. Methods The sample was formed by 204 university students (116 girls and 86 boys) from the Instituto Superior da Maia (115 practitioners and 87 non-practitioners; 96 PES students and 106 of other courses). To evaluate the students' personal judgment on their LS we use a version translated and adapted to the Portuguese reality of the Satisfaction With Life Scale (SWLSp) of Diener, Emmons, Larsen and Griffin (1985). Results The whole sample ( $3.69 \pm 0.6$ ), boys ( $3.73 \pm 0.56$ ) and girls ( $3.65 \pm 0.62$ ) revealed LS above the mean value of the scale, which is usual in western societies. Boys practitioners showed higher rates of LS than the girls practitioners ( $3.73 \pm 0.52$  vs  $3.62 \pm 0.69$ ;  $p = .018$ ). There were no statistical differences between practitioners and non-practitioners, both boys ( $p = 0.12$ ) and girls ( $p = 0.09$ ). Also we didn't find statistical differences between PES students and other courses students – total sample ( $p = 0.87$ ); boys ( $p = 0.31$ ); girls ( $p = 0.42$ ). Discussion These results show the LS influence of multifactor, highlighting the prevalence of some factors, such as in this case the university, at certain stages of life, and therefore could not only be the result of exercise training. References Diener, E., Emmons, R. A., Larsen, R. J. & Griffin, S. (1985). The Satisfaction With Life Scale. *Journal of Personality Assessment*, 49, p: 71-75.; Diener, E., Oishi, S. & Lucas, R. (2003). Personality, Culture and Subjective Well-Being: Emotional and Cognitive Evaluations Of Life. *Annual Reviews Psychology*, 54, p: 403–25.

## PREDICTING CHANGES IN STUDENT'S AMOTIVATION IN PHYSICAL EDUCATION

Jackson, R., Spray, C.

*LOUGHBOROUGH UNIVERSITY*

Abstract text Introduction In Physical Education (PE) amotivation is evident when individuals lack the intention and willingness to participate in the compulsory activities (Deci and Ryan, 1985). Therefore, the aim of this study was to investigate relationships between the four dimensions of amotivation (ability beliefs, value of the task, effort beliefs and task characteristics), physical self-concept and a student's effort, and to explore potential predictors of change in amotivation. This study also aimed to investigate whether a teacher satisfies a students' three needs of satisfaction; autonomy, competence and relatedness and whether satisfying these needs predicts changes in amotivation. Method A total of 179 students (male, mean age = 14 years) participated in the study by completing a questionnaire during their scheduled PE lesson. Participants completed the same questionnaire at the end of every PE lesson over three different time points during a five week unit of work. Measures included an adapted version of a recently devised academic amotivation scale and a physical self-concept scale. In addition students' perceptions of teachers need support (NS) were measured using a scale adapted by Standage, Duda and Ntoumanis (2005). Teachers rated student's effort on a rating scale of motivated behaviour. Results Multilevel regression analyses showed that at Time 1, all three needs of satisfaction negatively predicted the amotivation dimension; task characteristics. Competence NS and relatedness NS negatively predicted value of the task and task characteristics, but there was no significant relationship between need support and effort beliefs. The amotivation dimensions did not significantly predict physical self-concept and there was no significant rate of change over time. Value of the task, effort beliefs and task characteristics significantly predicted teacher ratings of effort and there were significant decreases in amotivation over time. Ability beliefs was the only amotivation dimension that did not significantly predict teacher ratings of student effort over time. Student's perceptions of need support did not predict changes in physical self-concept or teacher ratings of effort. Conclusions Overall the findings suggest that the three needs of satisfaction have an influence on levels of amotivation. Students who perceived their teacher as failing to support their need for autonomy, competence or relatedness, may find the task itself less interesting, be deficient in their ability beliefs and fail to see the value of the task, causing a decrease in amotivation over time. Moreover, student effort grades may be able to predict whether a student is lacking in motivation in Physical Education, and as a result may have important implications for how teachers assess their students in schools. References Deci, E.L and Ryan, R.M. (1985). *New York: Plenum*. Standage, M; Duda, J and Ntoumanis, N. (2005). *British Journal of Educational Psychology*, 75, p. 411-433.

## HEALTHY LIFE AND PERSONAL RESPONSIBILITY: STUDY ABOUT BELIEFS OF BRAZILIAN PHYSICAL EDUCATION STUDENTS

Vaisberg, T.M.J.A., Ambrosio, F.F., Fialho, A.A.

*Pontifícia Universidade Católica de Campinas- Brasil*

Considering that practice of health workers depends not only on scientific knowledge but also in beliefs sometimes unconscious, we investigated the collective imaginary of physical education students, that nowadays are recognized as important agents of health promotion. Methodology: Twenty-seven subjects participated in a collective interview organized with the use of the "Thematic Drawings and Stories Procedure". According to this method, we asked the subjects to imagine and draw a healthy person. Hereafter, we asked them to create and write a story about the figure drawn. Results: These physical education students believe that health depends on exercise practice, appropriate diet, contact with nature, church attendance, friendship and satisfactory love and sex life. They don't refer to social and environmental public policies. Discussion: These beliefs may be interpreted as result of a vision of health as a personal responsibility that depends only on individual actions. We conclude that the students have a positive attitude valuing self-care, but the lack of perception of the importance about social and environmental public policies can mean that health is not viewed as a right of the citizens.

## BODY IMAGE DISSATISFACTION IN PORTUGUESE YOUTH: THE ROLE OF OBESITY, GENDER AND PHYSICAL ACTIVITY

Coelho, E., Gomes, M., Rodrigues, V., Fonseca, S., Mourao, I.

*University of Trás-os-Montes and Alto Douro*

Introduction: Many studies have shown variability in body image dissatisfaction among children and adolescents based on weight status, gender and physical activity. The aim of this study was to compare body dissatisfaction according to obesity, gender and physical activity in Portuguese youths. Methods: The sample was composed by 331 youths, aged 10-16 years (176 boys and 155 girls). Body image was assessed using Collins's (1991) body shape silhouettes and participants were asked to identify the silhouette that most accurately represented their body size (real) and the ideal body image. Body dissatisfaction was calculated by the difference between the real and ideal body image. Height and weight were measured to calculate BMI and Cole et al. (2000) cutoffs were used to define obesity. The chi-square test was used to compare groups. Results: The prevalence of obesity was 30.1% in boys and 30.1% in girls. The prevalence of body dissatisfaction was 54.7%; 37.1% wants to be thinner while 17.6% wants to be fatter. According to physical activity level, 81% practise

regularly. The body weight dissatisfaction varied according to weight status ( $p=.000$ ). The obese youth were more dissatisfied with their body image than the normal weight youth (80.6% vs. 44.5%). Girls are more dissatisfied with body weight than boys (59.5% vs. 50.3%), and the majority want to lose weight (40.9%), but the differences were not statistically significant ( $p=.223$ ). The prevalence of body dissatisfaction was similar (50%), when we compared the youth with different levels of physical activity ( $p=.896$ ). Discussion: The present study identified that body weight dissatisfaction varied according to obesity prevalence. In disagreement with other investigations, physical activity and gender did not discriminate the body image dissatisfaction. We suggested the inclusion in future investigations of other important variables, like, socio-economic status and age. References: Collins, E. (1991). Body figure perceptions and preferences among preadolescent children. *International Journal of Eating Disorders*, 10 (2), 199-208. Cole T, Bellizzi M, Flegal M, Dietz W, (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J*, 320, 1-6

### **A SYSTEMATIC REVIEW OF THE CORRELATES OF SOCIAL COMPARISON IN PHYSICAL EDUCATION**

Barnes, J., Spray, C.M.

*Loughborough University*

Purpose: To identify and review the associations between social comparison and behavioural, affective and cognitive outcomes in physical education (PE). The review collates and critiques the findings of included studies highlighting the limitations of these in addition to providing recommendations for future research. Design: A systematic review including a narrative synthesis. Five papers all published in the English-language were identified using electronic searches of seven databases and by manually searching reference lists and personal files. Peer reviewed research involving children (aged 0 – 18 years), a grounding in social comparison and an outcome variable were included. Results: Physical-self concept was negatively related to class average ability. Boys reported higher self-evaluations of ability in PE than girls and higher levels of physical self-concept. Negative associations between comparative evaluations of ability within the class and free time physical activity level were also identified. Different associations with the dependent variables were found depending on the frame of reference in question (i.e. the class had a negative relationship, but a small group had a positive relationship). Conclusions: Children are influenced simultaneously by multiple frames of reference, however, how these associations effect one another is unknown. There is clearly a dearth of knowledge in this area demonstrated through the small number of studies identified and included. Additionally, the review highlights the need for future research assessing other dependent variables and the simultaneous effects of comparisons with multiple frames of reference in addition to the need to develop measures of social comparison.

### **CONSISTENCY OF THE ENVIRONMENTAL DIMENSIONS OF AN OBSERVATIONAL INSTRUMENT ASSESSING COACH INITIATED MOTIVATIONAL CLIMATE.**

Tzioumakis, Y., Papaioannou, A., Digelidis, N., Zourbanos, N., Krommidas, H., Keramidis, P.

*University of Thessaly*

CONSISTENCY OF THE ENVIRONMENTAL DIMENSIONS OF AN OBSERVATIONAL INSTRUMENT ASSESSING COACH INITIATED MOTIVATIONAL CLIMATE. Tzioumakis, Y.I, Papaioannou, A.I, Digelidis, N.I, Zourbanos, N.I, Krommidas, H.I, Keramidis, P.I. 1: DPES (Trikala, Greece) Introduction Motivational climate in physical education and sport settings had been traditionally assessed via self-report scales. Grounded to the Achievement Goal (AGT) and Self Determination Theories (SDT) an observational approach has been developed (Tessier, Tzioumakis, Smith, Sarrazin, Digelidis, Papaioannou, Quested & Duda, 2011) as part of a European based project (PAPA Project), for the objective assessment of the coach-created motivational climate, aiming to identify the empowering and disempowering features of coach-initiated motivational environments. Methods A series of 10 video recordings, of approximately 60 minutes each, were analyzed according to the instrument's empowering and disempowering dimensions. After acceptable interobserver reliability ( $k=.75$ ) was established, state lag sequential analysis using Observer XT® 7.0 software was conducted to examine the consistency of each of the seven environmental dimensions of the instrument. Results As the results revealed across all codings, the Autonomy support dimension was most often rated very low (0 in a 0-3 scale, while probability rate was .71 in a scale 0-1), the Controlling dimension was usually rated high = 2 (probability rate was .57), the Task-involving dimension was most often rated low = 1 (.70), the Ego-Involving dimension was usually rated low = 1 (.48), while Relatedness Support was most often rated very low = 0 (.73), Relatedness Thwarting was usually rated low = 1 (.59), and finally the Structure dimension was most often rated low = 1 (.74). Discussion Observers' ratings revealed discrete behavioral patterns in terms of coach-created motivational climate across the instrument's environmental dimensions, also adding to the reliability of the observational measure. As results showed, coaches created an environment that lacked autonomy support, while on the other hand they engaged in behaviors that emphasized control. Furthermore, empowering features of the climate as relatedness support and task involvement were low. Similarly, coaches placed weak emphasis on disempowering motivational dimensions as ego involvement and relatedness thwarting as well as in structure. Coaches might use the current observation system for self-monitoring and goal setting to enhance the empowering climate in their teams. References Tessier D, Tzioumakis Y, Smith N, Sarrazin P, Digelidis N, Papaioannou A, Quested E, Duda J. L. (2011). Development of an observational instrument assessing the coach-created environment. 13th FEPSAC European Congress of Sport Psychology, Madeira, Portugal, July 2011.

### **EFFECT OF PHYSICAL ACTIVITY AND CARDIORESPIRATORY FITNESS ON ATTENTIONAL VARIABLES**

Luque, A., Zabala, M., Morales, E., Sanabria, D.

*University of Granada*

Introduction Several studies indicate that chronic exercise provides positive effects on cognitive performance (Themanson & Hillman, 2006). The effect of training seems to be robust, but may selectively benefit cognitive performance. The aim of this study was to show the relationship between physical fitness and their effects on attentional performance in different task conditions. Methods There were two groups of participants (athletes and sedentary). Both groups completed three experimental conditions: rest, incremental exercise test and anaerobic power test. Three cognitive tasks involving attention and temporal processing were performed at rest (Psychomotor Vigilance Task "PVT", temporal orienting and time duration discrimination). In the other two experimental conditions, participants performed the PVT immediately after an acute bout of exercise. We used a SRM lab ergometer, a FirstBeat Bodyguard and a Lactate Pro Meter Set to determine the fitness level. Results The results showed a significant main effect of Group only in the PVT task. Reaction times were faster for the trained cyclists as compared to the sedentary group. This difference disappeared after performing acute exercise. In addition, both groups increased reaction times after exercise. No significant differences between groups were found in the temporal orienting task or in the time duration discrimination task. Discussion Our results support previous studies showing that the effect of training seems to have

selective benefits in cognitive performance (Colcombe & Kramer, 2003). The main benefit was obtained in the PVT that was designed to measure sustained attention. This benefit appeared only in the resting condition. This supports other research showing a decrease in brain activity in temporal processing after physical effort. Also, it suggests that the decrease in vigilance may appear only after strenuous exercise (Smit, Eling, Hopman, & Coenen, 2005). We conclude that a good physical fitness selectively improves sustained attention, while it does not modulate attentional temporal orienting or fine temporal discrimination. References Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science*, 14(2), 125-130 Smit, A. S., Eling, P. A. T. M., Hopman, M. T., & Coenen, A. M. L. (2005). Mental and physical effort affect vigilance differently. *International Journal of Psychophysiology*, 57(3), 211-217 Themanson JR, Hillman CH (2006). Cardiorespiratory fitness and acute aerobic exercise effects on neuroelectric and behavioural measures of action monitoring. *Neuroscience*, 141, 757-767

**13:45 - 14:45**

## Poster presentations

### PP-PM37 Sports Medicine 4

#### PREDICTING MUSCLE INJURIES WITH ISOKINETIC AND BODY COMPOSITION

Martínez-Ruiz, E.1, Esparza-Ros, F.1, Martínez-Pardo, E.2, Rubio-Arias, J.A.2, Alcaraz, P.E.2

*Catholic University of San Antonio*

**Introduction** The muscle injuries are characterized by high injury and re-injury rate. Therefore, a better understanding of morphology, mechanism and function muscles, could provide a basic for improving current rehabilitation strategies and predicting re-injury. So, the aim of this study was correlate muscle strength isokinetic and body composition variables with the severity grades of muscle injuries in semi-professional soccer players. **Methods** Twenty-four male soccer players were tested at the same day, in January (mid-season). Firstly, was assessed body composition with a dual energy X-ray absorptiometer, obtaining fat free mass, fat mass, segmental and total regions, and bone mineral content. Thereafter, was measured an isokinetic concentric test flex/extension knee at angular velocity of 60°/s, 180°/s and 270°/s, obtaining the peak torque (Nm), hamstring/quadriceps ratio (H:Q ratio), acceleration time (m/s) and power (W). Finally, the grade of injury was calculated following the methodology proposed Kujala et al. (1997). This data was analyzed with the Pearson's correlation coefficients (r) the priori level of statistical significance was set at  $p \leq 0.05$ . **Results** Body composition was not correlated with the grade of injury. However, significant correlation was found between the grade of injury and power knee flexion at 180°/s ( $r = 0.447$ ,  $p \leq 0.05$ ), power knee flexion at 270°/s ( $r = 0.428$ ,  $p \leq 0.05$ ) and with acceleration time for knee flexion at 180°/s ( $r = -0.452$ ,  $p \leq 0.05$ ). **Discussion** Our result suggest that the peak torque concentric, and specially the H:Q ratio, no appear to be relevant in the more or less grade of muscle injury. However, other variables as the muscle power, identified also by Henderson et al. (2010), and acceleration time, related to an altered neuromuscular control of hamstrings, specially at long muscle lengths (Sole et al., 2011), could show a better risk of injury. In summary, the isokinetic variables such as power muscle and acceleration time for knee flexion was correlated with the grade of muscle injury; and body composition variables not interacted with the risk of injury. **References** Henderson, G., Barnes, C. A., & Portas, M. D. (2010). Factors associated with increased propensity for hamstring injury in English Premier League soccer players. *J Sci Med Sport*, 13(4), 397-402. Kujala, U. M., Orava, S., & Jarvinen, M. (1997). Hamstring injuries. Current trends in treatment and prevention. *Sports Med*, 23(6), 397-404. Sole, G., Milosavljevic, S., Nicholson, H. D., & Sullivan, S. J. (2011). Selective strength loss and decreased muscle activity in hamstring injury. *J Orthop Sports Phys Ther*, 41(5), 354-363.

#### DEVELOPMENT OF A SKELETAL MUSCLE INJURY MODEL IN THE RAT AND IN VIVO EVALUATION OF THE USE OF HUMAN MESENCHYMAL STEM CELLS FROM THE UMBILICAL CORD MATRIX IN MYECTOMY INJURY TREATMENT

Pereira, T.1,2, Gärtner, A.1,2, Amorim, I.1, Ribeiro, J.1,2, Franca, M.1,2, Armada-da-Silva, P.A.S.3,4, Luís, A.L.1,2, Maurício, A.C.1,2

*1: ICBAS-UP (Porto, Portugal), 2: CECA-ICETA (Porto, Portugal), 3: FMH-UTL (Lisboa, Portugal), 4: CIPER-FMH (Lisboa, Portugal)*

**Introduction** Muscle injuries are common in athletes and it is important to develop new methods to improve muscle regeneration. Muscle has good regenerative ability, but the extent of muscle injury might prevent full regeneration. We developed a novel experimental muscle injury in the tibialis anterior muscle of the rat by using a biopsy punch to create a standardized myectomy lesion. Using this model we tested the use of a cellular therapy by application of HMSCs from human umbilical cord matrix. **Methods** We tested chemical (collagenase), mechanical (crush) and surgical (myectomy) lesions and assessed different times of muscle collection for histological analysis (3 to 60 days after lesion) in order to develop an optimal in vivo muscular lesion model. HMSC from Wharton's jelly umbilical cord matrix were cultured. Sasco Sprague male rats with 250-300g were used. After a standardized 5 mm-diameter myectomy lesion of the tibialis anterior muscle, we tested different treatment combinations (HMSCs and conditioned media) and vehicles (FloSeal and thrombin). After 15 days, animals were sacrificed and the anterior tibial muscles were collected and fixed in formaldehyde for qualitative histological analysis of myotubes and inflammatory cells presence. **Results** The myectomy model proved to be the most appropriate for a comprehensive and standard evaluation of the rat skeletal muscular regeneration ability. The transplanted HMSCs presented normal morphology and immunocytochemistry markers for MSCs. Myotubes were present in peripheral borders of the created injury whereas the center of the injury was occupied by an extensive and hypercellular inflammatory infiltrate. Injuries treated with HMSCs presented several ectopic calcifications that probably were caused by the Floseal vehicle since they were present in all these groups. **Discussion** At 15 days muscle regeneration was not complete after our myectomy injury suggesting the possibility of permanent changes in normal muscle architecture after such extensive muscle injury. The use of HMSCs did not prove to help regeneration but this could be explained by the vehicle (FloSeal) tested. The choice of proper vehicle seems to be critical for local application of stem cells in muscle injuries. Thrombin is an alternative vehicle that is currently being tested. **Acknowledgements** This work was supported by grant PTDC/DES/104036/2008 from Fundação para a Ciência e a Tecnologia, Portugal.

### DIFFERENCES IN INJURY RATES BETWEEN SOCCER CLUBS: A PROSPECTIVE STUDY

Stubbe, J., Stege, J., Verhagen, E., Van Mechelen, W.

*TNO: Netherlands Organisation for Applied Scientific Research*

Differences in Injury Rates between Soccer Clubs: A Prospective Study JH Stubbe (1,2), JP Stege (1,2), EALM Verhagen (2,3), W van Mechelen (2,3) 1) TNO, Leiden, The Netherlands 2) Body@Work TNO VUmc, VU University Medical Center, Amsterdam, The Netherlands 3) Department of Public & Occupational Health/EMGO+ Institute, VU University Medical Center, Amsterdam, The Netherlands In professional soccer, where large salaries are paid, the absence of players due to injuries leads to high costs. However, it is unclear whether there are large differences between soccer clubs in injury rate. PURPOSE: To study the injury rate in Dutch professional soccer players and investigate whether there are differences in injury rates between soccer clubs. METHOD: During the 2009-2010 season, the medical staff of 16 professional soccer clubs registered the injuries and recoveries according to the consensus statement established by the FIFA Medical Assessment and Research Centre (F-MARC). They provided information on the training and match exposure of each player per week. Players who sustained an injury were registered by the club (para)medic. RESULTS: In total 457 professional soccer players were registered of which 318 (67.7%) sustained one or more injuries. In total 679 injuries were reported, with 11.8% being reported as a re-injury. Significant differences between soccer clubs were found in the percentage of players that sustained an injury during the soccer season (lowest percentage = 41%; highest percentage = 92%) and in injury incidences (number of injuries per 1000 hours of training and matches). CONCLUSION: This study shows that the rate of injuries among professional Dutch soccer players is high. There are significant differences between clubs regarding the percentage of players that sustained an injury during the soccer season and injury incidences.

### EFFECTS OF A SINGLE SESSION OF WHOLE-BODY CRYOTHERAPY <-110 °C> ON MUSCULAR PERFORMANCE

Ferreira Júnior, J.B.

*University of Brasilia*

Ferreira-Junior, J.B.1,2, Vieira, C.1, Soares, S.1, Guedes, R.1, Rocha-Junior, V.A.1, Brown, L.E.3, Bottaro, M.1 1: UnB (Brasilia, Brazil), 2: IFTM (Paracatu, Brazil), 3: CSU, (Fullerton, USA) Introduction It has been shown that body cooling may decrease the performance of muscles. Whole-body cryotherapy (WBC) is a mode of cold therapy, in which patients are repeatedly exposed to very cold air (-110 to -140 °C). WBC has been used in sports medicine and to enhance recovery in athletes following heavy periods of training. However, the effect of a single session of WBC on muscle performance has not been documented. Therefore, the aim of this study was to evaluate the effects of a single WBC bout on strength in healthy subjects. Methods Fourteen young men (21.1 ± 2.3 yrs) were randomly exposed to two different conditions separated by a minimum of 72 hours: 1) WBC (Subjects were exposed to 3 min of WBC at -110 °C); 2) Control no-WBC (NWBC; subjects stayed in the WBC chamber for 3 min at 21 °C). All subjects were tested for maximal isokinetic elbow flexion at 60°.s<sup>-1</sup> before and after each condition. Statistical evaluation of the data was performed using a 2 x 2 repeated measures ANOVA [condition x time]. The significance level was set at  $p < 0.05$ . Results The peak torque of WBC was 65.54 ± 9.23 N.m in the pretest and 63.98 ± 9.39 N.m in the posttest. The NWBC group obtained 66.30 ± 9.25 N.m and 64.74 ± 10.14 N.m in the pretest and posttest, respectively. The total work performed by WBC in the pretest was 455.96 ± 68.85 J and in the posttest was 447.90 ± 70.22 J. For the NWBC the scores of total work were 450.95 ± 61.25 J in the pretest and 445.13 ± 64.08 J in the posttest. There were no significant differences in peak torque or total work between conditions or between pretest and posttest. Discussion The results indicate that a single 3-min session of WBC (-110 °C) did not decrease muscle torque production or work capacity. These findings were in disagreement with results previously reported. Westerlund et al. (2009) observed a decrease in the drop-jump flight time after a single WBC exposure. In the other hand, Fricke et al. (1999) found that the isokinetic torque of the knee flexors and extensors improved after a single WBC bout (2 min) in untrained healthy subjects. The differences between the present investigation's results and previous reports may be due to a difference in body segments analyzed in each study. Upper body and lower extremities may respond differently to the WBC. Further studies should test this hypothesis. However, the present findings suggest that coaches and physical therapists can use WBC before training and rehabilitation without compromising the performance of upper-body muscles. References Westerlund T, Oksa J, Smolander J, Mikkelsen M (2009). *J Therm Biol*, 4, 226–31. Fricke R, Grapo WG, Knauer G (1999). *DRV – Schriften*, 12,166–67. Financial support: FAPEMIG, CAPES and FAP

### BODY COMPOSITION ANALYSIS IN SUBJECT WITH DIFFERENT PATTERN OF PHYSICAL ACTIVITY

Rilova, N.1,2, Mustafina, L.1, Ahmetov, I.1

*1. Volga Region State Academy of Physical Culture, Sport and Tourism (Kazan, Russia), 2. Kazan State Medical University, Department of pediatrics (Kazan, Russia).*

Introduction Human body has a multi-component structure and can be studied by bioelectrical impedance analyzers at the tissue and molecular level. Body composition can vary between individuals depending on various factors such as gender, age, nutritional state and pattern of physical activity (Heyward and Wagner, 2004). Currently, measurement of bioelectrical impedance is actively used in many countries (Fornetti et al., 1999). Bioelectrical impedance measures the level of resistance of electrical current through the body. Since water conducts electrical current well, those tissues with higher water levels (muscle) conduct electricity better than those with lower levels (fat) (Kushner, 1992). Athletes tend to have greater lean mass (composed of metabolically active tissues, such as muscles and organs), while unfit subjects have an excess of fat mass (composed of visceral and subcutaneous adipose tissue). The aim of the study was to analyze body composition in subjects with different pattern of physical activity. Methods One hundred and twenty two subjects were recruited for the study. Body composition parameters (percentage of fat and muscle mass, visceral fat, body water, metabolic age, etc.) were assessed by bioelectrical impedance analyzer "Tanita MC 980" (Japan). Physical activity pattern was determined by a questionnaire. Subjects were first divided into several groups depending on their physical activity. Next, two groups at opposing extremities of physical activity pattern (16 sedentary men (age 24.8 (2.2) yr, weight 76.8 (4.3) kg) reported no regular physical activity (S group); 17 physically active men (age 22.9 (3.6) yr, weight 77.8 (12.5) kg) regularly participated in high intensity physical activity of more than 12 hours per week (A group)) were compared. Results We found that the percentage of body fat (9.5 vs. 19.1%;  $p < 0.01$ ), visceral fat mass (1.5 (0.5) kg vs. 4.3 (1.1) kg;  $p < 0.01$ ) and metabolic age (13 (2.8) yr vs. 26.7 (3.1) yr;  $p < 0.05$ ) were significantly lower in A group compared with the S group. In contrast, subjects from A group had a higher muscle mass (66.6 (8.9) kg vs. 58.8 (1.8);  $p < 0.02$ ), total body water (65.1 (4.2)% vs. 58.4 (3.5)%;  $p < 0.027$ ) at the expense of intracellular water (33.7 (4.7) vs. 26.8 (1.3);  $p < 0.03$ ). Conclusions Thus, men with high physical activity had a reduced fat mass, a lower risk of obesity and an increased muscle mass than sedentary men. We have demonstrated that significant changes in morphological and metabolic characteristics are formed under the influence of regular physical activity. References Kushner RF. Bioelectrical impedance analysis: a review of principles and applications. *Am Coll Nutr*. 1992;11:199-209. Heyward VH, Wag-

ner D. Applied Body composition assessment. *Human Kinetics*, 2004; pp. 159-173. Fornetti WC, Pivarnik JM, Foley JM, Fiechtner JJ. Reliability and validity of body composition measures in female athletes. *J Appl Physiol*. 1999;87(3):1114-1122.

## MEDICAL ATTENDANCE REQUIREMENTS OF HIGH PERFORMANCE ATHLETES

Porcar, C.1,2, Guerra, M.2

*1.Consorci Sanitari de Terrassa; 2 FPCEE-Blanquerna. University Ramon Llull*

Introduction Nowadays, to prevent injuries, it is important to know which kinds of injuries are more frequent. Some research has been done with an American high school population (Darrow, C J., Collins, C L., Yard, E E., Comstock, D., 2009). Through medical visits, we have studied athletes belonging to an Olympic Training Center and their epidemiologic characteristics to know the requirements for a medical attendance. Methods Informatics Clinical histories of medical attendance were obtained and analyzed determining the number of visits done by the physician in charge of these athletes, as well as the variables associated to these visits. 16925 visits were analyzed during 45 months, in 16 Olympic sports. Variables were the following: Acute disease, Chronic disease, Chronic injury, Acute Injury, Recidivated injury, Sequel of injury, Injury's circumstances (training, competition, non sportive), Topography of injury, Tissue structure damaged and Kind of injury. Results Respiratory Diseases were the most frequent (52 % of the total number of medical visits). Headache was the second more frequent (12 %), Digestive system problems (9 %), dermatological diseases (12 %) and ORL (8 %). In relation to muscle-skeletal system, 90 % of all the injuries appeared during training. Acute were the most frequent (75 %) and only an 18 % were chronic injuries. In relation to affected tissue, the muscle was the most affected (27 %), followed by bone (16 %), tendon (13 %) and ligament (12 %). The most injured sports were tennis and gymnastic (16% each of them), track and field (12 %) and swimming and Tae-Kwon-Do (12 % each of them). Topography of injury showed that knee (17%), ankle (12%), foot (11%) and low back (10%) were the most frequent. Discussion High performance athletes present peculiar epidemiologic characteristics (Spence, L., 2007; Alonso, J M., Tscholl, P M., 2010) that need to be studied to optimized the health service that they receive. More research is needed to determine the characteristics that differ from a general population as well to determine the kind of injury related to the kind of sport (Hootman, J M., Dick, R., Agel, J., 2007). References Alonso, J M., Tscholl, P M. (2010) Occurrence of injuries and illnesses during the 2009 IAAF World Athletics Championships. *Br J Sports Med*; 44: 1100-1105 Darrow, C J., Collins, C L., Yard, E E., Comstock, D. (2009). Epidemiology of severe injuries among United States High school athletes. 2005-2007. *The AJSM*, 37: 1798-1805 Hootman, J M., Dick, R., Agel, J. (2007). Epidemiology of Collegiate Injuries for 15 sports: Summary and recommendations for injury prevention Initiatives. *J of Athletic Training*; 42(2): 311-319 Spence, L. (2007). Incidence, etiology, and Symptomatology of Upper Respiratory Illness in Elite Athletes. *MSSE*; 39, (4):577-586

## POST EXERCISE RESPONSE OF STROKE PATIENTS TO AEROBIC REHABILITATION PROGRAMME.

Oladipo, O., Orege, A.

*University of Ibadan; Ibadan, Nigeria.*

Abstract Objective: To investigate the effect of Aerobic Training programme on the cardiorespiratory responses, aerobic fitness and exercise programme in the patients with chronic cerebrovascular injury. Design: Randomized pre-test, post-test experimental design. Setting: Exercise physiology laboratory, university of Ibadan, Nigeria. Main outcome: Maximum oxygen uptake, vital capacity, forced vital capacity, peak expiratory flow, maximum ventilatory volume were determined by spirometry measurements while exercise time was determined by the time spent on the bicycle ergometer by participants on reaching their volitional stoppage, blood pressure and heart rate were also determined before and after each training session. Result: The exercise intensity ranged from 50% to 80% heart reserve. Exercise duration was between 30 to 40 minutes for three days a week. The total number of participants included in the study was 30. A participant was disqualified due to his irregular systolic blood pressure on the second week of training and continuous right hamstring pain. A significant trend of improvement was found in all aerobic and cardiovascular parameters. Statistical analysis of one way anova revealed a significant improvement in favour of aerobic training to improve maximum oxygen uptake. (Vo2max) (95% confidence interval, 16.963-18.995; p<0.005), and exercise performance time (1614.069-1847.095, p<0.005). Improvement in sensory motor function was significantly related to aerobic capacity. Conclusion: We concluded that patients with chronic attack of stroke may improve their aerobic capacity, sub-maximal exercise systolic blood pressure and improve their functional abilities with aerobic training.

## EFFECTS OF PHYSICAL EXERCISE AN ANIMAL MODEL OF RESTLESS LEGS SYNDROME AND PERIODIC LIMB MOVEMENT

Esteves, A.M.1, Frussa-Filho, R.2, Lopes, C.1, Cavagnoli, D.A.1, Frank, M.K.1, Arida, R.M.3, Tufik, S.1, de Mello, M.T.1

*Universidade Federal de São Paulo*

Introduction Epidemiologic data have been increasingly attesting to the negative impact of restless legs syndrome (RLS) upon health. Treatment for idiopathic RLS is most commonly pharmacological. Notwithstanding, the beneficial influence of physical exercise on RLS symptoms and periodic leg movement (PLM) has also been the subject of clinical research. The purpose of the present study was to verify the influence of physical exercise on a experimental animal model (6-OHDA – induced lesion of A11 dopaminergic nuclei) of RLS and PLM. Methods In the first experiment (physical exercise post lesion of A11), control, SHAM operated and rats submitted a A11 lesion were submitted to baseline sleep recording and to a second sleep recording after the last session of a 4 week physical exercise program. In Experiment 2 (physical exercise pre- and post lesion of A11) a 2 week physical exercise was conducted before A11 lesion. Seven days after surgery the first (baseline) sleep recording session was performed and subsequently, a 4 week physical exercise program was conducted. After the last training session second sleep recording session was performed. The sleep analyses were realized in 24h and in 6 blocks of 4h (7-11am, 11am-3pm, 3-7pm, 7-11pm, 11pm-3am and 3-7am). Results The results demonstrated that A11 lesion produced and increased percent of wakefulness in the last block of the dark period (3-7am) and a significant enhancement of the number of limb movements (LM) through out the day. Chronic physical exercise (conducted before and /or after A11 lesion) counteracted both the sleep pattern alterations (decreased of percent of wakefulness) and the increase in the number of LM produced by 6-OHDA-induced A11 Lesion. Discussion While there is considerable experimental evidence linking physical exercise and an enhancement of dopaminergic function<sup>2,3</sup>, clinical studies have reported beneficial effects of this non pharmacological approach in RLS/PLM<sup>4,5</sup>. These findings extend the validation of 6-OHDA-induced A11 lesion as an animal model of RLS/PLM and strengthen the notion that physical exercise can produce beneficial effects on their symptoms. 1. Lopes C, Esteves AM, Frussa-Filho R, Tufik S, de Mello MT. (2009). *Mov Disord*. Dec 9. 2. Archer T, Fredrikson A, Johansson B. (2011). *Acta Neurol. Scand*. 123(2):73-84. 3. Greenwood BN, Foley TE, Le TV, Stron PV, Loughridg AB, Day HE, Fleshner M. (2011). *Behav Brain Res*. 217:354-62. 4. De Mello MT, Silva AC, Esteves AM, et al. (2002). *Spinal Cord*. 40(12):646-9. 5. Esteves AM, de Mello MT, Pradella-Hallinan M, et al. (2009). *Med Sci Sports Exerc*. 41(1):237-42.

**FREQUENCY OF POLYMORPHISM TRP64ARG IN BRAZILIAN ADOLESCENTS OBESE WITH METABOLIC SYNDROME**

Leite, N., Milano, G.E., Tiiski, A.C.T., Milano, G., Carvalho, H.M., Radominski, R.B., Coelho-e-Silva, M.J., Alle, L.F.

*Federal University of Paraná*

**Introduction** The  $\beta$ 3-adrenergic receptor ( $\beta$ 3-AR) gene polymorphism of the human  $\beta$ 3-AR gene has been reported to be positively associated with obesity (Kim-Motoyama et al., 1997) and obesity-related metabolic syndrome (Knowler, 1996). The  $\beta$ -adrenoceptors play important roles in energy expenditure and control body weight (Iwashita; Tanida; Terui, 2002), however there are also reports that showed no significant correlation of 64Arg allele with body weight gain and metabolic disorders (Matsushita et al., 2003). The aim of the present study was evaluate the frequency of polymorphism Trp64Arg in ADBR3 in obese adolescents with metabolic syndrome (MS). **Methods** The study included 114 obese with MS, classified as having MS if they met three or more criteria for age and sex according the Adult Treatment Panel III (ATP III). Systolic (SBP) and diastolic blood pressure (DBP), waist circumference (WC), BMI Score Z, glucose and lipid profile were determined. The Trp64Arg genotype of the ADBR3 gene was examined in peripheral blond leukocyte DNA. Student's t test was performed with a significance level of 0.05. **Results** Participated in the study 114 (50 girls and 62 boys) obese with MS. The frequency of polymorphism in the ADBR3 gene was 19% in this sample (n=22), consisting of 19 showed genotyping Trp/Arg and 3 Arg/Arg. Comparing the MS groups: G1 = without ADBR3 gene polymorphism group (Trp/Trp) and G2 = with ADBR3 gene polymorphism group (Trp/Arg and Arg/Arg), we observed similar results in both groups for age (G1= 12.73 $\pm$ 1.88 years vs G2= 12.58  $\pm$  1.52 years, p=0.26), BMI Score Z (G1= 3.45  $\pm$  0.13 vs G2= 3.71  $\pm$  1.12, p=0.23), WC (G1= 100.11  $\pm$  13.41 cm vs G2= 102.38  $\pm$  11.16 cm, p=0.37), SBP (G1= 110.39  $\pm$  14.93 mmHg vs G2= 110.53  $\pm$  16.15 mmHg, p=0.85), DBP (G1= 71.28  $\pm$  11.55 mmHg vs G2= 73.57  $\pm$  9.63 mmHg, p=0.32), HDL-c (G1= 42.14  $\pm$  7.33 mg/dL vs G2= 41.66  $\pm$  8.78 mg/dL, p=0.29), TG (G1= 135.04  $\pm$  60.74 mg/dL vs G2= 155.9  $\pm$  86.2 mg/dL, p=0.80) and glucose (G1= 90.46  $\pm$  9.05 mg/dL vs G2= 89.1  $\pm$  1.82 mg/dL, p=0.50). **Discussion** In this sample, the frequency of polymorphism in the ADBR3 gene in MS group was higher than obese group in study of Ochoa et al. (2004). When comparing MS groups with or without polymorphism in the ADBR3 gene were not found differences in variables related to MS. However, Tahara et al. (2011) found higher blood glucose values in the Trp64Arg polymorphism group. We suggest further studies with larger samples and different age groups. **References** Kim-Motoyama H, Yasuda K, Yamaguchi T, Yamada N, Katkura T, Shuldiner AR. (1997). *Diabetologia*, 40, 469-72. Knowler WC. (1996). *Diabetologia*, 1411-39. Iwashita S, Tanida M, Terui N. (2002). *Life Sciences*, 71(5), 537-46. Ochoa MC, Marti A, Azcona C, Chueca M, Oyarza'bal M, Pelach R, Patin'õ A, Moreno-Aliaga MJ, Martinez-Gonzalez MA, Martinez JÁ (2004). *International Journal of Obesity*, 28, S37-S41. Matsushita H, Kurabayashi T, Tomita M, Kato N, Tanaka K. (2003). *Maturitas*, 45, 39-45. Tahara A, Osaki Y, Kishimoto T. (2011). *Obesity research & Clinical Practice*, 5, 109-17.

**13:45 - 14:45****Poster presentations****PP-PM38 Nutrition 3****IMPACT OF AN ESSENTIAL AMINO ACID RICH IN LEUCINE/CARBOHYDRATE SUPPLEMENTATION ON MUSCLE MASS FOLLOWING RESISTANCE TRAINING IN YOUNG MEN**

Stragier, S., Vieillevoye, S., Poortmans, J., Carpentier, A.

*Université Libre de Bruxelles*

**Impact of an essential amino acid rich in leucine/carbohydrate supplementation on muscle mass following resistance training in young men** Stragier, S., Vieillevoye, S., Poortmans, J., Carpentier, A. *Université Libre de Bruxelles, Belgium* **Introduction** Recent studies indicated that orally administered leucine (leu) appears as a stimulus of the muscle protein synthesis in rats (Anthony et al, 2000) and humans (Dreyer et al, 2008). The aim of this study was to investigate the impact of oral essential amino acid (EAA) supplementation rich in leu on muscle mass in combination with resistance training. **Methods** Twenty height young males performed two sessions of resistance training per week during 12 weeks. They were divided into two groups, one group received placebo (30g carbohydrate; PL) and the other group received an EAA+leu (15g)/carbohydrate (15g) supply (S). Each exercise was performed at 70-85 % of the subject's one repetition maximum and consisted of about 50 repetitions subdivided in several sets. Dietary supplementations were consumed twice a day, with breakfast and immediately after the training session on the exercise days (and with dinner the others days). Maximal strength during squat and bench press exercise were tested on an isokinetic ergometer (Ariel CS 6000) before and after training programme. Skeletal muscle mass (SMM) was assessed by anthropometric measurements (Lee et al, 2000). **Results** Training resulted in an increase in SMM in both PL (2.3 $\pm$ 2.2%, p<0.01) and S groups (4.0 $\pm$ 2.4%; p<0.01). Concentric strength increased for the bench press and squat exercises by 9.9 $\pm$ 8.8% (p<0.01) and 11.7 $\pm$ 8.7% (p<0.001), respectively in S group and an increase was shown only for the bench exercise in PL group (12.6 $\pm$ 11.4%; p<0.001). After normalization of the initial strength with the initial SMM, a negative linear regression between this ratio and the increase in muscular strength after training was found in S group (r<sup>2</sup> = 0.47, p<0.01). **Discussion** Our results confirm that a combined EAA drink did not result in greater improvement in SMM and strength following a 3 months strength training programme. However, our data indicate that a daily intake of 10.5g of leu enhances SMM and strength, but did not provide greater gains in muscle mass, strength and power in young male compared to an intake of 5.7g/day (Vieillevoye et al., 2010). **In conclusion**, EAA/carbohydrate supplementation is effective to provide additional gains in SMM and muscle strength when combined with resistance training on subjects who had a lower initial muscle strength. **References** Anthony J, Yoshizawa F, Anthony T, Vary T, Jefferson L, Kimball S (2000). *J Nutr* 130:2413-2419 Dreyer H, Drummond M, Pennings B, Fujita S, Glynn E, Chinkes D, Dhanani S, Volpi E Rasmussen B (2008). *Am J Physiol Endocrinol Metab* 294:392-400 Lee R, Wang Z, Heo M, Ross R, Janssen I, Heymsfield S (2000). *Am J Clin Nutr* 72: 796-803 Vieillevoye S, Poortmans J, Duchateau J, Carpentier A (2010). *Eur J Appl Physiol* 110:479-488

## EFFECTS OF L-ARGININE SUPPLEMENTATION ON PLASMA LACTATE AND AMMONIA REMOVAL IN HIGHLY TRAINED RUNNERS

Alvares, T., Marques, A., Batista, D., Conte-Junior, C., Silva, J., Paschoalin, V.

*Federal University of Rio de Janeiro*

**EFFECTS OF L-ARGININE SUPPLEMENTATION ON PLASMA LACTATE AND AMMONIA REMOVAL IN HIGHLY TRAINED RUNNERS** Alvares, T.1; Marques, A.2; Batista, D.1; Conte-Junior, C.1; Silva, J.1; Paschoalin, V.1. 1: DBq-IQ-UFRJ (Rio de Janeiro, Brazil). 2: SPEED sports advisory group (Rio de Janeiro, Brazil). Introduction L-arginine has been used to promote an increase in blood perfusion in the active muscle, and supposedly increasing the removal of metabolites, such as lactate and ammonia, which are related to exercise fatigue during intense physical exercise. Therefore, the aim of this study was to analyze changes on plasma lactate and ammonia concentrations in response to exercise after L-arginine supplementation. Methods 15 highly trained runners (4 females) were randomly divided in ARG (6 g of L-arginine) and PLA (6 g of corn starch) groups. At the first, the runners took the supplementation and rested for 20 min. Afterwards, the subjects performed two bouts of a 5 km time-trial running test with a 10-min rest period. Blood samples were drawn before supplementation (T0), immediately after the first 5 km time-trial running test (T1), immediately after the second 5 km time-trial running test (T2) and after 20 min of rest (T3). Plasma lactate and ammonia were detected (in duplicate) by spectrophotometry at 450 and 570 nm, respectively. Two-way ANOVA with repeated measures was performed in order to identify differences between groups in plasma lactate and ammonia concentrations on the four time point in which measurements were taken. Results Significant increases in plasma lactate and ammonia from T0 to T1 and T2 ( $P < 0.01$ ) in both ARG and PLA groups with no significant change between the groups. However, a significant reduction ( $P < 0.01$ ) on plasma lactate and ammonia were observed from T2 ( $1.78 \pm 0.57$  mM lactate;  $179.1 \pm 101.0$   $\mu\text{mol/L}$  ammonia) to T3 ( $0.80 \pm 0.21$  mM lactate;  $79.73 \pm 78.14$   $\mu\text{mol/L}$  ammonia) only in ARG group. Discussion In both ARG and PLA groups, lactate and ammonia increased significantly in response to exercise. However, during the recovery period of the 5 km time-trial running test, the removal of lactate and ammonia were higher only in ARG. Previous evidence (Denis et al., 1991) has shown positive effect of L-arginine in reducing the exercise-induced hyperammonemia after 15 min of cycle ergometer exercise. Furthermore, the significant decreases on plasma lactate and ammonia in ARG group may be related with the possible effect of L-arginine on increasing blood perfusion as show by early evidence (Alvares et al., 2012). Although increases in the removal of plasma lactate and ammonia on ARG group were detected, they were not significantly different from PLA group. References Denis C, Dormois D, Linossier MT, Eychenne JL, Hauseux P, Lacour JR. Arch Int Physiol Biochim Biophys. 1991;99(1):123-7. Alvares TS, Conte CA, Paschoalin VM, Silva JT, Meirelles CM, Bhambhani YN, Gomes PS. Appl Physiol Nutr Metab. 2012;37(1):115-26.

## ACUTE EFFECTS OF ENERGY RESTRICTION DURING ENDURANCE TRAINING ON PHYSICAL PERFORMANCE

Pilger, N., Koehler, K., Zinner, C., Braun, H., Mester, J., Schaezner, W.

*German Sport University*

**Introduction** Many athletes, especially participants in endurance and aesthetic sports and weight category sports, are chronically energy deficient (Loucks, 2004). The effects of energy restriction on body composition, hormone levels and metabolism are well described, but little is known about the effects on physical performance capacity. Hence, our study was aimed on the effects of energy restriction combined with endurance training on physical performance parameters. **Method** Four male athletes ( $26 \pm 3$  y,  $79 \pm 8$  kg) underwent a randomized, cross-over-design intervention. Dietary energy intake was designed to reach either a normal energy availability of 40 kcal/kg FFM (control group = CG) or a low energy availability of 15 kcal/kg FFM (energy restriction group = ERG). Each intervention went for four consecutive days and daily endurance training sessions were performed at 60% of the maximal oxygen uptake. Training energy expenditure was 15 kcal/kg FFM. Energy intake was adapted to the subjects' typical diet, which was assessed with a diet history. Pre and post tests were performed to assess body weight, body composition, submaximal cycling performance, maximal power output during a Wingate test and isometric strength tests (leg curl, leg extensions and bench press). **Results** There was a significant reduction in body weight between CG and ERG of  $2.5 \pm 1.9$  kg ( $p < 0.01$ ). Body fat was reduced by  $2.2 \pm 1.1$  kg (ERG) vs.  $0.3 \pm 1.1$  kg (CG), without statistical significance. maximal isometric strength in bench press, leg curl and leg extension and maximal power output during the Wingate test did not change significantly. During the submaximal cycling test, heart rate was elevated during energy restriction ( $p < 0.05$ ). **Discussion** The results show that an acute energy restriction combined with training has no significant effects on several parameters of physical performance. Maximal anaerobic capacity measured with the Wingate test and strength tests showed no significant differences. Only in the submaximal cycling test, heart rate was significantly lower in the CG compared to ERG. If an acute energy restriction takes place in combination with training, athletes may loose weight but maximal performance capacity seems to be unaffected significantly. **References** Loucks AB. (2004). J Sports Sci, 22, 1-14.

## NUTRITIONAL INTAKE OF ELITE MALE AND FEMALE HIGH JUMPERS DURING THE GENERAL PREPARATION PHASE

VELIGEKAS, P., BOGDANIS, G.C., CHRISTOFI, E.

*University of Athens, GREECE*

**Introduction** The importance of physique in high jump is demonstrated by the prevalence of tall and extremely lean somatotypes among elite male and female high jumpers who also have a high muscle power to body mass ratio (O'Connor et al., 2007). Nutrition plays a key role in maintaining optimal body weight and body composition and also supports the requirements of heavy training (Stellingwerf et al., 2011). However, only a few studies have assessed the nutritional intake of high jumpers (Houtkooper et al., 2007). Therefore, the aim of this study was to investigate and compare the nutritional intake of elite male and female high jumpers during the general preparation phase of their annual training plan. **Methods** Fifteen elite male and female high jumpers took part in the study (7 males:  $1.86 \pm 0.08$  m,  $75.4 \pm 4.4$  kg, personal best:  $2.07 \pm 0.21$  m and 8 females:  $1.76 \pm 0.06$  m,  $59.4 \pm 5.6$  kg, personal best:  $1.67 \pm 0.15$  m). Participants weighed and recorded their diet for 3 days (2 weekdays and 1 weekend day), during the general preparation phase. Nutrient intake was analyzed using custom-made software based on a standard nutritional database (Food Standards Agency, 2002). Statistical comparisons between male and female jumpers were made using independent t-test ( $p < 0.05$ ). **Results** Average daily energy intake for male and female jumpers was  $11.3 \pm 1.8$  and  $7.9 \pm 1.0$  ( $p = 0.12$ ), respectively and was derived from carbohydrate by  $40 \pm 3\%$ , from fat by  $41 \pm 2\%$ , from protein by  $18 \pm 2\%$ , while alcohol represented less than 1%. Macronutrient intake per kg body mass did not differ between male and female jumpers and was  $3.6 \pm 0.8$  and  $3.3 \pm 0.5$  g/kg for carbohydrate,  $1.6 \pm 0.1$  and  $1.3 \pm 0.1$  g/kg for protein and  $1.6 \pm 0.3$  and  $1.5 \pm 0.2$  g/kg for fat. **Discussion** The main finding of this study was that both male and female elite high jumpers followed a diet that was inadequate to support their daily training and recovery needs in terms of carbohydrate intake (Houtkooper et al., 2007). Although total energy intake was moderate to



low, fat intake was in excess of what is recommended, while protein intake was within the range proposed to support intense training (Stellingwerff et al. 2011). The low energy and carbohydrate intake of elite high jumpers may be related with their perception that a low body weight is of paramount importance for success, but this may lead to sub-optimal training adaptations by affecting both duration and quality of training. References Food Standards Agency (2002). McCance and Widdowson's The Composition of Foods. Cambridge: Royal Society of Chemistry. Houtkooper L, Maurer Abbot J, Nimmo M. (2007). J Sports Sci, 25(S1), S39-S47. O'Connor H, Olds T, Maughan RJ. (2007). J Sports Sci, 25(S1), S49-S60. Stellingwerff T, Maughan RJ, Burke LM (2011). J Sports Sci, 29(S1), S79-S89.

### **AEROBIC EXERCISE TRAINING REDUCES SERUM CONCENTRATION OF LEPTIN BUT DOES NOT CHANGE THE TNF- $\alpha$ AND IL-10**

Matos-Neto, E.M.1, Trindade, M.C.C.1, Torres-Leal, F.L.1, Pantaleao, L.C.1, Fonseca-Alaniz, M.H.2, Rogero, M.M.1, Tirapegui, J.1

1: USP (São Paulo, Brazil), 2: INCOR (São Paulo, Brazil)

**Introduction** - The anti-inflammatory effect of exercise training (ET) is due, at least in part, to changes in the body composition, in the dietary intake, and in the synthesis and release of pro- and anti-inflammatory adipocytokines from the white adipose tissue (GLEESON et al., 2011). Therefore, the aim of this study was to investigate the effect of aerobic ET on body composition, dietary intake and serum concentrations of adipocytokines related to inflammation. **Methods** - For this study, we used 15 male Wistar rats with eight weeks of age. The animals were distributed in two groups: sedentary (SG, n=7) and trained group (TG, n=8). The TG animals were submitted to ET on a treadmill for eight weeks. Both groups were fed ad libitum AIN 93-M. The following parameters were analyzed: chemical composition of the carcass, weight of the fat pads and serum leptin, TNF- $\alpha$  and IL-10 through immunoassay multiplex method. **Results** - There was a significant difference in final body weight (SG: 426.7  $\pm$  11.3 and TG: 390.7  $\pm$  5.88). There was no statistical difference in the food intake of animals (SG: 54.07  $\pm$  2.61 and TG: 53.42  $\pm$  4.74). The ET significantly reduced the mass of subcutaneous (SG: 12.72  $\pm$  3.35 and TG: 4.81  $\pm$  0.22), periepididymal (SG: 14.51  $\pm$  2.51 and TG: 7.35  $\pm$  0.58) and retroperitoneal adipose tissues (SG: 10.96  $\pm$  1.57 and TG: 5.28  $\pm$  0.45). Also, ET increased the fat-free mass (SG: 82.57  $\pm$  3.62 and TG: 91.60  $\pm$  0.57) and significantly reduced the body fat percentage (SG: 17.43  $\pm$  3.62 and TG: 8.40  $\pm$  0.57), which was followed by a reduction in the serum concentration of leptin (SG: 19.02  $\pm$  2.03, TG: 8.68  $\pm$  0.78). Serum concentrations of both TNF- $\alpha$  and IL-10 did not change significantly between the groups (GS: 2.35  $\pm$  0.30, TG: 1.89  $\pm$  0.01 and GS: 101.5  $\pm$  21.35; GT: 91.51  $\pm$  16.61, respectively). **Discussion** - Confirming previous studies, we found that the reduction of body fat promoted by ET was accompanied by a reduction in serum leptin, an adipokine often related with anorexia, but also with infectious and inflammatory processes (OTERO et al., 2005), demonstrating that ET exerted an anti-inflammatory effect. However, when analyzing serum concentrations of TNF- $\alpha$  and IL-10, there were no significant changes between the groups. Therefore, the results presented here indicate that the aerobic ET anti-inflammatory action is independent of food intake (GAREKANI et al., 2011). References Garekani ET, Mohebbi H, Kraemer RR, Fathi R. Peptides. 2011 May;32(5):1008-12. Gleeson M, Bishop NC, Stensel DJ, Lindley MR, Mastana SS, Nimmo MA. Nat Rev Immunol. 2011 Aug 5;11(9):607-15. Otero M, Lago R, Lago F, Casanueva FF, Dieguez C, Gómez-Reino JJ, Gualillo O. FEBS Lett. 2005 Jan 17;579(2):295-301.

### **EFFECT OF 8 WEEKS OF AEROBIC TRAINING ON INFLAMMATION IN SPRAGUE DAWLEY RATS**

Pedroso, J.A.B., Nishimura, L.S., Matos-Neto, E.M., Moreira, R.L.L., Azevedo, L.B., Gimenis, D.P., Tirapegui, J.

University of São Paulo

**Introduction** Several studies have shown the effect of exercise in reducing the risk of developing chronic degenerative diseases and cardiovascular diseases. Although it is unclear in the literature, several authors suggest that this benefit is due to changes in the inflammatory responses caused by exercise. Thus, the objective of this study was to investigate the effect of endurance exercise training on inflammatory proteins. **Methods** Fourteen (14) adult male Sprague Dawley rats were assigned into two groups: sedentary (SED) (n = 6) and trained group (Training) (n = 8), which was subjected to 1-hour training per day on a treadmill for 8 weeks, 50 -70% VO<sub>2</sub>max. Cytokine levels were measured by multiplex immunoassay using rat serum adipokine (panel kit 7 LINCplex) for simultaneous measurement of TNF- $\alpha$ , IL-1 $\alpha$ , IL-6, MCP1 and leptin, in the automatic Lincplex 200. **Results** Trained group showed a higher concentration of IL-6 (880.36  $\pm$  276.09 pg / ml and 194.31  $\pm$  76.97 pg / ml) and IL-1 $\alpha$  (203.47  $\pm$  49.16 pg / ml, 31, 29  $\pm$  4.7 pg / ml) compared to SED group (p <0.05). There was no statistically significant difference on MCP1 and TNF- $\alpha$  levels between groups. We observed a higher leptin concentration in SED group (17.03  $\pm$  4.46 ng / ml) compared to trained group (6.44  $\pm$  1.06 ng / ml) (p <0.05). **Discussion** The results suggest that eight weeks of aerobic training was able to alter the production of some inflammatory proteins, exerting anti-inflammatory effects, and can provide several metabolic and hormonal improvements in different tissues, thus providing a powerful tool to control and / or reduce the risk of developing chronic degenerative disorders. Financial support: FAPESP and CNPq.

### **RELATION OF MACRONUTRIENTS CONSUMPTION AND MENARCHE IN ADOLESCENTS**

Leite, N., Mascarenhas, L.P.G., Titski, A.C.T., Moser, D., Rodrigues, A.M., Coelho-e-Silva, M.J., Boguszewski, M.C.S.

Federal University of Paraná - CAPES - Brazil

**Introduction** In several populations has been observed the decrease in age at menarche and the lack of scientific agreement about the factors that can stimulate increasingly early puberty (CABANES et al., 2009). The aim of this study was to identify the relationship between macronutrient intake and age at menarche in adolescents. **Methods** We evaluated 400 girls divided into two groups according to the intake of saturated fat acid (SFA) from food: Group G1  $\geq$  10% of saturated fat acid ingestion and Group G2 <10% of saturated fat acid ingestion. The height, weight, waist circumference (WC) and BMI were measured following the usual anthropometrics procedures. The menarche age was obtained by self-report. To assess the nutritional intake of young participants, the questionnaire of food frequency (FFQ) was applied. Student's t test and stepwise linear regression were performed with a significance level of 0.05. **Results** In the Groups Characteristics, there were no significant differences in age (G1= 14.06  $\pm$  2,13 years vs G2 =14.55  $\pm$  2,94 years; p= 0.37), weight (G1= 50,55  $\pm$  10,74 kg vs G2= 52, 02  $\pm$  14,73 kg; p= 0.28), height (G1= 156  $\pm$  0,8 cm vs G2= 154  $\pm$  0,8 cm; p= 0.15) and BMI (G1= 20,53  $\pm$  3,49 kg/m<sup>2</sup> vs G2= 21,42  $\pm$  4,85 kg/m<sup>2</sup>; p= 0.10). The G2, group with low saturated fat acid consumption has lower age of menarche than G1 (G1= 11.97  $\pm$  1,16 years vs G2= 11.60  $\pm$  1,26 years; p=0.03), calories intake (G1= 2755.40  $\pm$  806,58 kcal vs G2= 2399,35 $\pm$ 887,93 kcal; p=0.001), proteins (G1= 101,88  $\pm$  32,66 g vs G2= 81,93  $\pm$  31,08 g; p=0.001), total fat (G1= 98,04  $\pm$  37,81g vs G2= 60,84  $\pm$  32,24 g; p=0.001), and cholesterol (G1= 365,65  $\pm$  252,41 mg vs G2= 201,93  $\pm$  206,63 mg; p=0.001). By linear regression analyzes was observed that the consumption of saturated fatty acid can explain menarche age with R =0.232 and R<sup>2</sup> =0.05. **Discussion** In this study saturated fatty acids

were significantly associated with age at menarche. Others authors also found that high consumption of saturated fat acid is associated with postpone of menarche (MACLURE et al., 1991; GALLO et al. 2010). We suggest further studies with larger samples and longitudinal groups. References Cabanes A, Ascunze N, Vidal E, Ederra M, Barcos A, Erdozain N, Lope V, Pollám M. (2009). BMC Public Health, 9, 449. Maclure M, Travis LB, Willett W, MacMahon B. (1991). Clin Nutr, 54, 649-56. Gallo, S; Egeland, G; Meltzer, S; Legault, L; Kubow, S. (2010). J Clin End Metab, 95, 2410-17.

**13:45 - 14:45**

## Poster presentations

### PP-PM39 Adapted Physical Activity 2

#### THE EVOLUTION IN ONTOGENESIS OF THE ANTHROPOMETRIC INDICES AND MOTOR CAPACITY COMPONENTS OF THE CHILDREN WITH INTELLECTUAL DISABILITIES DURING THE SECONDARY LEVEL CYCLE

Suta, V.E.N.1,2, Marinescu, Gh.2, Salgau, S.3, Chirila, D.2, Tranca, S.2, Crangus, N.2, Petrisor, L.2, Paunescu, M.2, Oancea, C.2, Suta, L.1

1:Special School no 11 (Bucharest, Romania), 2:NUFES (Bucharest, Romania), 3:UVA (Bacau, Romania)

THE EVOLUTION ONTOGENESIS OF THE ANTHROPOMETRIC INDICES AND MOTOR CAPACITY COMPONENTS OF THE CHILDREN WITH INTELLECTUAL DISABILITIES DURING THE SECONDARY LEVEL CYCLE Suta, V.E.N.1;2, Marinescu, Gh.2, Salgau, S.3, Chirila, D.2, Tranca, S.2, Crangus, N.2, Petrisor, L.2, Paunescu, M.2, Oancea, C.2, Suta, L.1 1:Special School no 11 (Bucharest, Romania), 2:NUFES (Bucharest, Romania), 3:UVA (Bacau, Romania) Introduction The purpose of the research was highlight the evolution of the somatic indices and the development of the motor skills in ontogenesis of the students with severe mental deficiency, during the entire secondary level cycle. Methods During the study, there were used bibliographic research, the test method and statistical mathematical methods of data processing. The standardized biometric tests used to evaluate the 60 students with intellectual disabilities, divided in to 4 groups where the following: The Brockport Test Battery, The Romanian Biomotor Potential of the School Population, The Matorin Test and the Flamingo Balance Test of Euroit Test Battery. To process the recorded data there was used a statistical mathematical program called SPSS 16 before Windows, U Mann-Whitney Test being applied or two independent groups. The significance level taken as point of reference was  $p < 0,05$ . Results After comparing the group of the girls with mental disabilities from the 5th grade having 11-12 years and the group of girls with intellectual disabilities from the 8th grade, aged 15-16 years, there were recorded statistically significant differences at the level of waist, bust, weight, chest, muscle strength and the force of the bilateral flexors. There were recorded no significant statistically differences at the level of thoracic elasticity, running speed, hand and leg coordination, body mass index, shank plicae tricipital and subscapular, upper limb muscle strength and at the level of abdominal muscles, spine mobility, shoulder and hip joints, general coordination and balance. The comparisons made between the groups of boys with intellectual disabilities having the same age as the girls revealed additional significant differences at the level of the body mass index and hip joint mobility. Discussion The values of the anthropometric indices of the students with mental deficiency are statistically significant increasing between 11 and 15 years, while in terms of motor capacity components values there are no major differences in ontogenesis during the secondary level cycle. References Chandler T., Cronin M., Vamplew W. (2006). Sport and Physical Education: The Key Concepts, Routledge Taylor & Francis Group, London, 152-176 Epuran M. (2005). Metodologia cercetarii activitatilor corporale, Editura Fest, Bucuresti, 163-188 Winnick J.P., Short F.X. (1995). The Brockport Physical Fitness Test Manual - A Health-Related Test for Youths with Physical and Mental Disabilities, Human Kinetics, 74-111

#### COMPARISON BETWEEN REAL AND VIRTUAL ENVIRONMENTS IN AN ADAPTED TABLE TENNIS TASK

Silva, E., Teruya, T.T., Mochizuki, L., Silva, T.D., Guimaraes, E.A., Santos, B.S., Santos, L.C., Neiva, J.F.O., Monteiro, C.B.M.

University of São Paulo

Introduction The use of training for the physically disabled in a virtual environment is highly questioned (Deutsch et al, 2011; Shih et al, 2012). The aim of this study was to compare the stroke performance of individuals with physical disabilities in the real and virtual conditions. Methods 19 wheelchair athlete performed the strokes with a table tennis robot and playing a tennis table video game (Wii Sport Resort, Nintendo). Each trial was 30 s long. A triaxial accelerometer was attached to the table tennis paddle and to the video game remote control. The sampling rate was 1 kHz. The analysis of variance was ran to test the effect of practice condition (real and virtual) in the peak acceleration of the table tennis racket and Nintendo Wii remote controller on the transversal, longitudinal and perpendicular axes. Results There was no effect on the type of practice in the maximum acceleration in the transversal ( $F(1,36)=0.2, p=0.29$ ) and longitudinal axes ( $F(1,36)=0.07, p=0.79$ ), but had effect on the perpendicular axis ( $F(1,36)=25.1, p<0.001$ ). For the perpendicular acceleration to the paddle or remote control, the post-hoc Tukey HSD test showed that the practice in the real environment had the highest peak acceleration. Discussion Currently, different studies are assessing the use and application of virtual games in performance improvement of the physically disabled (Shih, 2012). The results showed differences in peak acceleration of movement in the ball return in table tennis when practiced in a real environment. The perpendicular acceleration is the highest for the table tennis stroke in a real condition; because the participants did not hit the ball with so much effort during the virtual table tennis as they did for the real condition. References Deutsch JE, Brettler A, Smith C, Welsh J, John R, Guarrera-Bowlby P, Kafri M. Nintendo wii sports and wii fit game analysis, validation, and application to stroke rehabilitation. Top Stroke Rehabil. 2011;18(6):701-19. Shih CH, Chang ML, Mohua Z. A three-dimensional object orientation detector assisting people with developmental disabilities to control their environmental stimulation through simple occupational activities with a Nintendo WiiRemote Controller. Res Dev Disabil. 2012; 33(2):484-9.

### MOTOR LEARNING THROUGH VIDEO GAMING IN CEREBRAL PALSY

Silva, E., Silva, T.D., Guimaraes, E.A., Santos, B.S., Santos, L.C., Neiva, J.F.O., Monteiro, C.B.M.

*University of São Paulo*

**Introduction** Cerebral Palsy describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior, by epilepsy, and by secondary musculoskeletal problems (Rosenbaum et al, 2007). An option of physical activity and sport that uses current technological advances are virtual video consoles. The objective of this study is to verify the occurrence of motor learning in a video game task in individuals with cerebral palsy. **Methods** Participating in the intervention were five children (2 girls, 3 boys) diagnosed with cerebral palsy, aged between eight and twelve years. Task execution consisted of playing a bowling game on a Nintendo Wii video game console. To verify the occurrence of motor learning, 10 attempts were held to throw the bowling ball a distance of 2 meters in the television in the acquisition stage; 5 attempts in the retention phase and 5 in the immediate transfer phase, which was held at a distance of 3 meters. To organize the results and data comparison, we chose to display the value of means of pins knocked down in each phase of the task. **Results** The following are data of the phases evaluated through the mean of the last attempt of each phase: acquisition 1(3.8), acquisition 2 (5.3), retention (4.2) and transfer (4.2). **Discussion** There is a growing use in the practice of virtual games used by individuals who have a physical disability (Silvia and Howe, 2012), and to consider motor learning when analyzing the results in the acquisition phase, the occurrence of better performance can be deduced due to participants showing an improvement in scores when compared to the starting point to a point later in time (acquisition 1 with respect to acquisition 2). However, the maintaining of values was not observed in the phases of retention and transfer, determining that more practice is perhaps necessary in the release task of the bowling ball in the virtual environment, providing improved performance in all phases that characterize motor learning. **References** Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M. A report: the definition and classification of cerebral palsy. *Dev Med Child Neurol Suppl.* 2007; 109:8-14. Silva CF, Howe PD. Difference, adapted physical activity and human development: potential contribution of capabilities approach. *Adapt Phys Activ Q.* 2012 Jan;29(1):25-43.

### EFFECTS OF POSTURE ON INTEGRATED EMG IN RESPIRATORY MUSCLES ACTIVITY DURING SPORT BLOWGUN

Hayashi, S., Arakane, K., Takahara, T., Yamaguchi, H., Imai, H., Onodera, S.

*Kwasaki University of Medical Welfare*

**Introduction:** Sport Blowgun is used as a disabled sport. The same rules are applied for non-disable person and disabled person in a competition. Wheelchair users play a game with the sitting posture. It is able to estimate the different pattern of muscle activities between sitting and standing posture. The purpose of this study was to compare to respiratory muscle activities and flying distance of arrow between standing condition and sitting condition. **Methods:** Six healthy young male subjects (age, 22.7±1.2 yr; height, 171.3±6.1 cm; weight, 67.7±5.8 kg) volunteered to participate in this study (mean ± SD). All participants underwent measurement in standing and sitting conditions. None had medical history with respiratory system. Respiratory function tests were performed with a spirometer. The forced vital capacity and first second forced expiratory volume were recorded. Electromyography (EMG) was used to measure expiratory muscle activity. The external oblique, rectus abdominis, and external intercostal were chosen as target muscle. After the full-wave rectified, integrated EMG of pre and post 50msec from expiratory commenced was calculated. Flying distance of arrow was also recorded. **Results:** The respiratory function did not have a significant difference between standing condition and sitting condition. Different posture did not affect the respiratory function. However, flying distance of arrow and the pattern of activity of the different muscle was distinct. Flying distance of arrow in standing condition was longer than sitting condition ( $p < 0.05$ ). Rectus abdominis activity did not have significant difference between each condition. External oblique and external intercostal activity of the standing condition was higher than sitting condition ( $p < 0.05$ ). **Discussion:** It is considered that the decline of stimulation for the brainstem reticular formation from lower limb suppressed expiratory muscular strength according to practice in sitting condition. Previous studies reported that external oblique muscle activity was large in forced expiratory (Hodges P.W et al. 1997). Flying distance of arrow is reflected the activity of external oblique. It suggests that the activity of external oblique and external intercostal contributed to the increase of flying distance of arrow. In conclusion, the muscular activities of wheelchair were significantly lower than that of standing posture.

### CHANGES IN HEART RATE, BLOOD PRESSURE, AND RATING OF PERCEIVED EXERTION DURING 200M-CRAWL SWIMMING IN SINGLE-HANDED WITH ELBOW JOINT FIXED CONDITION

WADA, T.1, SAITO, T.1, TAKAGI, Y.1,2, ARAKANE, K.1, ONODERA, S.3

1: GRADUATE SCHOOL, KAWASAKI UNIVERSITY OF MEDICAL WELFARE, 2: RESEARCH FELLOW OF THE JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE, 3: KAWASAKI UNIVERSITY OF MEDICAL WELFARE

**Purpose:** The purpose of this study was to investigate the relationship of the heart rate, blood pressure, and rating of perceived exertion during swimming in single-handed with elbow joint fixed condition in normal person. **Methods:** Eight Japanese males (age: 21.4 ± 0.9 years, weight: 60.3 ± 7.7 kg, height: 166.8 ± 6.5 cm) volunteered to this study. We got an informed consent from subjects. We conducted this study in indoor pool at K University, 2011. This study consisted of two experimental conditions; Crawl swimming in normal condition (NC) and single-handed with elbow joint fixed condition (SC). Subjects participated in both conditions. After 200 meters swimming, they sat down for 15 minutes. Measurement items were heart rate, blood pressure (SBP: Systolic Blood Pressure / DBP: Diastolic Blood Pressure), rating of perceived exertion (RPE) and Frontal projected area. These were measured at rest time, 5 (Rec5) · 10 (Rec10) · 15 (Rec15) minutes after swimming. The water temperature was 30 degrees Celsius. **Results:** Heart rate at Rec5 (106 ± 6 bpm), Rec10 (102 ± 7 bpm) and Rec15 (98 ± 7 bpm) in SC was higher than that of NC ( $p < 0.05$ ). RPE at Rec5 (14 ± 2) and Rec10 (12 ± 2) in SC was higher than that of NC ( $p < 0.05$ ). SBP at Rec15 (115 ± 7 mmHg) in SC was higher than that of NC ( $p < 0.05$ ). Frontal projected area in SC was larger than that of NC ( $p < 0.05$ ). **Discussion:** There was significantly difference between SC and NC. Increase of frontal projected area by elbow joint fixed increased viscosity resistance in water to SC. In addition, the pull turnover of person with short upper limb in SC increases more than NC. Therefore, it was considered that heart rate and RPE in SC were higher than that of NC. **Conclusion:** Heart rate and RPE in single-handed with elbow joint fixed condition were higher than that of normal condition in 200M-crawl swimming. **References:** Kanai S. (2006). The textbook of swimming. Taishukan Shoten, 14-22. (In Japanese) Onodera S.et al. (1999) Effect of buoyancy and body density on energy cost during swimming. *Biomechanics and Medicine in swimming.* 355-358.

### THE GYNECOPATHY RISK FACTORS ASSOCIATED WITH HIGH PHYSICAL ACTIVITY IN SPORT

Kovalenko, T., Shklyarenko, A., Ulyanov, D., Tkachenko, L.

*Volgograd State University*

THE GYNECOPATHY RISK FACTORS ASSOCIATED WITH HIGH PHYSICAL ACTIVITY IN SPORT Russia, Volgograd State University T.Kovalenko, A. Shklyarenko, D.Ulyanov, L.Tkachenko Introduction Despite the high adaptability of the female body, according to statistics there is a steady increase in female reproductive function abnormality in the last decade. Many researchers such as Serov and others, 2002; Vikhlyaeva and others 2003; Kulakov 2005; Prilepskaya and others 2009) have revealed that the frequency of infertile marriages in Russia is about 18-20% and there is no reduction tendency. Methods We used dynamic medical and educational techniques as well as methods of evolution of the functional status (rheography). Results The anamnesis revealed numerous gynecological diseases (retroflexion, retroversion of uterus) in young girls associated with high physical activity in sport. Such sports as heavy athletics (stress and straining efforts), artistic gymnastics (dismounts from apparatus gymnastics), wrestling, track-and-field athletics: high jumps, long jumps (concussion and shaking of the body), etc can provoke abnormal uterine version (retroversion) and flexio uteri (retroflexio). We developed therapeutic exercise techniques based on specially selected and measured methods aimed at gynecological pathology treatment. They have stress on loads on the pelvic floor muscles, abdominal and internal surface muscles. The developed exercise techniques has a restorative effect as well as rehabilitation of correct position of the uterus thanks to the right choice of preparatory position and the special exercises that rehabilitate and fix the uterus to its normal position. Discussion 1. The major risk factors for female reproductive function and infertility were revealed. 2. Our research showed the frequency of complications during pregnancy and childbirth among the former athletes which is up to 32%. 3. The most vulnerable were athletes whose out-of-season activity took place during the menstrual cycle when the uterus is filled with blood, heavy, and it changed its position easily. Whereas concussion and shaking of the body increased intra-abdominal pressure, stress and straining efforts lead to pathology. 4. The developed method has reduced the gynecopathy risks and contributed to disease prevention.

### THE COMPARISON OF MOTOR ABILITIES BETWEEN ATHLETE AND NON-ATHLETE DOWN SYNDROMES

Sabbaghian Rad, L.

*Sharif University of Technology*

Background & Aim: The main purpose of this research was to study and compare the gross motor and fine motor skills of athletes and non-athletes with Down syndrome. Methods: All of the participants have mild intellectual disability and educable. They were between 24-33 years old from Iran. There were two groups in this study. Athletes group and non-athletes group (10 males, and 10 females in each group). Athletes groups had trained for an average of 4 hrs/week and they were members of Iranian Special Olympics. Non-athletes groups didn't have the regular physical activity. The short form of Bruininks-Oseretsky test was used to assess gross motor and fine motor skills (Test of Motor Proficiency= BOTMP).It has 8 subtests and 14 tests and take 10-15 minutes. Results: Regarding the scores, a significant difference was found in scores of fine skills and gross skills. The gross and fine motor skills scores of non-athletes were also significantly lower than athletes with Down syndrome. Conclusion: The findings in this study illustrate a clear relation between the fine and gross motor skills and physical activity and it also showed that physical activity improved fine skills and gross skills in Down syndrome.

### THE FUNCTIONAL FITNESS CAPACITY OF ADULTS WITH DOWN SYNDROME IN SOUTH AFRICA

Boer, P., Terblanche, E.

*Stellenbosch University*

Introduction Considering all the health related problems that Down syndrome (DS) individuals are born with, their tendency to live sedentary lifestyles and a high likelihood of obesity, it is imperative that functional capacity is maintained in order to perform activities of daily living with as much independency as possible. To date, there is no information available on the amount of physical activity that DS individuals engage in, and their functional capacity has not been quantified yet. This information is important when one needs to consider how much exercise and what type of exercise should be prescribed for DS individuals in order for them to maintain or improve their functional capacity. The purpose of the study was to establish the functional fitness capacity of adults with DS in South Africa. Methods Data was collected at various intellectual disability centres and private homes in 7 provinces of South Africa. 371 DS individuals (199 male and 172 female) from 18-66 years were tested. Thirteen tests consisting of balance (2), flexibility (2), coordination (2), muscular strength and endurance (5), agility (1), and one maximal cardiovascular test (1) were analysed. Descriptive statistics were expressed as means and standard deviations. Four age groups (18-25, 26-35, 36-45, and older than 46) were constructed. Multiple analyses of variance and Tukey post-hoc tests were calculated to determine age- and gender related differences in variables amongst the DS adults. Trend analysis will also be performed to examine changes in fitness with age. A p value <0.05 will be considered statistically significant. Results DS men performed significantly better on all but two tests compared to the DS women (P<0.05). DS women performed better on the sit-and-reach flexibility item and the chair stand test however, differences were not statistically significant. Significant differences across age groups were also measured for 9 of the 13 functional fitness tests (p<0.05). Conclusions This study confirms that adults with DS have low functional capacities which deteriorate even more with increasing age. This has serious implications for these adults to maintain their ability to function independently as they grow older.

### ANALYZING THE EFFECTS OF PHYSICAL ACTIVITY LEVEL ON SENSE OF PAIN IN SOME PHYSIOTHERAPY APPLICATIONS

Taskin, G.

*Başkent University Hospital*

The aim of this study is to determine the effect of existing physical activity levels of people between the ages of 35-65 on sense of pain in classical physiotherapy applications used in clinics. 250 cases between the ages of 35 and 65 diagnosed with such musculoskeletal system diseases as cervical spondylosis, lomber spondylosis, carpal tunnel syndrome, cervical herniation nucleus pulposus (CHNP), lomber herniation nucleus pulposus (LHNP) and gonarthrosis; applied to Başkent University Hospital, Department of Physical Medicine and Rehabilitation and having some physiotherapy programs were participated in the study. Existing physical activity level, sex, BMI, age, income level, education level, occupation, diagnosis and whether taking physiotherapy beforehand and pain level before and after the treatment of cases were evaluated. Questions were applied to evaluate the socio-demographic features of cases, visual analog scale (VAS) was applied for pain evaluation and physical activity evaluation survey (PAES) was applied to evaluate the level of physical activity.

Information was given to the participant subjects and their written consent was taken. Data collected were made with the help of SPSS 16.0 statistics program. T-test and ANOVA (single direction variance analysis) were used in the evaluation of data. Our results show that women consume more energy in house works and men in workplace and sports. A significant difference wasn't found between sex, BMI, age, occupation variables and pain. There is a statistically significant difference between the diagnosis and pre-treatment pain. It has been ascertained that income level doesn't affect the physical activity level and pain level. It has been observed that the more education level increases, the more MET value increases. When the relation between the occupation of cases and their PAES values, it can be said that being a housewife and retirement are a risk factor for physical inactivity. It has been determined that there isn't a statistically significant relation between the physical activity levels of cases and PAES values. This result indicates that physical activity level doesn't have any effect on pain in physiotherapy patients.

### EFFECTS OF WEIGHT LOSS ON THE CHANGES IN DYNAMICAL MARKS OF CENTRE OF GRAVITY

Szablics, P.1, Szabó, S.1, Dvorák, M.1, Orbán, K.1, Balogh, L.1, Molnár, A.H.1, László, F.1,2, Varga, Cs.2

*University of Szeged*

EFFECTS OF WEIGHT LOSS ON THE CHANGES IN DYNAMICAL MARKS OF CENTRE OF GRAVITY Szablics, P.1, Szabó, S.1, Dvorák, M.1, Orbán, K.1, Balogh, L.1, Molnár, A.H.1, László, F.1,2, Varga, Cs.2 <sup>1</sup>Institute of Physical Education and Sport Sciences <sup>2</sup>Department of Physiology, Anatomy and Neuroscience University of Szeged (Szeged, Hungary) Introduction: The quality and dynamical marks of movement deteriorate due to obesity and overweight. Several studies suggest that body weight begins to normalise and the health status improves resulting from submaximal, aerobic training. Based on these data the movement dynamics is also improved by recreational training (Katzmarzyk and Lear, 2012). Aims: We investigated the changes in dynamical marks of centre of gravity (CG) after weight loss in case of simple movements like crouch and jump. Methods: 93 participants (age: 11-70 years, mean BMI: 26.9±0.57) took part in our study. They did 60 minute long recreation trainings two times a week for 3 months on 60 percent of maximal heart rate. APAS 3D system was used for movement analysis. The examination was performed in the beginning and at the end of training program in 2 dimensions with 4 reference points and 11 joint points (ankles, knees, hips, shoulders, elbows and forehead). Participants crouched and jumped in front of a camera. The speed of video record was 30 frames per second. We analysed the position, velocity and acceleration of CG. Changes of body weight, fat and muscle mass were determined by InBody230. Participants were divided into the following five age groups: gr. I: 11-18 years, gr. II: 19-29 years, gr. III: 30-45 years, gr. IV: 46-60 years, gr. V: 61-70 years. Results: Significant decrease of body weight was detected in gr. II (-1.17±0.6kg), gr. III (-4.83±1.5kg), gr. IV (-1.15±0.6kg) and gr. V (-1.19±0.3kg). The fat mass was reduced in gr. II (-1.65±0.8kg) and gr. III (-3.9±1.3kg). We observed significant increase in lifting of CG in case of jump in gr. III (+2.6±1.3cm) and gr. V (+2.2±1.1cm). The increase of CG velocity was significant in gr. IV (+47.5±17.5cm/s) and gr. V (+25.75±8.7cm/s). In case of crouch the extent of sinking and the velocity of CG were enhanced significantly in gr. IV (-5.09±2.7cm and +85.37±43.9cm/s). We did not detect any significant changes in acceleration of CG in neither group. Conclusion: Our results suggest that low intensity recreational training optimizes the body composition and the dynamics of movement. Weight loss mends the position and velocity of CG in case of crouch and jump. Our training program was the most effective among 30-60 year-old people. Reference: Katzmarzyk PT and Lear SA. (2012). Obesity Reviews, 13(2), 95-105. Support: SROP 4.2.2-08/1-2008-0006; SROP 4.2.1/B-09-1/KNOV-210-0005

### PHYSICAL ACTIVITY IN SPORT SCHOOL CHILDREN FROM AGE 10 TO 12, A LONGITUDINAL STUDY

Uvacsek, M.1, Tóth, M.1, Ridgers, N.D.2

*Semmelweis University: 1: SU (Budapest, Hungary), 2: DU (Melbourne, Australia)*

Introduction There is a lack of information about objectively measured physical activity levels of primary school children in Hungary (Hamar 2009). The aim of this study was to investigate the differences in physical activity levels of children attending a sport school between 2008 and 2010. Methods Fifty-two children took part in the first investigation in 2008, with 35 (19 boys, 16 girls) providing follow-up data at 18 months (67% retention rate). Physical activity (PA) was quantified every 5-seconds using uni-axial accelerometry for 3 (baseline) and 5 (follow-up) consecutive school days. The accelerometer was worn on the right hip using a fitted elastic belt during all waking hours except for water-based activities. Time spent in sedentary, light (LPA), moderate (MPA), and vigorous physical activity (VPA) during school days was determined using existing age-appropriate cut-points (Riddoch 2007). Children who did not have complete data for 2 week-days (480 minutes wear time per day) were excluded from the analyses. Thirty-two children provided complete data over both testing occasions. Differences in body dimensions (BF% and BMI) and PA were assessed using dependent samples t-tests. Statistical analyses were conducted using Statistica for Windows 8.0. Statistical significance was set at  $p < 0.05$ . Results The prevalence of overweight, according to BMI cut-points for children (Cole 2000), decreased from 16% to 13%. Time spent being sedentary increased significantly (477.7 ± 63.1 min/day to 555.4 ± 66.4 min/day), whilst MVPA decreased significantly (148.4 ± 45.1 min/day to 116.2 ± 22.8 min/day). Discussion All the children met the 60 minutes per day international recommendation, though decreases in MVPA were evident over 18 months. The relatively high average of MVPA during weekdays may be explained by the daily physical education lessons and participation in afternoon clubs in schools, though further research is needed to determine why increases in sedentary time and decreases in MVPA were observed. References Cole TJ, Bellizzi M, Flegal K, Dietz WH: Brit. Med. J. 320, 1-6 (2000) Hamar P, Biddle S, Soós I, Takács B, Huszár Á: Eur. J. Public Health 20, 85-90 (2009) Riddoch CJ, Mattlocks C, Deere K, Saunders J, Kirkby J, Tilling K, Leary SD, Blair SN, Ness AR: Arch. Dis. Child 92, 963-969 (2007)

13:45 - 14:45

## Poster presentations

## PP-PM40 Nutrition 4

**POST EXERCISE ORAL CONJUGATED LINOLEIC ACID SUPPLEMENTATION CANNOT IMPROVE SUBSEQUENCE ENDURANCE PERFORMANCE**

Cheng, I.S.1, Tsao, J.P.2, Chen, H.W.1

1: NTCU (Taichung, Taiwan), 2: NTUPES (Taichung, Taiwan)

**Introduction** Conjugated linoleic acids (CLA) is refers to a group of polyunsaturated fatty acid with two double bonds (Evans et al., 2002). Previous studies showed that CLA had advantages for reducing body fat mass in human study (Blankson et al., 2000). Little study is regarding to whether CLA administration is expected to cause metabolic consequence in exercised human and resulted in improvement of endurance performance. The purpose of this study was to demonstrate the effect of post-exercise CLA supplementation on subsequenced endurance performance. **Methods** This study was a double-blind, crossover design and eight healthy male subjects participated in two treatments which included placebo or CLA supplementation after cycling at 70% VO<sub>2</sub> peak oxygen consumption for 60 mins, separated at least 7 days. When the subjects consumed carbohydrate meal with 4.0 g mixed-isomer CLA supplementation after exercise, immediately performed endurance exercise performance on a cycle ergometer of 70% VO<sub>2</sub> peak until voluntary fatigue. The blood samples were measured for glucose, insulin, NEFA and glycerol concentrations. The gas parameters were measured for respiratory exchange ratio (RER), CHO oxidation rate and fat oxidation rate. **Results** All parameters which included blood glucose, NEFA, glycerol and serum insulin concentrations or RER, carbohydrate oxidation rate and fat oxidation rate were no significantly different between CLA and placebo trials. No significant differences in subsequenced endurance performance were shown between CLA and placebo supplementation immediately after a single bout of exercise (CLA: 37.3 ± 3.1 mins ; Placebo: 38.4 ± 1.8 mins). **Discussion** The present study cannot support the evidences in animal study that dietary conjugated linoleic acid increases endurance capacity (Mizunoya et al., 2005), as evidenced by no significant improvement in endurance performance after post-exercise CLA supplementation. In human study, the concentration of CLA in chylomicrons reached peak level at 4 h after CLA supplementation (Ferne et al., 2004). The suggestion in our study is commended, to examine the endurance performance over 4 hours after CLA supplementation. However, the present results of this study will not positively benefit to athletes, who are training for competitions. **References** Blankson J A, Stakkestad J A, Fagerun H, Thom E, Wadstein J, Gudmundsen O. (2000). *The Journal of nutrition*, 130(12), 2943. Evans M, Brown J, McIntosh M. (2002). *J Nutr Biochem*, 13(9), 508. Fernie C E, Dupont I E, Scruel O, Carpentier Y A, Sébédio J L, Scrimgeour C M. (2004). *European journal of lipid science and technology*, 106(6), 347-354. Mizunoya W, Haramizu S, Shibakusa T, Okabe Y, Fushiki T. (2005). *Lipids*, 40(3), 265-271.

**ANAEROBIC PERFORMANCE DURING MODERATE ALTITUDE EXPOSURE UNDER ACID OR ALKALINE FORMING NUTRITION**

Limmer, M., Platen, P.

*Ruhr-University Bochum*

**Introduction** The present pilot study was conducted to examine the effects of moderate altitude exposure in combination with acid or alkaline forming nutrition on parameters of the anaerobic energy metabolism and on acid-base blood parameters in moderately trained sport students. **Methods** 12 healthy physical education students (n=10 males; n=2 females) were randomized into 2 groups according to the acid/alkaline load of their nutrition: the alkaline forming (ALK; n=6) and acid forming (ACID; n=6) group. 7 days of moderate hypobaric altitude exposure (MA) were obtained in the European Alps while living and hiking at an altitude level of 2434 m to 3772 m. During MA, ALK mainly consumed alkaline forming nutrients while ACID mainly consumed acid forming nutrients. To assess anaerobic power subjects performed a 15 s skipping test to maximum exertion prior to MA, during MA (on days 2, 5 and 7), and 1 day after returning to sea level. Anaerobic performance related parameters (maximal lactate production rate (VLamax) and blood bicarbonate concentration (HCO<sub>3</sub><sup>-</sup>) were determined in pre- and post-exercise capillary blood samples taken from the earlobe. All parameters were analysed directly after sampling. Data were analysed with repeated measures ANOVA. **Results** VLamax, and HCO<sub>3</sub><sup>-</sup> decreased continuously (p<0.01) during MA in the collective group and did not reach the pre-MA level after 1 day at sea level (VLamax (mmol/l/min): 0.76±0.10, 0.68±0.12, 0.67±0.15, 0.60±0.12, 0.64±0.16; HCO<sub>3</sub><sup>-</sup> (pre-exercise, mmol/l): 26.6±3.6, 24.1±2.4, 23.1±2.3, 22.1±1.0, 24.8±1.6; HCO<sub>3</sub><sup>-</sup> (post-exercise, mmol/l): 23.5±2.7, 20.9±2.4, 19.0±2.4, 18.7±2.0, 20.2±2.5; values are listed for the tests prior to MA, during days 2, 5 and 7, and after MA, respectively). ALK or ACID did not have any significant influence on VLamax and HCO<sub>3</sub><sup>-</sup>, although VLamax and HCO<sub>3</sub><sup>-</sup> declined less during MA in some subjects of the ALK group. **Discussion** The results clearly indicate that moderate altitude exposure negatively affects VLamax and HCO<sub>3</sub><sup>-</sup> in moderately trained sport students. Nutritional acid/alkaline load does not clearly influence anaerobic performance related parameters during MA. Further studies with longer or higher altitude exposure are needed to demonstrate possible chronic effects of nutritional acid or alkaline loads on anaerobic metabolism.

**NITRATE SUPPLEMENTATION AND HIGH-INTENSITY CYCLING PERFORMANCE**

Hoon, M.H.1, Burke, L.B.2, Jones, A.M.3, Hopkins, W.G.4, Johnson, N.J.1, Halson, S.L.1, Martin, D.T.1, West, N.P.5, Bartram, J.1

1: *University Of Sydney*, 2: *Australian Institute Of Sport*, 3: *University Of Exeter*, 4: *Auckland University Of Technology*

**Introduction** Recent studies have demonstrated that consumption of inorganic nitrate enhances endurance performance, most likely via the conversion of nitrate to nitric oxide. Most of the research has been conducted on recreationally trained subjects, but in athletes cardiovascular adaptations to exercise training may blunt the response to nitric oxide. **Aim** To investigate the effect of nitrate supplementation in national-level cyclists on performance of two 4-minute cycling time trials, separated by 75 min. The effect of the timing of nitrate ingestion was also investigated. **Methods** In a randomised cross-over design, 26 cyclists performed the time trials on Wattbike cycle ergometers under four conditions, each separated by a seven-day washout: consumption of 75 ml of nitrate-rich beetroot juice either 150 min or 75 min before the first time trial, consumption of a 30-ml top-up dose following the first time trial in the 150-min condition, and consump-

tion of a placebo. Plasma nitrite was sampled at five time points. A linear mixed model with adjustments for learning effects and athlete fitness (peak incremental power) was used to estimate and express mean power in each time trial of each nitrate condition as percent change from that in the placebo condition, with probabilistic inferences based on a smallest effect of 1.0%. Results Plasma nitrite concentration rose to a peak of ~50% above baseline by ~75 min after consumption of nitrate. Collectively, there was an unclear mean effect on average power in each of the nitrate conditions in the first time trial (1.1%, 90% confidence limits  $\pm 1.7\%$ ) and a possibly harmful effect on the second time trial (-0.5%,  $\pm 1.6\%$ ). For the fitter cyclists (+1SD), the effect of nitrate supplementation was possibly harmful in both time trials (-0.6%,  $\pm 2.8\%$ ; -1.7%,  $\pm 2.7\%$ ). Conclusion On the basis of these results, acute nitrate supplementation in the form of beetroot juice cannot be recommended for high-intensity performance in highly trained cyclists.

### **EFFECT OF A SPORT DRINK WITH ELECTROLYTE AND ISOMALTULOSE ON TIME TO EXHAUSTION AT AN INTENSITY ABOVE ANEROBIC THRESHOLD**

De Angelis, M., Spinozzi, M., Chiavaroli, S.

*University of L'Aquila*

**EFFECT OF A SPORT DRINK WITH ELECTROLYTE AND ISOMALTULOSE ON TIME TO EXHAUSTION AT AN INTENSITY ABOVE ANEROBIC THRESHOLD** De Angelis, M.1, Spinozzi M.2, Chiavaroli S.1 1: BST dept. (L'Aquila, Italy), 2: Sport Science Faculty (L'Aquila, Italy) Introduction Sports drinks are formulated to provide fluid, facilitating drinking, essential electrolytes and carbohydrate replacement for an optimal thermoregulation and to maximize exercise performance. Isomaltulose, for its slow rate of hydrolysis and low glycaemic index (Lina et al., 2002), and for the characteristics of fructose, its component, with increased fluid and solute absorption in the small intestine and increased exogenous oxidation (Johnson and Murray, 2010), could improve the duration of exercise. The aim of this study was to test, with a trial to exhaustion, one commercial sport drink with these elements. Methods Twenty young subjects performed, not knowing the aim of the test and not seeing the clock, two separate trials at exhaustion on a cycle ergometer, at a fixed power 10% higher than their Lactate Threshold, during which they could drink ad libitum, in a random order, plain water or a commercial sport beverage (H3OPro®), with electrolytes, isomaltulose, vitamins B and C. Heart rate, blood lactate, time to exhaustion and drunk fluid were measured at the end of the trial. Paired Student-t test were performed. Results When subjects could drink H3OPro® they drank more (505 vs 361ml;  $p=0.031$ ), cycled longer (40'24" vs 32'57";  $p=0.005$ ) and reached a lower blood lactate (4.9 vs 5.5mM) than with plain water. Discussion A beverage, like the one tested, that helps drinking more fluid can maintain euhydration and, therefore, optimal thermoregulation. A moderate and balanced concentration in the ingested fluid of essential electrolytes enhances both water absorption and retention (Wendt et al. 2007). A sound carbohydrate formulation provides useful fuel for muscles but, according to blood lactate values, and differently from other studies (Achten et al., 2007), fat oxidation seemed to be higher and carbohydrate oxidation lower with H3OPro® than with water. This could be probably due to the presence of isomaltulose that, as previously showed (West et al. 2011; Achten et al. 2007), can lower carbohydrate and enhance lipid oxidation rates during the later stages of exercise. Consuming a well balanced sport beverage can significantly improve duration of exercise in cycling. References Achten J, Jentjens RL, Brouns F, Jeukendrup AE. (2007). *J Nutr*, 137(5), 1143-8. Johnson RJ, Murray R. (2010). *Curr Sports Med Rep*, 9(4), 253-8. Lina BA, Jonker D, Kozianowski G. (2002). *Food Chem Toxicol*, 40(10), 1375-81. Wendt D, van Loon LJ, Lichtenbelt WD. (2007). *Sports Med*, 37(8), 669-82. West DJ, Morton RD, Stephens JW, Bain SC, Kilduff LP, Luzio S, Still R, Bracken RM. (2011). *Med Sci Sports Exerc*, 43(2), 204-10.

### **EFFECTS OF BETA-ALANINE COMBINED WITH SODIUM BICARBONATE ON FREESTYLE SWIMMING PERFORMANCE**

Coelho, D.

*University de São Paulo*

Coelho, DF.1, de Salles Painelli, V.1, Campos, PL.1, Artioli, GG.1, de Jesus, F.1, Galves, VF.1, de Oliveira, N.1, do Carmo, CA.1, Solis, MY.1, Benatti, FB.1, Roschel, H.1, Sale, C.2, Harris, RC.3, Gualano, B.1, Lancha Junior, AH.1. 1: USP (São Paulo, Brazil), 2: NTU (Nottingham, United Kingdom), 3: UCC (Chichester, United Kingdom). Introduction Muscle acidosis is a major cause of fatigue during high-intensity exercise. Anaerobic contribution to simulated swimming bouts of 100 and 200 yd is known to be high. Few nutritional aids are able to reduce intramuscular H<sup>+</sup> accumulation, namely sodium bicarbonate (SB) and beta-alanine (BA) supplementation. Two studies were conducted to investigate the effect of BA supplementation alone (study A) and the combined effect of BA plus SB on 100-m and 200-m swimming performance (study B). Methods In Study A, 16 trained swimmers received either BA (3.2 g/d for 1 week plus 6.4 g/d for 4 weeks) or placebo (PL). At baseline and after 5 weeks, the athletes completed simulated 100-m and 200-m freestyle swimming races. In Study B, 14 trained swimmers received either BA (3.2 g/d for 1 week plus 6.4 g/d for 3 weeks) or PL. Swimming time trials were performed at baseline, after 4 weeks and following 4 days of combined SB and PL supplementation, in a crossover fashion. Blood lactate was assessed in both studies. Results Study A: BA supplementation significantly improved performance in the 200-m race by 2.0% (-2.8 seconds,  $p=0.01$ ). Study B, both BA and SB alone improved 200-m time trial performance when compared to PL (BA-SB: 2.11%, PL-SB: 1.43%; BA-PL: 1.2%,  $p<0.05$ ). The co-ingestion of BA plus SB provided no further benefit in comparison to BA or SB alone ( $p=0.78$  and  $p=0.53$ , respectively). BA, with or without SB, had no significant effect on 100-m time trial performance. Blood lactate concentration increased, as a function of exercise trials. However, SB led to greater lactate accumulation when compared with other conditions. Discussion BA supplementation effectively improved the 200-m freestyle swimming performance. Our additional results indicated that BA and SB were equally capable of improving swimmers performance; the co-ingestion of both supplements promoted a further non-significant improvement. SB resulted in higher blood lactate concentration after the exercise, probably caused by an SB-induced increased activity of monocarboxylate transporter-1 (Requena et al., 2005). Neither BA nor SB promoted a significant improvement in 100-m time-trial performance, which is in line with other studies (Webster et al., 1993; Derave et al., 2007). References Derave W, Ozdemir MS, Harris RC, Pottier A, Reyngoudt H, Koppo K, Wise JA, Achten E. (2007). *J Appl Physiol*, 103(5), 1736-1743. Requena B, Zabala M, Padial P, Feriche B. (2005). *J Strength Cond Res*, 19(1), 213-224. Webster MJ, Webster MN, Crawford RE, Gladden LB. (1993). *Med Sci Sports Exerc*, 25(8), 960-965.

### **EFFECT OF LEUCINE AND ARGININE SUPPLEMENTATION ON RESISTANCE EXERCISE PERFORMANCE AND BODY COMPOSITION IN HEALTHY MALE SUBJECTS**

Rosa, F., Dacar, M., Donatto, F., Seelaender, M.

*University of São Paulo*

Effect of leucine and arginine supplementation on resistance exercise performance and body composition in healthy male subjects Dacar, M1, Rosa, FO1, Donatto, FF1, Seelaender, M.C.L1 1:University of São Paulo (São Paulo, Brazil) Introduction: The anabolic effect of

leucine on protein synthesis is of great interest both in the prevention of reduction of lean body mass in various diseases, and in the maintenance/enhancement of lean body mass in healthy individuals. Arginine is employed by athletes for increasing lean muscle mass, by inducing vasodilation. Therefore, the aim of this study was to determine whether chronic leucine or arginine supplementation may, in fact, improve strength exercise performance, and anthropometric characteristics in healthy young individuals. Methods: Fourteen male (aged 19-37 yr old), supplemented with leucine (LEU, n=6), arginine (ARG, n=6) and valine (VAL, n=6), experienced weightlifters with at least 1 year or more experience in strength training, and with body mass index (BMI) between 21 and 26 kg/m<sup>2</sup>, except by one subject (33 kg/m<sup>2</sup>) were submitted a progressive resistance training program after all baseline assessment and which was performed 4 times a week for 6 weeks (~22 training days), analyses strength was assessed by Strength Testing (1 RM), Body Composition (Body mass index as kg/m<sup>2</sup>) and whole lean and fat mass were determined by hydrostatic weighing, according to the equations described by (Siri, 1961). Results: There were no significant changes in fat mass for all three groups over time. Significantly higher (P < 0.01) lean mass gain was observed in group LEU (mean 2.93 kg) in relation to ARG (mean 1.22 kg) and VAL (mean 0.08 Kg). The LEU(0.48 ± 0.12 - 0.55 ± 0.13Kg) group had significantly improved effects (P < 0.001) performance in barbell bench press, when compared to VAL(0.55 ± 0.07 - 0.60 ± 0.06Kg) and ARG (0.56 ± 0.18 - 0.60 ± 0.16Kg) groups. Discussion: Resistance exercise increases muscle protein synthesis through changes in muscle cell signaling. In particular, it appears to elicit its effects by signal transduction through the mammalian target of rapamycin (mTOR) pathway leading to phosphorylation and activation of its downstream target proteins. Not all amino acids have the same potency in stimulating protein synthesis, and studies shown that BCAA, particularly leucine, seem to be the most potent among all amino acids with regard to promoters skeletal muscle protein synthesis. In conclusion, we demonstrated that the combination of resistance exercise training and leucine supplementation conferred greater gain in lean body mass and improved performance during training sessions in healthy male athletes strength.

### EFFECTS OF BIOLOGICAL MATURITY ON HYDRATION STATUS AND SWEAT RESPONSES TO MATCH PLAY IN HIGHLY-TRAINED YOUNG SOCCER PLAYERS

Gurr, S.1, Al Haddad, H.2, Mendez Villanueva, J.A.2

*1)Aspetar Sports Medicine Hospital 2)Aspire Academy of Sports Excellence*

Introduction Empirical field based data on the hydration status and sweat response of highly trained young soccer players during competitive matches is scarce (Da Silva et al., 2012). Laboratory based studies that have examined the thermoregulatory response in children and adolescents during continuous exercise modes have found post-pubertal children sweat more than pre-pubertal children when exercising at the same relative intensity (Araki et al., 1979; Falk et al., 1992). However, it is not clear whether the results of these studies are readily applicable to the intermittent nature of soccer played outdoors. The aim of this study was to compare the pre-match hydration status and sweat response of highly-trained adolescent soccer players differing in biological maturity during competitive soccer matches played in warm conditions. Methods Thirty nine players (Age: 14.7 ± 1.4 yrs; body mass: 49.1 ± 9.2 kg; Height: 165.4 ± 8.9 cm) from the same football academy were monitored for hydration status and sweat response during eleven games lasting 70-90 minutes. Urine samples were collected before the game and analyzed for osmolality. Sweat loss was assessed from the change in body mass after correction for fluid intake and urine losses. Heat Index (HI) was used as a marker of environmental conditions. Players were later subdivided into three non-overlapped maturational groups based on their age of predicted height velocity (APHV): 1) Pre-APHV <-1.1 yrs to PHV (n=11), around the estimated APHV (Circum-APHV >-1yrs to PHV to <+1 yrs) (n=18) and post-APHV (>1 PHV) (n=10). Differences in the mean values were assessed using a one-way ANOVA. Bonferroni's post hoc tests was applied when a significant interaction was found. Results There was no significant difference in the environmental conditions (HI-33.2 ± 2.5°C pre-APHV; 35.2 ± 3.7°C circum-APHV; 34.6 ± 1.9°C post-APHV; p=0.25) or in the pre-match hydration status (699 ± 311 mOsm/kg pre-APHV; 884 ± 217 mOsm/kg circum-APHV; 673 ± 377 mOsm/kg post-APHV; p=0.12) between the groups. There were significant differences between all groups for percentage change in body mass (Pre-APHV vs. Post-APHV (0.8 ± 0.6 vs. 2.3 ± 0.8; p < 0.001); Circum-APHV vs. Post-APHV (1.5 ± 0.7 vs. 2.3 ± 0.8; p = 0.022); Pre-APHV vs. Circum-APHV (0.8 ± 0.6 vs 1.5 ± 0.7; p=0.045). Corrected for differences in body mass, a significant difference in sweat losses was only observed between Pre-APHV and Post-APHV groups (19.6 ± 4.4 vs. 25.9 ± 4.5 ml/kg/hr; p= 0.017). Discussion This study supports previous laboratory-based findings that pre-pubertal adolescents rely less on evaporative sweat loss than post-pubertal adolescents when exercising in the heat. The large variability sweat rates within groups reinforces the need to individualise hydration advice for players. References Da Silva RP, T. Mundel T, et al. (2012). *J Sports Sci*, 30(1), 37-42. Araki T, Toda Y, Matsushita K, Tsujino A (1979). *Jap. J. Fitness Sports Med*, 28, 239-248. Falk, B., O. Bar-Or, et al. (1992) *Med Sci Sports Exerc*, 24(6), 688-694.

### DYNAMICS OF EXERCISE PERFORMANCE AND AEROBIC CAPACITY OF ATHLETES IN THE CONDITIONS OF COMBINED HYPOXIA AT INTAKE OF MIXTURE OF BAS

Sukhov, S., Ivanov, A.

*National Research and Practical Centre of Physical Culture*

Introduction At coaching and contesting in mountain terrain, athletes are exposed to combined hypoxia. To minimize its negative effect on athletes, there was developed a mixture of biologically active supplements (BAS) characterized with antihypoxic action. The goal of the study was to test its effect on exercise performance and aerobic capacity of athletes in the conditions of combined hypoxia. Methods Forty-five elite judoists (22 athletes – experimental group, 23 athletes – control group) have been examined. Both groups were coached with the same program and catered in the same canteen. Athletes in the experimental group received BAS mixture for 8 weeks. Duplicate testing of athletes, at an 8-week interval, was made at breathing with hypoxic mixture with oxygen content 14% that corresponds to altitude 3300 m above sea level. There was assessed the physical performance on bicycle ergometer at a three-step discrete small, submaximal and maximal aerobic load, maximum oxygen consumption (VO<sub>2</sub>max) and oxygen pulse. Results At the second testing of the experimental group, the physical performance at heart rates 130, 150, 170 bpm and maximal heart rate has increased, as compared with the first test. In the control group, at heart rates 130 and 150 bpm, the physical performance at the second test was lower, as compared with the first examination, while at heart rates 170 bpm and maximal rate it remained on the same level. Overall volume of work in the experimental group has increased at the second testing from 220±5.0 to 231±5.5 kgm•kg<sup>-1</sup>, while in the control group it has slightly decreased from 209.5±5.8 to 202.6±4.0 kgm•kg<sup>-1</sup>. Prior to administration of BAS, in the experimental group the VO<sub>2</sub>max was 2524±98 ml•min<sup>-1</sup> (37.72±1.27 ml•kg<sup>-1</sup>•min<sup>-1</sup>), while after the intake it reached 2598±90 ml•min<sup>-1</sup> (38.95±1.25ml•kg<sup>-1</sup>•min<sup>-1</sup>). In the control group, at the first test the VO<sub>2</sub>max was equal to 2547±97 ml•min<sup>-1</sup> (36.12±1.06 ml•kg<sup>-1</sup>•min<sup>-1</sup>), and at the second test it reached 2493±95 ml•min<sup>-1</sup> (35.41±1.24 ml•kg<sup>-1</sup>•min<sup>-1</sup>). Oxygen pulse in the experimental group did not change at rest and tended to increase at loads of different aerobic capacity, while the control group has demonstrated an opposite trend. Conclusion The tested BAS mixture has



demonstrated a positive effect on the physical performance, VO<sub>2</sub>max and oxygen pulse of athletes in the conditions of combined hypoxia.

### **CARBOHYDRATE GEL INGESTION SIGNIFICANTLY IMPROVES THE INTERMITTENT ENDURANCE CAPACITY OF ADOLESCENT TEAM GAMES PLAYERS DURING PROLONGED INTERMITTENT SHUTTLE RUNNING**

Phillips, S.M.<sup>1</sup>, Turner, A.P.<sup>2</sup>, Sanderson, M.F.<sup>2</sup>, Sproule, J.<sup>2</sup>

*1: University of Abertay Dundee, Scotland; 2: University of Edinburgh, Scotland*

**Introduction** In recent years, ingestion of carbohydrate (CHO) in the form of a gel has become more prevalent, due in part to the ability to manipulate CHO and fluid intake independently and to ingest greater amounts of CHO in gel compared with solution form. Carbohydrate gel ingestion has been demonstrated to significantly enhance intermittent endurance capacity in adults (Patterson & Gray, 2007). However, its efficacy has not been studied in young people. The aim of this study was to investigate the influence of ingesting a CHO gel on the intermittent endurance capacity, sprint performance, and physiological response of adolescent team games players during prolonged intermittent, high-intensity running. **Methods** Eleven participants (mean age 13.5 ± 0.7 years, height 1.72 ± 0.08 m, body mass (BM) 62.1 ± 9.4 kg) performed two trials. In each trial, they completed four 15 min periods of part A of the Loughborough Intermittent Shuttle Test (LIST), followed by an intermittent run to exhaustion (part B). In the 5 min pre-exercise, participants consumed 0.8 ml.kg BM of a CHO or a non-CHO placebo gel, and a further 0.3 ml.kg BM every 15 min during part A of the LIST (38.0 ± 5.5 g CHO.h in the CHO trial). **Results** Intermittent endurance capacity was increased by 21.1% during part B when the CHO gel was ingested (4.6 ± 2.0 vs. 3.8 ± 2.4 min, P < 0.05, r = 0.67), with distance covered in part B significantly greater in the CHO trial (787 ± 319 vs. 669 ± 424 m, P < 0.05, r = 0.57). Gel ingestion did not significantly influence mean 15 m sprint time (P = 0.33, r = 0.31), peak sprint time (P = 0.81, r = 0.08), heart rate (P = 0.66, r = 0.16), gut fullness (P = 0.09, r = 0.51) or gastric discomfort (P = 0.72, r = 0.11) ratings during exercise. **Discussion** Pre-pubertal children are able to oxidise more exogenous CHO than adults (Timmons et al., 2007), and adolescents may also have this ability, although exogenous oxidation rates decline throughout puberty (Timmons et al., 2007). Greater exogenous CHO use may enable greater sparing of muscle glycogen and therefore increased intermittent endurance capacity in adolescents. The lack of influence of CHO supplementation on mean sprint duration and physiological responses throughout the LIST is in line with previous adult work (Nicholas et al., 1995; 1999). **References** Nicholas CW, Williams C, Lakomy HKA, Phillips G, Nowitz A. (1995) *J Sports Sci*, 13, 283–290. Nicholas CW, Tsintzas K, Boobis L, Williams C. (1999) *Med Sci Sports Exerc*, 31, 280–286. Patterson SD, Gray SC. (2007) *Int J Sport Nutr Exerc Metab*, 17, 445–455. Timmons BW, Bar-Or O, Riddell MC. (2007) *Appl Physiol Nutr Metab*, 32, 416–425.

### **THE EFFECTS OF CREATINE SUPPLEMENTATION ON FATIGUE AND RECOVERY AFTER RESISTANCE EXERCISE IN FEMALES**

Touba, M., Altareki, N.

*Alfateh University*

**ABSTRACT** The objective was to quantify the effect of creatine (Cr) supplementation on muscular strength and biochemical responses to resistance exercise in female subjects. The methodological studies described in the pilot and main studies were used to create the protocols to reliably assess MVC and RFD. Subjects undertook a resistance exercise session at an intensity corresponding to 80% of 1-RM. They were required to consume 20g of creatine monohydrate or placebo in a double-blind experimental design for 5 days before being tested. Blood samples were taken before each session of tests, and analyzed for blood biochemical variables which included: creatine kinase (CK), Growth hormone (GH), Myoglobin (MYO). A significant effect of Cr was found on MVC and RFD recovery (P<0.01). Body mass was not significantly different between sessions (P= 0.14) but there was a slight increase following Cr supplementation session (1.0 kg) compared to other conditions. The CK and MYO, data revealed no significant main effect on time and conditions (P>0.05). It was concluded that short-term creatine supplementation does not alter the responses of creatine kinase, and myoglobin to a single bout of fatigue and recovery on heavy resistance exercise but were greater on growth hormone with Cr condition. These data suggest that oral creatine supplementation does not reduce muscle damage but enhances recovery following a resistance exercise challenge. These partially explain the increases in strength and improvements in exercise performance following oral creatine ingestion and has strong support as a nutritional strategy for females.

### **THE EFFECTIVENESS OF A NUTRITIONAL INTERVENTION ON THE ATHLETIC PERFORMANCE OF NON-PROFESSIONAL MALE BOXERS.**

Veniamakis, E., Giovani, D., Nikolaidis, P.

*Technological Education Institute of Crete*

**Abstract Background:** The purpose of this study was to assess the effectiveness of a nutritional intervention on athletic performance of male non-professional boxers. **Methods:** Eight non-professional male boxers (29,4±3,2 age, 77,6±8,6 kg, 39,3±7,5 VO<sub>2</sub>max) participated in the study, in which they were randomly divided into two groups of four (control group and intervention group). The control group continued their eating habits, as they were until before the study, whereas the intervention group followed a diet for three weeks according to their needs in energy, micro- and macronutrients in combination with the needs of boxing training in order to maintain their current weight. Before and right after the nutritional intervention, anthropometric (weight, height, body composition and body type) and fitness assessment measurements (flexibility, sub-maximal aerobic test (W170), maximal aerobic test (VO<sub>2</sub>max), speed force test for upper and lower extremities, upper extremities strength test, body core strength test, body core-lower extremities strength test and Wingate test) were conducted to the athletes. For the data analysis a paired-samples t-test and an independent-samples t-test were used. **Results:** The intervention group showed an increase in VO<sub>2</sub>max, upper extremities strength, and free-fat mass, with a simultaneous decrease in % body fat. **Conclusions:** This study showed that the nutritional intervention can improve the athletic performance of non-professional male boxers. More research is needed on this area, as the period of the nutritional intervention was short and also a follow up study is necessary.

13:45 - 14:45

## Poster presentations

## PP-PM41 Health &amp; Fitness: Sport and supplements

**ATTITUDES TOWARDS DOPING IN PARTICIPANTS OF A POPULAR LONG-DISTANCE ROAD CYCLING EVENT ACCORDING TO THEIR PERFORMANCE**

Zabala, M.1,3, Freire, C.1, Ramírez-Lechuga, J.2, Morente-Sánchez, J.1

*1 Faculty of Sport Sciences, University of Granada (Spain); 2 Faculty of Sport, University Pablo Olavide (Seville-Spain); 3 Spanish Cycling Federation, Madrid (Spain)*

**Introduction** Social science researchers strive to better understand psycho-social variables of doping (attitudes or beliefs) that may be salient in educational programs directed towards the prevention of such behavior (Gucciardi et al. 2011). The purpose of this study was to know the attitudes towards doping of participants of a popular long-distance road cycling event according to their performance. **Methods** A sample of 2022 amateur cyclists (40.95±9.42 years) who participated in a long-distance (205 km) Spanish road cyclist event called "Quebrantahuesos" (UCI Golden Bike), was divided into groups according to their performance (<6 hours -G1-, 6-7 hours -G2-, 7-8 hours -G3-, 8-9 hours -G4-, 9-10 hours -G5-, >10 hours -G6-). Sample size for each group was: G1=321; G2=495; G3=618; G4=365; G5=157; G6=66). Descriptive design was carried out by means of a validated questionnaire (Petroczi & Aidman, 2009) of 17 questions using a Likert scale from 1 (Strongly Disagree) to 6 (Strongly Agree) for different statements that supported the use of doping in sport. Mean value ± Standard Deviation was obtained for each item and Mann Whitney test for independent variables with Bonferroni post hoc was carried out. **Results** Analyzing the total sample, the overall score was 41.61±12.51 (from 17 to 102) and the mean score was 2.45±0.74 (2=Through Disagree). In addition, the lowest score was observed for the item "Doping is not cheating since everyone does it" with 1.40±1.11, and the highest for "Athletes are pressured to take performance-enhancing substances" with 4.17±1.63 (4=Slightly Agree; 5=Agree). For the mean score and the overall score significant differences were observed in G1 vs G2 (p<0.001), and G1 vs G3 (p<0.002), respectively. Furthermore, there were significant differences for certain items in different groups: legalizing performance-enhancing substances would be beneficial for sports (G1 vs G2, p<0.002); The media blows the doping issue out of proportion (G1 vs G2 & G2 vs G5, p<0.001; G2 vs G4, p<0.002); Media should talk less about doping (G2 vs, G1, G4, G5. P<0.001). **Discussion** The G1 (<6 hours), which should be composed by the best cyclists, showed the lowest values regarding attitudes towards doping. Despite of having the best performance, G1 showed the highest disagreement towards doping. In addition, media is considered as one of the responsible agents of spreading the phenomenon of doping. **References** 1. Gucciardi, D., Jalleh, G. Donovan, R. (2011). An examination of the Sport Drug Control Model with elite Australian athletes. *Journal of Science and Medicine in Sport* 14: 469–476. 2. Petroczi, A., Aidman, E. (2009). Measuring explicit attitude toward doping: Review of the psychometric properties of the Performance Enhancement Attitude Scale. *Psychology of Sport and Exercise*. 10: 390–396.

**STRESS AND BURNOUT SYNDROME VS. PERFORMANCE OF REFEREES IN BASKETBALL**

Antic, T., Curcic, D., Dikic, N., Radivojevic, N., Vukasinovic-Vesic, M., Andjelkovic, M., Baralic, I.

*Sports Medicine Association of Serbia*

**Introduction** In this study we evaluated the level of stress in basketball referees and their performance in the court in terms of how much time they spent in running, walking and standing during the games. We used these parameters to evaluate correlation between performance during the game and level of stress and burnout syndrome among referees. **Methods** This study included 30 referees on FIBA Eurochallenge men and FIBA Euroleague women competition. **Methodology** of this study included two inventories: Self-assessment scale for stress level and Maslach Burnout Inventory (MBI) adapted for workers in the sport. MBI scale consists of three subscales: Emotional Exhaustion (sense of emotional overload), Depersonalization (sense of alienation, loss of empathy and idealism in the work) and Personal Accomplishment subscale (perceptions of their own professional efficiency). The other part of this study visualized and analyzed the referee's movements in the court. This was possible thanks to the use of ESpor (E-analyze) Software (Ankara Technology Development) that generates data of the position of the referees during the basketball match. We calculated how much time referees spent in running, walking and standing during the basketball games. **Results** The obtained parameters showed intermediate level of stress in referees. Six referees had moderate and one referee had high level of emotional exhaustion. On Depersonalization subscale 15 referees had moderate level and even 8 referees had high level of depersonalization. We noticed that referees with higher level of depersonalization were performing at a lower level during the game (they spent less time in running compare to other referees in a particular match). We used Independent sample T test and found statistically significant difference in level of depersonalization among referees who had highest and lowest level of running (p=0,012). There was no statistically significant difference in level of stress among referees in terms of running during the game. **Discussion and conclusions** Referees who had higher level of stress did not run less than referees who were not under stress at all, which could be explained by the fact that many people are relieving from the stress by engaging in high intensity physical activity. Since depersonalization is defined as sense of alienation, loss of empathy and idealism in the work it can be concluded that this mental condition can affect performance in the court in terms of less running during the game. **References** Kate Goodger et al. Burnout in Sport: A Systematic Review *The Sport Psychologist*. 2007, 21, 127-151

**DIETARY HABITS AMONG POLISH AMATEUR RUNNERS**

Szygula, Z.1, Kossak-Machno, D.2, Schlegel-Zawadzka, M.2

*1: University School of Physical Education (Krakow, Poland), 2: Jagiellonian University Medical College, (Krakow, Poland)*

**Introduction** Numbers of different studies confirm the importance of physical activity in civilization disease prevention. One of the groups of free time physical activity practitioners are amateur runners. They start running in different ages, taking part in group races of 10-42 km distance. **Aim** Assessment of nutritional habits and physical activity undertaken amongst the Polish amateur runners taking part in mass races. **Methods** The study was conducted on a group of 53 amateur runners (34 men and 19 women) aged 40,1±11,8 (20-67 years) within the Krakow region. The questionnaire was used to collect data and was conducted individually during the tournaments. **Questionnaire**

included questions on life-style, free-time physical activity level (Baecke Questionnaire on Regular Physical Activity), and nutritional habits. Moreover, the height and body mass were assessed (BMI and waist-to-hip ratio were calculated). Energetic expenditure during one-hour training session was calculated from heart rate assessed using telemetry system POLAR S120 (Polar Electro OY, Finlandia). To calculate statistic differences  $\alpha=0.05$  was assumed. Results Women ran mainly to keep their silhouette (73.7%). Both sexes indicated health and shape as the main reason for running (69.8% and 71.7%). 90% of the group consumed meals in a regular way, amongst them 45% consumed 4 and 34% consumed 3 meals per day. Runners (50%) ingested mainly fruits between main meals. Fish intake was on the low level as 66% consumed it less than once a week. Nutriment for athletes were taken by 35.8% of all runners, while majority did not consult their intake with specialist. 73.7% of runners had proper BMI (20-24.9kg/m<sup>2</sup>), 11.3% were obese (BMI 25-29.9 kg/m<sup>2</sup>, only men) and 15.0% underweight (BMI <20kg/m<sup>2</sup>, only women). Waist-to-hip ratio was proper in majority of runners (<0.8 women – 63.2%, <1.0 men 91.2%). Around 3.4±0.9 hours a week, which gives one month during the year, are spent on running. During one-hour training session runners use-up approximately 720.6±186.0 kcal (361-1020 kcal). Conclusions Amateur running influences physique and prevents obesity. Not all nutritional habits (especially amongst men) were assessed as proper, which may be caused by the lack of knowledge within this subject.

### IS THE DOPING FIGHT LOST: AN EMPIRICAL ANALYSIS OF THE DRUG ABUSE IN FITNESS GYMS IN THE NORTH OF GERMANY

Schulz, T., Pukowski, P., Peters, C., Oberhoffer, R.

*Technical University Munich*

Introduction The abuse of prohibited substances according to the world antidoping code is not only a problem of elite athletes (Bahrke and Yesalis 2004). It is also an important public health problem of leisure time and fitness sports. Several international studies indicate that doping substances are used widely, ranging from 3–31% among gym users (Wiefferink et al. 2008). In Germany on an average 7 million people trained in fitness gyms in 2009. Therefore, the purpose of this investigation was to determine the substances used and the attitudes towards doping of leisure time fitness athletes in the area of Greifswald in the northern part of Germany. Methods A 12-page questionnaire was designed to determine the drug abuse, the knowledge about the used doping substances and the motivation for the fitness training. The questionnaire was divided into seven parts: 1. body perception, 2. training, 3. motivation to fitness training, 4. body development, 5. knowledge of doping substances, 6. abuse of doping substances 7. personal data. Altogether the questionnaire contained 43 questions with 160 items. We received the filled-in questionnaires from 184 athletes: 153 from fitness athletes of normal gyms and 31 from athletes of a real bodybuilder gym. Results Altogether 21,3% of the athletes used performance enhancing doping substances. Subdivided in normal gyms and bodybuilder gyms we found only 15,2% users for the normal gyms and 48,4% for the bodybuilder gym. 21,2% of the athletes in normal gyms and 51,5% of the bodybuilders used stimulants. 9,3% of the athletes in normal gyms used anabolic-androgenic steroids (AAS) whereas 48,4% of the bodybuilder gym already abused AAS. The age of the abusers was between 17 and 34 years. Knowing that the abuses of prohibited substances had no biomedical side effects, 27,9% of normal gym athletes and 64,5% of the bodybuilder gym would use doping substances. Normally, the abusers obtain their drugs from friends or acquaintances. All in all, the knowledge about side effects of doping in both groups was rare, especially in the group of the normal gym athletes. 59,3% of all athletes believed that the abuse of doping substances under control of a medical doctor is not dangerous. Discussion/Conclusion In summary our results showed that doping in leisure time sports especially in fitness gyms is a common problem in the group of young adults of an average age of 29 years in Germany. Reasons for the abuse were in most cases the promotion of a body shaping. On the basis of these results effective prevention programs to counteract doping in fitness gyms have to focus on the improvement of the knowledge about the biomedical side of the athletes. References Yesalis, CE. (2004). *AIDS Read.* 157-60. Wiefferink CH, Detmar SB, Coumans B, Vogels T, Paulussen TG. (2008). *Health Educ Res.* 23(1):70-80.

### RELATIONSHIP BETWEEN INSULIN RESISTANCE AND INFLAMMATORY MARKER WITH MEASUREMENTS OF FATNESS AND FITNESS AMONG PORTUGUESE ADOLESCENTS

Moreira, C., Santos, R., Santos, P.C., Abreu, S., Vale, S., Mota, J.

*Faculty of Sport, University of Porto*

Introduction: Obesity is increasingly among children and adolescents worldwide. This is alarming because childhood obesity is associated with several risk factors of cardio-metabolic diseases. Insulin resistance is a key component in the development of metabolic syndrome and low-grade inflammation may provide a mechanism linking obesity with cardio-metabolic diseases and it is also related to cardio-respiratory fitness (CRF). Therefore, the aim of this study was to determine if fatness and fitness is related to insulin resistance and inflammation during adolescence. Methods: A cross-sectional school-based study was conducted on 517 adolescents aged 15-18, from the Azorean Islands, Portugal. Intravenous blood samples were taken after an overnight fast to determine insulin resistance (HOMA-IR) and for high sensitivity C-reactive protein (hs-CRP). The percentage of body fatness (BF) was assessed using the Bioelectric Impedance Analysis. CRF was measured with the 20-m-shuttle-run-test from Fitnessgram battery test as number of laps. Results: Girls had higher percentage of BF than boys (25.5 vs 14.4%  $p<0.001$ ). No differences in HOMA-IR and hs-CRP were observed between sexes. HOMA-IR and hs-CRP were positive and significantly correlate with BF ( $r=0.34$  vs  $r=0.23$   $p<0.001$ ) while the correlation between HOMA-IR and hs-CRP and CRF were negative and significant ( $r=-0.22$  vs  $r=-0.15$ ,  $p<0.001$ ). Linear regression, controlling for age, sex and pubertal stage, showed that HOMA-IR and hs-CRP increased with BF percentage ( $B=1.7$  vs  $B=0.2$ ,  $p<0.05$ ), whereas only HOMA-IR declined with CRF level ( $B=-2.8$ ,  $p<0.001$ ). Conclusions: Our findings emphasize the importance of promoting and increasing CRF levels and decrease fatness among adolescents in order to prevent cardiovascular diseases in the upcoming adult population. Funding: This study was supported by FCT-MCTES grants: BD/44422/2008; BPD/65180/2009; BSAB/1025/2010, PTDC/DES/098309/2008 and by the Azorean Government.

### ATTITUDES TOWARDS DOPING IN PARTICIPANTS OF A POPULAR LONG-DISTANCE ROAD CYCLING EVENT ACCORDING TO COMPETING CATEGORY

Zabala, M.1,3, Freire, C.1, Ramírez-Lechuga, J.2, Morente-Sánchez, J.1

*1 Faculty of Sport Sciences, University of Granada (Spain); 2 Faculty of Sport, University Pablo Olavide (Seville-Spain); 3 Spanish Cycling Federation, Madrid (Spain)*

Introduction The aim of this study was to know the attitudes towards doping of non-professional cyclists taking account their competing category (Junior, U23, Elite, Master, Cycle-tourist, One-day License). Methods A sample of 2022 amateur cyclists (40.95±9.42 years) who

participated in a long-distance (205 km) Spanish road cyclist event called "Quebrantahuesos" (UCI Golden Bike), was divided into groups according to the competing category (30 Junior -G1-, 9 U23 -G2-, 32 elite -G3-, 546 Master -G4-, 1013 Cycle-tourist -G5-, 392 One-day License -G6-). Descriptive design was carried out by means of a validated questionnaire (Petroczi & Aidman, 2009) of 17 questions using a Likert scale from 1 (Strongly Disagree) to 6 (Strongly Agree) for different statements that supported the use of doping in sport. Mean value  $\pm$  Standard Deviation was obtained for each item and Mann Whitney test for independent variables with Bonferroni post hoc was carried out. Results The lowest overall score was observed for G6 ( $39.46 \pm 11.62$ ) and G1 ( $40.07 \pm 11.61$ ), and the highest was showed by G3 ( $49.06 \pm 14.10$ ). For the mean score and overall score were observed significant differences between G6 vs G3, G4, G5 ( $p < 0.001$ ). For certain items there were significant differences between different groups: The risks related to doping are exaggerated (G3 vs G6,  $p < 0.001$ ); Athletes should not feel guilty about breaking the rules and taking performance enhancing drugs (G3 vs G6,  $p < 0.001$ ; G4 vs G6,  $p < 0.002$ ; G3 vs G5,  $p < 0.003$ ); Health problems related to rigorous training and injuries are just as bad as from doping (G3 vs G4 & G5 vs G6,  $p < 0.001$ ; G3 vs G5,  $p < 0.002$ ); The media blows the doping issue out of proportion (G3 vs G5 & G4 vs G5,  $p < 0.001$ ; G4 vs G6,  $p < 0.002$ ); Media should talk less about doping (G5 vs G1, G3, G4, G5,  $P < 0.001$ ). Just for one item ("Doping is not cheating since everyone does it") significant differences ( $P < 0.001$ ) were found between G1 ( $1.03 \pm 0.18$ ) and G3 ( $1.84 \pm 1.35$ ). Despite of not having significant differences, mean scores of G1, G2 and G3 were  $2.36 \pm 0.69$ ,  $2.54 \pm 0.61$  and  $2.89 \pm 0.83$ , increasing respectively. Discussion This results contrast with others studies (Morente-Sánchez et al. 2011) which also used PEAS and where a sample of elite cyclists (Spanish cycling national team) showed a lower mean score ( $2.06 \pm 0.39$ ). So, it seems that the higher age, the higher score. Due to the fact that overall scores are lower in Junior and U23 than elite, we consider that a psychosocial intervention since the earliest ages is needed to keep attitudinal levels. References 1. Petroczi, A., Aidman, E. (2009). Measuring explicit attitude toward doping: Review of the psychometric properties of the Performance Enhancement Attitude Scale. *Psychology of Sport and Exercise*. 10. 390–396. 2. Morente-Sánchez, J., Freire, C., Femia-Marzo, P., Sánchez-Muñoz, C., Zabala, M. (2011). Attitude towards performance-enhancing drugs in Spanish road cycling national teams. *Book of Abstracts of the 16th Annual Congress of the ECSS*. 6-9 July 2011 Liverpool-UK. 222-223.

### PROTEIN SUPPLEMENT USE AMONG NETSURFERS VISITING HEALTH AND FITNESS COMMUNITY: FINDINGS FROM AN INTERNET-BASED SURVEY

Caramazza, G.2,3, Battaglia, G.1,2, Bianco, A.1,2, Bellafiore, M.1,2, Palma, A.1,2

*University of Palermo*

Introduction It is largely known that protein supplement (PS) use is a widespread and accepted practice by athletes and people who attend commercial gyms (Bianco et al., 2011). However, only few studies have been carried out in order to investigate supplement use and lifestyle in netsurfers of health and fitness community. For this reason the purpose of this preliminary study was to investigate the use of PS, age and lifestyle of people who visited a specific Italian sporting website: [www.fitnessa360.com](http://www.fitnessa360.com). Methods 273 subjects netsurfing in the [www.fitnessa360.com](http://www.fitnessa360.com) completed the 6-item online-questionnaire about age, gender, daily cigarette consumption, protein supplement use, information source about use of PS and sitting time per day. All data were analyzed by a preliminary descriptive statistical analysis. Results The survey showed that subjects, of which 170 males and 103 females, declared an age of 15-20 years (11%), 21-30 years (8%), 31-40 years (72%), 41-50 years (4%), 51-60 years (3%), 61-70 years (0%), 71-80 years (0%), 81-90 years (2%). When examining the daily cigarette consumption, we found that the majority of the subjects claimed not to smoke (66.0%) and to take SP (62%). Moreover, 60% of participants did not specify the information source about use of SP. Only 37% of sample declared to use SP. Moreover, examined data showed that 15%, 40%, 30%, 12% and 2% of subjects spent sitting time per day 1-3 h, 3-5 h, 5-8, 8-10, >10 h respectively. Discussion This preliminary analysis showed that netsurfers of the used health and fitness Italian community mainly appear to be office workers with healthy lifestyle. Indeed in agreement with Nagaya et al. (2007), that showed a coexistence between smoking and sedentary lifestyle, we found that the majority of participants (66%) did not to smoke. Moreover, protein supplementation does not appear to interest the netsurfers of the used sporting website heavily. An online survey can be a low-cost, efficient, and confidential modality to investigate the netsurfers' lifestyle of sporting websites. However only by a dissemination strategy of this questionnaire from other Italian sporting websites we could investigate the lifestyle of their netsurfers. References: Bianco A, Mammina C, Paoli A, Bellafiore M, Battaglia G, Caramazza G, Palma A, Jemmi M. (2011). *J Int Soc Sports Nutr*, 8(1), 25. Nagaya T, Yoshida H, Takahashi H, Kawai M. (2007). *Nicotine Tob Res*, 9(10), 1027-32.

### EFFECTS OF THE SUMO EXERCISE ON ALLEVIATING LOWER BACK PAIN.

Nigorikawa, T., Endo, S., Shintani, K., Kato, H., Ishiwata, T., Kanou, H., Hirono, M., Yasukawa, M., Oishi, K.

*Rikkyo University \*Chuo University*

Introduction Lower back pain (LBP) among Japanese people has become a serious social problem. Previous researches indicate that certain types of exercise are effective for alleviating and preventing LBP, including findings that suggest that the basic movements of the traditional Japanese sport of 'sumo wrestling' may be helpful. However, there have been few empirical studies on this topic, and it is hoped that further studies will be conducted. Accordingly, this study was conducted to examine whether "sumo exercise" were effective in alleviating LBP compared to the other types of conventional lower back exercises. . Methods The subjects of the study consisted of 119 adults (47 men and 72 women). They were interviewed to determine the presence or absence of LBP by using JOA( Japanese Orthopaedic Association) back pain evaluation questionnaire (JOA). JOA can be used to measure several items which related to LBP, namely the degree of LBP, psychological disorders, walking impairment, disability of social life and so on. Moreover, the subjects were divided into three groups and assigned tasks consisting of 'the sumo exercises', 'conventional lower back exercises', and 'no exercises', which were performed for 10 months respectively. A comparative study was then made of the preventive and ameliorative effects demonstrated by these exercises. Results According to the survey of JOA, the sumo exercise group showed a significant improvement in the two items which were degree of LBP and disability of social life. In contrast, the conventional exercise group showed a significant improvement also in the two items which were disability of social life and psychological disorders. As far as the no exercise group, there was no significant change in any item. Discussion Improvement of QOL by betterment of LBP has become an important theme in Japanese society. Several findings suggested that basic movement of the sumo wrestling represented by "shiko" was effective for alleviating and preventing LBP. Results of this study showed that the sumo exercise, in the sense of improving the degree of LBP, was more effective than conventional exercise. In the future, if customarily done this kind of exercise among the Japanese, it might be able to reduce the problem of LBP in Japan.

## DIET AND EXERCISE ADHERENCES CORRELATIONS BY SEXES IN WEIGHT LOSS PROGRAMS

Rojo-Tirado, M.A.1, Peinado, A.B.1, Benito, P.J.1

*Facultad de Ciencias de la Actividad Física y del Deporte (INEF), Universidad Politécnica de Madrid, Spain*

**Introduction** Physical activity in conjunction with moderate dietary energy restriction and behavior modification has been promoted as an important component of a successful weight-loss regimen (1-3). Low-energy diets and physical activity are important for weight loss, defining successful efficacy (4, 5). Therefore, the aim of this study was to compare the diet and exercise adherences by sex, and know if both adherences have any kind of correlation. **Methods** One hundred eighty overweight and obese people (Body Mass Index: 25-34.9 kg•m<sup>-2</sup>), aged from 18 to 50 years, participated in the study (84 males, 96 females) during 6 months. Four types of treatments were randomly assigned: strength training (S, n=43), endurance training (E, n=51), combined S and E training (SE, n=46), and diet and physical recommendations (C, n=40). All participants followed a 25% calorie restriction diet. Adherence to diet was calculated as the estimated Kcal of the diet divided by the real Kcal intake in percentage, representing the major adherence the value 100%. Higher values mean a higher restriction and on the contrary. Adherence to exercise was calculated by the number of sessions developed from the total. A MANOVA was used to determine differences between sexes in diet and exercise adherences. The Pearson's correlation coefficients were used to analyze the relationship between both adherences. Probability level for statistical significance was set at  $\alpha=0.05$ . **Results** The weight loss was lower in women than in men (-7.56±4.05 vs. -9.56±4.58 kg, respectively,  $p=0.02$ ). Women were more adherent to diet program (104.03±22.46%) than men (116.33±35.42%) ( $p=0.017$ ). However, for exercise program women and men had the same adherence (88.9±7.25 vs. 88.85±7.63%, respectively,  $p=0.967$ ). No correlations were found between diet and exercise adherences, since for women it was obtained  $r=-0.006$  ( $p=0.96$ ) and for men  $r=-0.117$  ( $p=0.379$ ). **Discussion** Although women had a higher adherence to diet than men (near to 100 %), men followed a more restrictive diet what might explain the greater weight loss. In a weight loss program, exercise adherence is equal for women and men, so physicians should pay more attention to diet fidelity. As no significant correlations between adherences have been found, it is not possible to conclude that people who was more adherent to diet, was more adherent to exercise too. **References** 1. Pate RR, et al. JAMA. 1995 Feb 1;273(5):402-7. 2. Volpe SL, et al. J Am Coll Nutr. 2008 Apr;27(2):195-208. 3. Stiegler P, et al. Sports Medicine. 2006;36(3):239-62. 4. Catenacci VA, et al. Nat Clin Pract Endocrinol Metab. 2007 Jul;3(7):518-29. 5. Tsai AG, et al. Obesity (Silver Spring). 2006 Aug;14(8):1283-93.

## ARTERIAL STIFFNESS AND PHYSICAL FITNESS IN PUBERTY

Matsumoto, N.1, Yoshioka, A.2, Takahara, T.3, Nose, Y.4, Takagi, Y.5, Saito, T.4, Arakane, K.4, Yamaguchi, H.6, Iemitsu, M.7, Takahashi, K.8, Miyachi, M.9, Onodera, S.3

*1)Shujitsu Junior College, 2)Kagawa Univ, 3)KUMMW, 4)Graduate School, KUMMW, 5)JSPS Reserch Fellow, 6)KIBI International Univ, 7)Ritsumeikan Univ, 8)TAU, 9)National Institute of Health and Nutrition.*

**PURPOSE:** Arterial stiffness progressively increases with aging. The high level of arterial stiffness is an independent risk factor of cardiovascular diseases. Higher levels of physical fitness, especially cardiorespiratory fitness are associated with delay of age-related arterial stiffening in adults. Yamamoto et al. recently reported that arterial stiffness was significantly correlated with flexibility in middle-aged and elderly people, but there was no such correlation in young people. The purpose of the present study was to clarify the correlation between arterial stiffness and fitness (muscular strength and flexibility) in puberty. **METHODS:** 72 Japanese adolescents participated in this study (40 boys and 32 girls). We measured their height, body weight, blood pressures, arterial stiffness, muscular strength (handgrip test) and flexibility (sit-and-reach test). The arterial stiffness was measured by the pulse wave velocity between brachial and ankle arteries (baPWV). We examined the relationship between fitness and baPWV. **RESULTS:** The handgrip strength of boys indicated a significant positive correlation with their height, weight and systolic blood pressure. However, there was no relationship between handgrip strength and baPWV. In girls, there were no relationships at all. The flexibility in both of boys and girls indicated significant positive correlation with their height. However, there was no relationship between flexibility and baPWV. **DISCUSSION:** The handgrip strength in boys was associated with systolic blood pressure. It is possible that the relationship between handgrip strength and blood pressure is associated with an increase in muscle mass, blood volume and sex hormone secretion with growth development. We speculate that the flexibility and baPWV were unconcerned because artery in pubertal child were distensible enough. In conclusion, the present results indicate that arterial stiffness is not associated with muscular strength and flexibility in puberty. (The Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Research Activity Start-up 23800070)

## PHYSIOLOGICAL RESPONSE, ENJOYMENT AND RATE OF PERCEIVED EXERTION FOLLOWING A BOUT OF INTERACTIVE GAME CYCLING AND CONVENTIONAL CYCLING IN ADULTS

Monedero, J., Collins, N., Torris, L., O'Gorman, D.J.

*Dublin City University*

**Introduction** Physical inactivity is the fourth leading risk factor for global mortality (WHO, 2010). Though sedentary behaviour is a modifiable risk factor for a myriad of chronic diseases, adult physical activity levels remain low. Innovative approaches are required to reverse these behaviours and increase daily energy expenditure. Interactive video games have become popular in recent years but it is not clear how they compare with conventional exercise. The purpose of this study was to compare cardiovascular, metabolic, perceptual and enjoyment responses between one bout of conventional cycling and one bout of interactive game cycling at a matched workload. **Methods** Thirty four healthy subjects (sixteen women and eighteen men) volunteered for this study. Peak oxygen uptake (VO<sub>2</sub>peak) was measured using an incremental cycling test and subjects were familiarised with the cycling game prior to testing. Subjects carried out a 30 min interactive cycling trial and a 30 min conventional cycling trial at 55% of peak power output, in random order, with at least 2-days between trials. During the trials, VO<sub>2</sub> was measured using a metabolic system (Innovision Ltd, Odense) and heart Rate (HR) was measured by radiotelemetry. These measures were used to calculate heart rate reserve (HRR), VO<sub>2</sub> Reserve (VO<sub>2</sub>R), the rate of energy expenditure (REE) and MET's. Rate of Perceived Exertion (RPE) and enjoyment was measured every 10 minutes with Borg scale and a modified PACES scale. **Results** Interactive cycling resulted in a significantly greater VO<sub>2</sub>R (68.31% ± 10.12% vs 64.9% ± 9.6%), REE (8.8 ± 1.9 vs 8.47 ± 2 kcal/min), MET (7.1 ± 1 vs 6.8 ± 1.1) and enjoyment (27.2 ± 6.1 vs 17.1 ± 5.7),  $p<0.05$ . No significant differences between interactive cycling and conventional cycling were found for HRR (72.5 ± 10.4 vs 71.4 ± 10.1%) and RPE (13.1 ± 1.8 vs 13.2 ± 1.7). **Discussion** The main finding of this study was that interactive cycling resulted in significantly higher metabolic responses and energy expenditure. Interactive game cycling did not result in higher perceptual ratings of effort and was deemed more enjoyable. Interactive cycling games can be a valid alternative to conventional exercise since they result in a higher intensity of effort and have higher enjoyment ratings. **References** 1. War-

burton, D.E.R, Sarkany, D., Johnson, M., et al. (2009) Med. Sci. Sports Exerc., Vol 41, No 4, 920-926 2. World Health Organisation. Global Recommendation of physical activity for health. 2010

**14:45 - 15:45**

## Poster presentations

### PP-PM42 Training & Testing 8

#### RUNNING DEMANDS AND HEART RATE RESPONSES IN RUGBY SEVENS REFEREES

Suarez moreno arrones, I.

*Faculty of sport*

Running Demands and Heart Rate Responses In Rugby Sevens Referees Suarez-Arrones, L.1, Portillo, J.2, Calvo-Lluch, A.1 and Mendez-Villanueva, A.3 1:Pablo de Olavide University,Seville.2:University of Castilla la Mancha.3:ASPIRE, Qatar. Introduction To date, only very limited information exists on the physiological and running demands associated to match play in rugby refereeing, and no data are available yet on rugby sevens. Accordingly, the aim of this study was to examine for the first time the match running demands and exercise intensity associated with men rugby sevens refereeing. Methods Time-motion analysis of running activity was collected from 12 elite male rugby referees. Match analyses were performed 2–4 times on each referee during a total of 38 matches played during two international rugby sevens tournaments. Portable global position system (GPS) technology and heart rate (HR) responses were used to assess match running demands and exercise intensity, respectively. GPS data were recorded at 15 Hz frequency. Results Referees covered an average distance of 1665.2 m per game. Over this distance, 22.3% (371.8 m) was spent standing and walking, 25.9% (431.2 m) jogging, 12.4% (206.5 m) cruising, 23.8% (395.6 m) striding, 8% (133.3 m) high-intensity running, and 7.6% (126.7 m) sprinting. The average maximal distance of sprints, the number of sprints and the mean sprint distance over the game were: 31.3±13.4 m, 5.76±3.6 sprints, and 19.9±7.8 m respectively. The referee's work-to-rest ratio was 3.5:1, and the average heart rate in the second half was higher ( $P<0.05$ ) than the heart rate recorded in the first half. Discussion The referees evaluated in the present study were exposed to a higher running demands than their counterparts refereeing other rugby codes (Kay and Gill, 2003; Martin et al., 2001). Compared with video data collected in rugby league (Kay and Gill, 2003) and union (Martin et al., 2001) referees, the current group of rugby sevens referees covered substantial greater total distance per min (110 m.min<sup>-1</sup>) in comparison with ~79 m.min<sup>-1</sup> in rugby league and 101 m.min<sup>-1</sup> in rugby union. The average heart rate of the referees in this study was slightly lower than the estimated HRmax reported in rugby league referees (Kay and Gill, 2004) and the HRmax obtained in male rugby sevens players (Suarez-Arrones et al., 2011). References Kay B., Gill N.D. (2003) Physical demands of elite Rugby League referees: Part one--time and motion analysis. *J Sci Med Sport* 6:339-42. Kay B., Gill N.D. (2004) Physical demands of elite Rugby League referees, part two: heart rate responses and implications for training and fitness testing. *J Sci Med Sport* 7:165-73. Martin J., Smith N.C., Tolfrey K., Jones A.M. (2001) Activity analysis of English premiership rugby football union refereeing. *Ergonomics* 44:1069-75. Suarez-Arrones L., Nuñez F.J., Portillo J., Mendez-Villanueva A. (2011) Running demands and heart rate responses in men rugby sevens. *J Strength Cond Res*.

#### THE IMPORTANCE OF LEAN MASS IN PROFESSIONAL AUSTRALIAN FOOTBALL PLAYERS: SEASONAL CHANGES AND RELATIONSHIPS WITH PHYSICAL PERFORMANCE

Bilsborough, J.C.1,2, Greenway, K.1, Livingstone, S.1, Hocking, J.1, Sullivan, C.1,2, Cordy, J.1, Coutts, A.J.1,2

*1. Carlton Football Club (Melbourne, Australia). 2. UTS (Sydney, Australia)*

Introduction Most studies show muscular strength and power are reduced during the competition season in team sports, with these changes often being attributed to reduced training volume, accumulated fatigue, and altered body composition. Whilst it is likely that losses in lean mass (LM) underpin these changes, to date no studies have examined the importance of LM in highly trained team sport athletes. Therefore, the purpose of this investigation were; 1) to examine the relationships between LM and various components of physical performance in professional Australian Football players, and 2) to examine if changes in LM during the competition phase of the season are related to changes in muscular strength and power. Methods Forty one professional players from an Australian Football League (AFL) team (age, 22.6±3.3 y; height, 189±7 cm; mass, 88.2±8.1 kg; mean ±SD) were assessed for muscular strength (1-RM bench press, deadlift and squat), lower body power (weighted CMJ30) and unweighted counter movement jumps (CMJ)), speed (20 m sprint), Yo-Yo intermittent recovery test (Yo-YoIR2) performance, and DEXA-derived LM and fat mass (FM), immediately prior to-, midway, and at the completion of the 24 week AFL competition season. In addition, match activity profiles (i.e. m/min and distance travelled higher speed running (>14.4 km/h) were collected using 10-Hz GPS during the season. Pearson's correlations (•90% confidence intervals) were used to determine strength of associations of changes in anthropometry, physical performance characteristics. One-way ANOVA was used to examine differences between the pre-mid and post-season anthropometry and performance measures. Results Significant relationships between LM and strength (deadlift: 0.58,•0.21, bench press: 0.46,•0.23), power (CMJ: 0.67,•0.15, CMJ30: 0.70,•0.14), YoYoIR2 (-0.38,•0.27) and match activity profiles (m/min: -0.48,•0.18, HSR: -0.64,•0.18) were observed. Relative LM (LM%) was moderately related to YoYoIR2 (0.33,•0.29). FM was correlated with strength (deadlift: 0.37,•0.27), power (CMJ: 0.40,•0.23, CMJ30: 0.34,•0.24), YoYoIR2 (-0.40,•0.27) and match activity profiles (m/min: -0.37,•0.26, HSR: -0.46,•0.18). Mass and LM, remained stable at the mid-point of the season; however, BF increased at the end of the season ( $P<0.05$ ). The small changes in LM during the season were related to changes in strength (0.49,•0.36) and power (0.37,•0.43). Discussion and Conclusions Increased LM is related to improved strength and power performance; however, increased LM was associated with poorer YoYoIR2 scores and lower match activity profiles. The negative associations with match activity profiles are most likely due to positional roles within AF. Nonetheless, small changes in LM during the season may be important as these were associated with poorer strength and power. To ensure consistent physical performance toward the end of the season, strategies should be implemented to protect the loss of LM and prevent increases in FM during the competition season.

## PHYSICAL PERFORMANCE AND EVIDENCE OF FATIGUE IN RUGBY SEVENS REFEREES

Portillo Yábar, L.

*Universidad Castilla La Mancha*

PHYSICAL PERFORMANCE AND EVIDENCE OF FATIGUE IN RUGBY SEVENS REFEREES Portillo, L. J.1, Suárez-Arrones, L.2., Sánchez M.1, Sánchez, F.1, Nuñez, F.J.2, García J.M.1 1: UCLM (Toledo, Spain), 2:UPO (Sevilla, Spain) INTRODUCTION The aims of this study was to examine changes in running demands and effects of fatigue in elite referees during the competition of rugby sevens tournament. METHODS A prospective and observational study design was used to assess physical demands of 7 elite referees in 21 competition matches. Time-motion analysis of running activity was collected using Global Positioning System (GPS, SPI Pro X 15Hz) and HR monitors. RESULTS Mean total distance ( $\pm$  SD) covered over the whole match by referees was  $108.5 \pm 9.5$  m $\cdot$ min<sup>-1</sup>. The number of sprint during the match was  $6.1 \pm 3.1$  with rank from 1 to 13 sprints. The distance of high-speed zone ( $> 20$  km.h<sup>-1</sup>) was  $18.6 \pm 6.5$  m. with rank from 7 to 74.4 m. The referees spent most of their match time at HR intensities between 81- 90% HRmax with significant differences ( $P < 0.05$ ). The fatigue in matches have been analyzed considering information by quarters. Whole match is divided in four quarters and therefore each half has two. There was a significantly reduction in traveled distance between first quarter and second quarter of both halves ( $P < 0.01$ ). When the three tournament matches were analyzed total distance decreased significantly between first and last match ( $P < 0.01$ ). Distance of sprinting decreased significantly ( $P < 0.05$ ). Also the peak of maximum speed decreased between first and last match ( $P > 0.05$ ). DISCUSSION There are substantial differences around the development of the physical demands of referees during the matches in rugby sevens tournament. Running demands of referees investigated in this study are higher than other types of rugby (Kay & Gill, 2003; Martin et al., 2001) and similar to the rugby sevens players (Suarez-Arrones et al., 2011a ; 2011b). This study has reported running demands in rugby sevens referee. Running speed is higher than other modalities such as rugby union. Study findings can be used as a reference value to adapt specific training programs for rugby sevens referees. REFERENCES Kay, B.; Gill, ND. (2003) Physical demands of elite Rugby League referees: Part one--time and motion analysis. *J Sci Med Sport*, 6, 339-342. Martin, J.; Smith, NC.; Tolfrey, K.; Jones, AM. (2001) Activity analysis of English premiership rugby football union refereeing. *Ergonomics*, 44, 1069-1075. Suarez-Arrones, L.; Nunez, F.; Portillo, J.; Mendez-Villanueva, A. (2011a) Match running performance and exercise intensity in elite female Rugby Sevens. *J Strength Cond Res.* [Ahead of print] Suarez-Arrones, L.; Nuñez, F.J.; Portillo, J.; Mendez-Villanueva, A. (2011b) Running demands and heart rate responses in men rugby sevens. *J Strength Cond Res.* [Ahead of print]

## DIFFERENCES IN PHYSICAL DEMANDS BETWEEN INTERNATIONAL AND NATIONAL FEMALE RUGBY SEVENS PLAYERS

Portillo Yábar, L.

*Universidad Castilla La Mancha*

DIFFERENCES IN PHYSICAL DEMANDS BETWEEN INTERNATIONAL AND NATIONAL FEMALE RUGBY SEVENS PLAYERS Portillo, L. J.1, Suárez-Arrones, L.2., Sánchez M.1, Sánchez, F.1 García J.M.1 1: UCLM (Toledo, Spain), 2:UPO (Sevilla, Spain) INTRODUCTION In this study, the physiological demands of an international and national women's rugby 7s were investigated during competition. Obtaining measures of physiological demands between different level of performance in rugby 7s female players during the competition match enabled us to determine how these athletes responded to a competition and if exists differences between physiological and movement patterns. METHODS Variables were measured by means of GPS receivers and HR monitors. In order to determine whether there were physiological changes in these aspects, participants were tested during international and national tournament. The data used in the study was gathered from 20 players (10 international and 10 national players) during four matches in both levels of competition. RESULTS The results of this study show that, during a Rugby 7s match, there are differences in the physiological profile of international and national female rugby sevens players. Mean total distance ( $\pm$  SD) covered over the whole match by international players was  $1642 \pm 171.20$  m. and national players was  $1363.45 \pm 221.87$ . The number of sprints during the match by international players was  $6.18 \pm 3.13$  and national players was  $1.97 \pm 1.49$ . The distance of high-speed zone ( $> 20$  km.h<sup>-1</sup>) was  $62.01 \pm 37.80$  m. and  $21.10 \pm 24.50$  m. The average speed obtained throughout the game was  $6.06 \pm 0.33$  km.h<sup>-1</sup> and  $5.29 \pm 0.63$  km.h<sup>-1</sup>. The international players spent at HR intensities ( $> 95\%$ ) expressed as percentage of HRmax,  $26.55 \pm 16.09\%$  and national players was  $13.28 \pm 10.60\%$ . In general, physical demands were significantly greater ( $p < 0.01-0.001$ ) by international players. DISCUSSION The results of this study are similar to those obtained by (Suárez-Arrones L. et al., 2011) in the physiological profile of international female rugby sevens player. The data of studies (Anita C. Sirotić et al., 2009; Cameron Brewer A et al., 2010; D. G. Higham et al., 2011) examine differences in physical performance between elite and semi-elite games findings significantly differences. Collectively, these findings provide important information that can be used in the training process for improve specific qualities of female rugby 7s. REFERENCES Anita C. Sirotić, Aaron J. Coutts, Hayden Knowles, Craig Catterick. (2009). *Journal of Sports Sciences*, February 1st 27(3):203-211. Cameron Brewer A, Brian Dawson, B, Jarryd Heasmana, Glenn Stewart, Stuart Cormack. (2010). *Journal of Science and Medicine in Sport* 13618-623. Dean G. Higham, David B. Pyne, Judith M. Anson, Anthony Eddy (2011). *Journal of Science and Medicine in Sport*. Nov. 17. Suárez-Arrones L, Nuñez F, Portillo J, Mendez-Villanueva A. (2011). *Journal of Strength and Conditioning Research*. Sep.29

## THE PHYSICAL FITNESS PARAMETERS OF SENIOR SOCCER PLAYERS

Polat, C., Cerrah, A.O., Ertan, H.

*Anadolu University*

Introduction Talent identification in soccer starts from the early ages. There have been some soccer abilities that are need to be evaluated at that ages. So, the purpose of the current study was to compare the natural talent selection method with physical parameters to identify 11-12 years old senior soccer players across a number of primary school teams. Material & Methods A group of soccer coach has visited the primary schools and contact with the PE teachers to organize small-scale tournaments. A written consent has been achieved from the parents of each senior boy to participate the study. After preliminary natural selection with expert observation, the soccer coaches and PE teachers have selected a school team. A total number of 217 senior boys have been selected to participate in a tournament. The whole group (n=217) has participated to a test session to determine the motor abilities, flexibility, agility, explosive power, and general balance (Table 1). After a tournament, total number of players has been decreased to 35 by the votes of soccer experts. In order to compare result, unpaired t-tests were applied. Results The comparison of selected and non-selected senior soccer players by natural talent identification has been applied. According to results, all of the performance parameters were higher in selected group than that of non-selected (Table 1). However, statistical significant differences ( $p < 0.05$ ) occurred only in weight, sit-up and 20 m sprint tests. Table 1: Physical fitness parameters of soccer players Selected Non-Selected (n=35) (n=182) Parameters Mean $\pm$ SD Mean $\pm$ SD Age 11.02 $\pm$ 0.74 10.93 $\pm$ 0.77 Height (cm) 140.6 $\pm$ 5.71 143.4 $\pm$ 7.56 Weight (kg) 33.87 $\pm$  4.19 38.07 $\pm$ 9.22\* Sit and Reach (cm) 22.38 $\pm$ 5.19 22.22 $\pm$ 5.98 Sit-up 19.20 $\pm$  3.07\*\* 17.51  $\pm$  3.05

Squat Jump (cm) 21.27±5.13 19.61±4.62 CMJ (km/s) 24.74±3.90 23.02±4.30 10m sprint (sec) 2.02±0.32 2.06±0.12 20m sprint (sec) 3.69±0.29\* 3.83±0.29 Flamingo Balance 7.68± 3.22 7.64±2.78 Medicine Ball Perfor. 2.94±1.91 2.67±0.72 Standing B J (cm) 1.46±0.18 1.46±0.69 Bent-arm hang 14.78±7.52 12.26±9.99 \* p<0.05 ; \*\* p<0.01 Discussion & Conclusion In conclusion, the findings from this study suggest that successfully selected players showed consistent performance across all tests in comparison to non-selected players who performed well in one or two tests. On the other hand, the chosen performance parameters are important and decisive to determine the successful soccer players. Findings obtained from this study have a similarity with the results of the researches made by Gravina, et. al (2000); Reilly, et. al (2005). References: 1. Gravina L, Gil SM, Ruiz F, Zubero J, Gil J, Irazusta J. Sports Sci. 18(9):669-83, 2000 2. Reilly T, Bangsbo J, Franks A. Sports Med. 35(6):501-36, 2005

### THE ROLE OF CONDITIONING ON PERFORMANCE IN PROFESSIONAL SOCCER

Reer, R., Stein, D., Wellmann, K., Braumann, K.M.

*University of Hamburg*

Introduction Expert suggest that since 1990's there has been a steady increase in performance demand as well as performance level in professional soccer players. The endurance conditioning level of the German national players in the 1990's is similar to the conditioning of the 3rd division players today. In contrast to endurance performance, the sprint performance level of the national players in the 1990's is achieved only in the 1st professional soccer division today. Therefore, the aim of this study was, based on multiyear record keeping, data collection, and observations, to investigate how the sport specific endurance, speed, and strength that are prerequisites for successful professional soccer players can be improved, maintained, and enhanced. Methods We conducted numerous seasonal tests with a group of professional soccer players. The tests were soccer specific endurance, sprints, jumps and strength training of specific muscle groups. In addition to soccer specific demands, we designed and implemented individually tailored strength and interval training. This type of training was conducted 3-4 hours per week. Results There were statistically significant improvements in soccer specific endurance from the beginning of the 3rd division 4.11±0.19 m/s to 4.26±0.2 (p<0.01) at entry to 2nd division and improved to 4.62±0.25 m/s (p<0.001) at the start of the 1st division. Similar results were observed for 30m sprints. They improved their sprint performance time from the beginning of the 3rd division to 2nd division from 4.27±0.23s to 4.1±0.14s (p<0.01). At entry to 1st division they improved their sprint time to 4.0±0.15s (p<0.001). However, there was no significant difference for counter movement jumps (38.0±3.5cm to 39.2±4.2cm). Discussion The performance of a professional soccer team depends on multitude of factors. The results suggest that systematic and individualized improvements in soccer specific endurance and sprint performance greatly contribute to the success in professional soccer. In addition, our results suggest that players possess physiological abilities that can be harvested and thus can greatly benefit individually and collectively from training methods employed in this investigation. References Sjøkvist J, Laurent MC, Richardson M, Curtner-Smith M, Holmberg HC, Bishop PA (2011). J Strength Cond Res, 25,1726-35. Clark JE (2010). J Strength Cond Res, 38, 1773-81.

### EVOLUTION OF PHYSICAL PROPERTIES IN DIFFERENT PERFORMANCE LEVELS IN SOCCER PLAYERS.

Rodríguez-Rosell, D., Franco-Márquez, F., Pareja-Blanco, F., González-Badillo, J.J.

*Pablo de Olavide University*

EVOLUTION OF PHYSICAL PROPERTIES IN DIFFERENT PERFORMANCE LEVELS IN SOCCER PLAYERS. Rodríguez-Rosell, D.1, Franco-Márquez, F.1, Pareja-Blanco, F.1, González-Badillo, J.J.1 1Pablo de Olavide University, Seville, Spain Introduction During a soccer game, endurance plays an important role on performance. Nevertheless, the most conclusive actions are realized at maximum intensity and short periods of time (2). Several works have analyzed correlations among different variables (1RM half squat, sprint and jumping height) in elite soccer players (3). However, to our knowledge there has been no study to analyze the correlation between strength and endurance variables throughout a soccer player's life. Methods One hundred forty-eight male soccer players belonging to the same football club took part in this study. The subjects were divided into seven different teams according to age and category (T1: 11.9±0.2, T2: 12.6±0.5, T3: 13.8±0.5, T4: 14.6±0.5, T5: 16.2±0.5, T6: 17.3±0.6, T7: 24.4±4.5 years). The evaluation was done at the beginning of the season and the variables measured were: countermovement jump (CMJ), full squat 1RM (T-Force System, Ergotech, Spain), acceleration capacity in 10, 20 m (T10, T20, T10-20), maximal aerobic speed (MAS) and maximal throw velocity (MTV). One-way ANOVA was used to detect differences between groups of subjects. The correlation between variables was determined through Pearson's coefficient correlation taking as the control variable age of subjects. Results Every variable measured displayed high reliability (CCI: 0.914-0.997; CV: 1.94-2.61%). As a result we obtained that every physical qualities measured (1RM, CMJ, T10, T20, T10-20, MAS and MTV) improved progressively with age, reaching statistically significant differences (p<0.05) between each category in most cases. Furthermore, we found statistically significant correlations (p<0.01) between each performance analyzed variables (0.36-0.95). Discussion This study indicates that with increasing age of soccer players, those variables that can be explained through improvement of strength (CMJ, 1RM full squat, T10, T20, T10-20 and MTV) show more gains than those variables that depend on endurance (MAS), which do not show improvements after 14 years. These findings could indicate that factors which explain soccer performance would be more related with explosive-type actions (changes of direction, jumps, sprints, tackles) (1) where a high production of strength, power and rate of force development have a more determinant role than MAS. References Hoff, J. Training and testing physical capacities for elite soccer players. J Sports Sci 23: 573-582, 2005. Stolen, T, Chamari, K, Castagna, C, and Wisloff, U. Physiology of soccer: an update. Sports Med 35: 501-536, 2005. Wisloff, U, Castagna, C, Helgerud, J, Jones, R, and Hoff, J. Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. Br J Sports Med 38: 285-288, 2004.



**14:45 - 15:45****Poster presentations****PP-PM43 Physiology 11****EXERCISE TRAINING ENHANCES BUT DOES NOT RESTORE INSULIN SENSITIVITY AND SIGNALLING IN OBESE WOMEN WITH PCOS**

Cassar, S.1, Stepto, N.K.1,2,3, Hutchison, S.K.3, Harrison, C.L.3, Teede, H.J.3

*1 School Sport and Exercise Science, Victoria University, Melbourne, Australia. 2 ISEAL, Victoria University, Melbourne, Australia. 3 Jean Hailes Research Group, Monash University, Clayton, Australia*

Introduction Polycystic Ovary Syndrome (PCOS) is a complex disorder comprising metabolic, endocrine and reproductive dysfunctions, affecting 18% of reproductive aged women (March et al., 2010). Insulin resistance (IR) is recognised as a key aetiological feature of PCOS (Teede et al., 2007). The mechanisms underlying insulin resistance in PCOS remain elusive but may be attributed to impaired insulin signalling within skeletal muscle (Corbould et al., 2005). Methods 8 obese PCOS and 8 control women were recruited. PCOS was diagnosed according to NIH criteria (Harrison et al., 2011). Insulin sensitivity was determined from glucose infusion rate [GIR] during an euglycaemic hyperinsulinaemic clamp. Muscle biopsies were taken for assessment of insulin signalling (p-Akt ser473). Body composition, VO<sub>2</sub>peak, GIR and insulin signalling were analysed before and following 12-weeks of intensified exercise training. Results Body composition did not change over the duration of the study. VO<sub>2</sub>peak improved by 23 (4%) [mean (SEM)] in PCOS vs. 16 (2%) in Control (P<0.05). Insulin sensitivity (GIR) improved by 17 (3%) vs. 23 (4%) (PCOS vs. Control; P<0.05). Changes in insulin sensitivity were accompanied by increases of p-Akt ser473 of 1.3 (0.1) and 2.0 (0.2) fold in PCOS vs. 1.8 (0.2) to 2.3 (0.2) fold in Control pre and post training respectively (time-effect P<0.001). These similar fold changes occurred despite the lower overall insulin stimulated p-Akt ser473 expression in PCOS women (P<0.01, group, time & group x time). Discussion IR was improved following intense exercise in women with PCOS. Akt ser473 phosphorylation was increased, but not normalized in the PCOS group. This may be related to intrinsic aberrant IRS, PP2A and/or PTEN signalling. References Corbould, A., Kim, Y.B., Youngren, J.F. et al. (2005). *Am J Physiol Endocrinol Metab*, 288, E1047–E1054. Harrison CL, Stepto NK, Hutchison SK, Teede HJ (2011) *Clin Endocrinol* 76:351-7 March WA, Moore VM, Willson KJ, Phillips DIW, Norman RJ, Davies MJ (2010) *Hum Reprod* 25: 544-551 Teede HJ, Hutchison SK, Zoungas S (2007) The management of insulin resistance in polycystic ovary syndrome. *Trends Endocrinol Metab* 18: 273-9 Study funded by NH&MRC (#606553), Monash University ECR Grant Scheme & Jean Hailes Foundation.

**EFFECTS OF ENDURANCE TRAINING ON PLASMA CONCENTRATION OF VISFATIN AND INSULIN RESISTANCE AT REST IN RESPONSE TO ACUTE ENDURANCE EXERCISE IN DIABETIC RATS**

Fallah omran, S.1, Kordi, M.2, Ahmadizad, S.3, Mojtahedi, S.4

*Faculty of Physical Education and Sports Sciences*

In this study, we have investigated the effect of endurance training on plasma concentration of visfatin and insulin resistance at rest in response to acute endurance exercise in diabetic rats. Methods : Sixty diabetic wistar rats were randomly divided into sedentary diabetic control (n = 29) and trained diabetic groups (n = 31). Diabetes was induced by single intravenous injection of streptozotocin (STZ; 50 mg/kg BW). The exercise training protocol consisted of treadmill running, 5 times/week for 8 weeks, after 8 weeks one single bout acute exercise consisted of treadmill running with the velocity of 20m/min, 30 min, %5 inflation. Rats were sacrificed 48 h after the last training period and the blood samples were collected. Plasma circulating levels of glucose, insulin, visfatin were assessed. To specify the effect of endurance training on blood factors, the pair t-test was used. Additionally, response to acute endurance exercise was determined by using the repetitive variance analysis (2\*2). Results: plasma visfatin level were decreased after endurance training (p < 0.895, t = 0.037) and this level were significantly reduced (p < 0.001) in response to acute exercise. Insulin resistance was decreased after 8 weeks endurance training and in response to acute exercise. Discussion: There was a significant reduction in plasma visfatin levels in response to acute exercise in diabetic rats. The decrease of visfatin after 8 weeks exercise suggests that other factors than glucose metabolism, body weight, or the lipid profile may be responsible for this finding (Frydelund- Larsen et al 2007, Haider 2007). Although the molecular mechanism underlying attenuated glucose-stimulated insulin secretion in Namp1+/- islets is still unclear, alterations in NAD levels could alter activities of important enzymes in metabolic pathways such as glycolysis or fatty acid oxidation in pancreatic  $\beta$  cells (Revollo et al 2007). References: Frydelund- Larsen L, Akerstorm T, Nielsen S, Keller P, Keller C, Pedersen BK. (2007). Visfatin mRNA expression in human subcutaneous adipose tissue is regulated by exercise. *Am J Physiol Endocrinol Metab*, 292 (1) : E 24- 31. Haider DG, Pleiner J, Franceconi M, Wiesinger GF, Muller M, Wolzt M. (2006). Exercise training lowers plasma visfatin concentrations in patients with type 1 diabetes. *J Clin Endocrinol Metab*, 91 (11): 4702- 4. Revollo JR, Korner A, Mills KF, Satoh A, Wang T, Garten A, et al. (2007). Namp1/ PBEF/ Visfatin regulates insulin secretion in beta cells as a systemic NAD biosynthetic enzyme. *Cell Metab*, 6(5): 363- 75.

**EFFECTS OF EXERCISE TRAINING AND ENERGY-RESTRICTED DIET ON FATTY LIVER IN ZUCKER FATTY RATS.**

Shiroya, Y., Umetsu, Y., Kitamura, H., Minato, K., Yamauchi, H.

*Wayo Women's University*

Backgrounds Both energy-restricted diet and physical exercise have been used for the improvement of obesity. In particular, daily physical exercise has beneficial effects on lipid metabolism. We have found that voluntary running training with energy-restricted diet improved fatty pancreas in Zucker Fatty rats, but not energy-restricted diet treatment only. Aim The purpose of the present study was to investigate whether voluntary running training and/or energy-restricted diet improves fatty liver in Zucker Fatty rats. Methods Male Zucker Lean rats were used as control (LC). Male Zucker Fatty rats were divided into 3 groups; Obese (OB), Energy-restricted diet (ERD), and Trained (TR) groups. The LC and the OB rats had free access to food, the ERD and TR rats had food intake restricted to 69% and 74% of the OB group level, respectively. The TR rats were exercised voluntarily on the wheel ergometer with a load of 30% on their body weight every day. After 6 weeks, all rats were prepared for experiment. The liver was excised and weighed. Hepatic tissue was prepared for transmission electron microscopy. Results Body weight in the LC group was significantly lower than in the Fatty groups. Body weight in the OB

group was greater than in the ERD and the TR groups. Final body weight was matched between the ERD and the TR groups. Serum triglyceride and total-cholesterol concentrations in the OB and the ERD groups were higher than in the LC and the TR groups. Liver weights in the OB and the ERD groups were significantly greater than in the LC group. Liver weight in the TR group was significantly lower than in the OB and the ERD groups. Electron micrographs of the hepatocytes in both OB and ERD groups revealed accumulation of lipid droplets and degeneration of mitochondria. In contrast, the hepatocytes from TR group showed reduction of lipid droplets and increase of mitochondria content. Discussion The main finding in the present study was that training combined with energy-restricted diet obviously decreased lipids in serum and tissues of the liver in Zucker Fatty rats, but not in the energy-restricted diet group. Training accelerates lipolysis in the adipocyte and utilization of fatty acids in the muscle and the other cells, not only exercise period but also resting period, energy-restricted diet alone may decrease resting-metabolic-rate and inhibit these lipid metabolism to the contrary. The findings in the present study suggest that physical exercise combined with energy-restricted diet may improve lipid metabolism in Zucker Fatty rats, while energy-restricted diet alone may not.

### **NEW MECHANISMS FOR ENDURANCE TRAINING ON GLUCOSE HOMEOSTASIS: REDUCED INSULIN CLEARANCE AND LIVER INSULIN DEGRADING ENZYME EXPRESSION**

Costa, J.M.1, Ferreira, S.M.1, Rezende, L.1, Zoppi, C.1, Protzek, A.O.1, Oliveira, C.A.M.2, Santos, G.J.1, Boschero, A.C.1, Carneiro, E.M.1

1: State University of Campinas ; 2: Federal University of São Paulo State

Introduction It is well established that endurance training improves peripheral insulin sensitivity in liver and skeletal muscle, but the mechanism for this effect is poorly understood. Moreover, it has been recently proposed that insulin clearance plays a major role in both glucose homeostasis and insulin sensitivity. Therefore, our goal was to assess the mechanism by which endurance training improves insulin sensitivity and how it controls insulin clearance in mice. Material and Methods Swiss mice were separated in sedentary (S) and trained (T) groups. At the end of 4 weeks training, mice achieved a treadmill speed of 0.27 m/s  $VO_2$  máx for 60'. We evaluated glucose tolerance by ipGTT, insulin resistance by ipITT and kITT tests and insulin clearance. After tests, mice were killed for liver, skeletal muscle, and adipose tissues analysis. Proteins phosphorylation and expression were assessed by Western-Blot. Results Trained mice showed increased max  $VO_2$ , time to exhaustion and reduced fat pads, evidencing training effectiveness. Those mice presented lower plasmatic insulin and glucose, both in fasted and non-fasted states. Also, trained mice were more glucose tolerant, as evidenced by lower ipGTT and AUC of ipGTT, and more insulin sensitive, as evidenced by ipITT, kITT and AUC of ipITT. Endurance training also reduced insulin removal from plasma, as evidenced by insulin clearance test. Liver from trained mice had increased phosphorylation of Insulin receptor and AKT (insulin canonical pathway), as well as increased phosphorylation of CaMKII, AMPK and ACC. In skeletal muscle, on the other hand, there is no activation of insulin canonical pathway (Insulin receptor and AKT), but a marked increase in CaMKII, AMPK and ACC phosphorylation. The lower insulin clearance observed in trained mice could be attributed to reduced expression of Insulin degrading Enzyme (IDE) in liver. Discussion Taken together, our results show that endurance training improves glucose homeostasis not only by increasing peripheral insulin sensitivity, but also by reducing insulin clearance through reduced IDE expression in liver. Moreover, we found that endurance training improved insulin action on skeletal muscle and liver through increased activation of the CaMKII-AMPK pathway, which allows us to propose that this is an alternative signalling pathway for the long-term action of physical exercise. Financial Support: FAPESP/CNPq

### **THE ANTI-INFLAMMATORY EFFECT OF THE WHOLE BODY CRYOSTIMULATION IN OBESE MEN**

Ziemann, E., Olek, R.A., Grzywacz, T., Kasprovicz, K., Antosiewicz, J., Laskowski, R.

University of Physical Education and Sport

Introduction The increasing number of obese people was recorded in recently published report (Ruesten et al. 2011). Elevation of adipose tissue is the crucial factor in the regulation of many pathological processes. Certain cytokines produced by this tissue are thought to provide an important link between the obesity and related inflammatory disorders (Tigl 2006) The method, which may effectively exert the anti-inflammatory response is exposure to cold. Therefore, the aim of this study was to investigate the effect of the whole body cryostimulation on secretion of the cytokines in obese men Methods Seven obese men (BMI >30 kg/m<sup>2</sup>) participated in the study. Body composition was assessed using a multi-frequency bioelectrical impedance analysis (In Body 720, Biospace). Additionally maximal oxygen capacity was determined on an electromagnetically braked cycle ergometer (ER 900 Jaeger, Germany/Viasys Health Care). The subjects were exposed to the series of 10 sessions in a cryogenic chamber (ones a day at 9:30, for 3 min, at temperature -120°C). Blood samples were collected prior to the first cryostimulation and after finishing the last one. Results The series of 10 whole body cryostimulation sessions triggered the alteration in blood cytokines profile. Concentration of pro-inflammatory adipocytokines decreased by 6.8 % and 7.4% in resistin and visfatin, respectively. At the same time no change in adiponectin and leptin was observed. Moreover, the cold exposure induced 22% elevation of the anti-inflammatory cytokine IL-10. Furthermore, TNF $\alpha$  was 4.3 fold lower to the baseline, and IL-6 decreased by 19%. No changes of hematological parameters were noted. Discussion The investigation revealed that series of 10 whole body cryostimulations resulted in a significant decrease of pro-inflammatory and increase anti-inflammatory cytokines in obese men. It is important to note that concentrations of pro-inflammatory cytokines were above normal level in all subjects. This suggests that they experienced low- grade systemic inflammation and cryotherapy could be the strategy to reduce it. Our recently published data (Ziemann et al. in press), where cold exposure-induced drop of TNF $\alpha$  concentration in professional sportsmen could be supporting this conclusion. References 1.von Ruesten A, Steffen A, Floegel A, van der AD, Masala G, (2011), PLoS One 6: e27455 2. Tilg H. Moschen AR (2006), Nat Rev Immunol 6: 772-783. 3.Ziemann E, Grzywacz T, Kujach S, Olek RA, Antosiewicz J, et al. (in press). J. Ath.Train.

### **EFFECT OF NEUROPEPTIDE W ON FEEDING ACTION WITH VOLUNTARY EXERCISE**

Takenoya, F.1,2, Kageyama, H.3, Yamamoto, N.4, Ryushi, T.5, Shioda, S.2

1:Hoshi Univ. 2: Showa Univ. 3: Kiryu Univ. 4:Japanese Red Cross Hokkaido College of Nursing. 5:Daito Bunka Univ.

Introduction Neuropeptide W (NPW), isolated from the porcine hypothalamus, was identified as the endogenous ligand for both GPR7 (NPBWR1) and GPR8 (NPBWR2) that belong to the orphan G protein-coupled receptors (GPCRs) family [1]. NPB/NPW is reported to be widely distributed in brain including the hypothalamus [2], pituitary and adrenal glands, suggesting that NPB/NPW may have important roles in modulating neuroendocrine functions [3]. Central (icv) infusion of NPW is known to decrease food intake in rodents [4]. Several types of stress are reported to suppress feeding behavior through the hypothalamus-pituitary-adrenal gland (HPA) axis. NPW may pro-

mote to secrete CRF (corticotropin-releasing factor), adrenocorticotropin hormone (ACTH) and corticosterone. It is generally accepted that voluntary wheel running reduces the activation of HPA axis to stimuli. Therefore, we studied to clarify the effect of infusion of NPW on feeding action with voluntary exercise in mouse. Methods Male C57BL/6J and DIO (Diet-induced obesity) mouse were icv infused with the vehicle (saline) and NPW (2 nM) once a day. Body weight, food intake, water intake and locomotor activity were measured 24 hours after infusion of NPW. The animals were used which adapted themselves to running wheel for 5 days, afterwards the mouse moved voluntarily. Then, the animals were sacrificed and then the brain sections of control and exercise group were immunostained with c-Fos antibody to look at the light microscope. Results DIO mouse did not change body weight, food intake, water intake and locomotor activity by voluntary exercise with NPW icv infusion. The voluntary wheel running canceled the NPW-induced anorexia and c-Fos expression was decreased in the paraventricular nucleus of the hypothalamus. Discussion These results suggest that the voluntary exercise stimulates the HPA axis and to influence feeding regulation in mice. References [1] Shimomura Y, Harada M, et al. (2002) *J Biol Chem* 277, 35826-35832. [2] Takenoya F, Kageyama H, Shioda S, et al. (2010) *Neuropeptides*, 44:99-106. [3] Takenoya F, Kageyama H, Shioda S, et al. (2010) *Ann N Y Acad Sci* 1200,162-169. [4] Date Y, Kageyama H, Takenoya F, Shioda S, et al. *Endocrinology* 2010, 151: 2200-2210.

## ADHERENCE TO DIET AND DAILY ACTUAL KILOCALORIE DISCREPANCY BETWEEN GROUPS IN WEIGHT LOSS PROGRAMS

García-Hortal, M.I, Rojo-Tirado, M.A.I, Peinado, A.B.I, Benito, P.J.I

*Facultad de Ciencias de la Actividad Física y del Deporte - INEF, UPM*

**Introduction** Physical activity in conjunction with moderate dietary energy restriction and behavior modification has been promoted as an important component of a successful weight-loss regimen (1-3). Low-energy diets and physical activity are important for weight loss, defining successful efficacy (4, 5). Therefore, the aim of this study was to evaluate the dietary adherence and daily kilocalorie discrepancy between different treatments, in order to know which program has a higher level of adherence. **Methods** Eighty-four overweight people (Body Mass Index: 25-29.9 kg•m<sup>-2</sup>), aged from 18 to 50 years, participated in the study (36 males, 48 females) during 6 months. Four types of treatments were randomly assigned: strength training (S, n=19), endurance training (E, n=25), combined S and E training (SE, n=22), and diet and physical recommendations (C, n=18). All participants followed a 25% calorie restriction diet. Adherence to diet was calculated as the estimated Kcal of the diet divided by the real Kcal intake in percentage, and daily kilocalorie discrepancy was calculated through food diaries records. Two-way ANOVA (treatment and time) with repeated measures was used to determine differences between treatments and months. Multiple comparisons were made with the Bonferroni post hoc test. Probability level for statistical significance was set at  $\alpha=0.05$ . Results No significant differences were found between treatments and months for adherence to diet. Only one difference was revealed in month 4 between treatments E and SE (100.39±3.83 vs. 105.05±12.78%, respectively;  $p=0.030$ ). No significant differences were found between months, except for C treatment between months 2 and 4 (109.84±18.79% vs. 102.13±5.42, respectively;  $p=0.035$ ). When the daily kilocalorie discrepancy was analyzed no significant differences were discovered between months and groups. Only a significant difference was found for group E among months 1 and 4 (-51.56±138.98 vs. 8.54±77.6 kcal/day, respectively;  $p=0.013$ ). **Discussion** The four types of treatments have the same adherence to diet and no differences exist between daily kilocalorie discrepancies. In this way, the treatment selected in any weight loss program similar to us, would not be an important factor to determine the adherence to diet and daily kilocalorie discrepancy. References 1. Pate RR, et al. *JAMA*. 1995 Feb 1;273(5):402-7. 2. Volpe SL, et al. *J Am Coll Nutr*. 2008 Apr;27(2):195-208. 3. Stiegler P, et al. *Sports Medicine*. 2006;36(3):239-62. 4. Catenacci VA, et al. *Nat Clin Pract Endocrinol Metab*. 2007 Jul;3(7):518-29. 5. Tsai AG, et al. *Obesity (Silver Spring)*. 2006 Aug;14(8):1283-93.

## EFFECTS OF GLYCEROL INGESTION AND SUBSEQUENT PLASMA AND BLOOD VOLUME EXPANSION ON VO2MAX

Aphamis, G., Maughan, R.J.

*Loughborough University*

**Introduction** Glycerol ingestion acutely increases serum osmolality attracting and retaining water in the vascular space, with potentially some tissue dehydration, including muscle (Gleeson et al., 1986). A moderate increase in circulating blood volume induced by dextran infusion is known to increase stroke volume, VO<sub>2</sub>max and time to fatigue (Coyle et al., 1990), but reduced muscle hydration could have a different effect on exercise. The aim of this study was to investigate potential effects of glycerol ingestion on body water distribution, VO<sub>2</sub>max and exercise performance. **Methods** Eight healthy males (Mean ± SD age 23 ± 3 y) performed an incremental VO<sub>2</sub>max test on a cycle ergometer on two occasions, 30 min after ingestion of 6 ml•kg<sup>-1</sup> body mass of either a lemon-flavoured glycerol (1 g•kg<sup>-1</sup> body mass) solution or lemon-flavoured water. Percentage changes in blood and plasma volume were estimated from haemoglobin and haematocrit values (Dill & Costill, 1974). Results Glycerol ingestion increased resting serum osmolality from 288 ± 3 mosmol•kg<sup>-1</sup> to 299 ± 5 mosmol•kg<sup>-1</sup>, which was higher ( $P < 0.001$ ) than on the water trial (286 ± 3 mosmol•kg<sup>-1</sup>). Hyperosmolality resulted in 5.4% increase in blood volume ( $P = 0.05$ ) secondary to a 7.7% ( $P = 0.03$ ) increase in plasma volume, potentially due to a watershift from the intracellular to the extracellular space. Water ingestion had no effect on resting blood and plasma volumes. There was no difference between the two trials in VO<sub>2</sub>max (glycerol trial 50.5 ± 10.4 ml•kg<sup>-1</sup>•min<sup>-1</sup>; water trial 51.2 ± 8.1 ml•kg<sup>-1</sup>•min<sup>-1</sup>) or maximum heart rate (glycerol trial 178 ± 12 bpm; water trial 185 ± 8 bpm). Total exercise time on the glycerol trial (904 ± 167 s) was less by 33 s (4.4%) ( $P = 0.04$ ) than on the water trial (937 ± 179 s). Blood lactate at fatigue was similar on both trials (glycerol trial 12.9 ± 3.5 mmol•l<sup>-1</sup>; water trial 13.3 ± 3.6 mmol•l<sup>-1</sup>). **Discussion** Glycerol ingestion increased blood volume, as muscle water potentially decreased. Hyperosmotic blood volume increase did not improve VO<sub>2</sub>max. Blood lactate was similar on both trials, but the shorter exercise time on the glycerol trial indicated an accelerated lactate efflux. Muscle dehydration may be an important limiting factor for exercise performance during an incremental test. References Dill, D.B., & Costill, D.L. (1974). Calculation of percentage changes in volumes of blood, plasma and red cells in dehydration. *J Appl Physiol*, 37, 247-248. Coyle, E.F., Hopper, M.K., & Coggan, A.R. (1990). Maximal oxygen uptake relative to plasma volume expansion. *Int J Sports Med*, 11, 116-119. Gleeson, M., Maughan, R.J., & Greenhaff, P.L. (1986). Comparison of the effects of pre-exercise feeding of glucose, glycerol and placebo on endurance and fuel homeostasis in man. *European J Appl Physiol Occ Physiol*, 55, 645-653.

## OXYGEN UPTAKE KINETICS AND ENDURANCE TRAINING

Da Boit, M.1, Tam, E.1,2, Pogliaghi, S.2, Squatrito, S.1, Capelli, C.2

*Alma Mater Studiorum University of Bologna and University of Verona*

**Introduction** Previous studies have shown faster pulmonary oxygen uptake ( $\dot{V}O_2A$ ) kinetics after endurance training (1). It has been postulated that muscular  $\dot{V}O_2$  kinetics ( $\dot{V}O_{2m}$ ), whose  $\dot{V}O_2A$  kinetics is a reliable proxy, is regulated by muscular mechanisms during moderate intensity exercise in young adults. We investigated  $\dot{V}O_2$  and cardiac output ( $Q'$ ) kinetics during rest to moderate-intensity exercise transitions in young adults at different times of an endurance training (ET) program. Should the adaptation of  $\dot{V}O_{2m}$  kinetics be dissociated from that of  $Q'$ , the peripheral origin of the mechanisms affecting  $\dot{V}O_2$  kinetics during moderate intensity exercise would be confirmed. **Methods** 10 moderately active subjects (males and females) ( $25 \pm 4.8$  years,  $175 \pm 9.0$ ,  $70.6 \pm 11.9$  kg,  $\dot{V}O_{2max}$   $41.1 \pm 6.74$  mL/kg min) performed 3 step transitions of cycling exercise (0 to 100 W) separated by 6 minutes of recovery. Experiments were carried out every week during a 6-week period of aerobic training.  $\dot{V}O_{2max}$  and ventilatory threshold (VT) were assessed (2) at the beginning and at the end of ET that consisted in 45 minutes of cycling exercise performed 3 times a week at an intensity of about 65% of  $\dot{V}O_{2max}$ . Breath-by-breath  $\dot{V}O_2A$  and beat-by-beat  $Q'$  were measured during the tests.  $\dot{V}O_2$  and  $Q'$  values of each single experiment were 1-s normalised, aligned and overlapped to obtain a single time series for. Responses were fitted by using bi-exponential models. Results The time constant ( $\tau$ ) of the fundamental phase of  $\dot{V}O_2$  kinetics became faster during ET (22%) with an absolute rate of decrease of  $1.21s/week$  (before  $27.5 \pm 4.7$  after  $21.4 \pm 4.0$  s,  $P < 0.05$ ).  $Q'$  kinetics did not change significantly.  $\dot{V}O_{2max}$  and VT significantly improved by 7.5% and by 19%, respectively. The weekly rate of decrease of  $\tau$  was related to VT absolute variation:  $y = -0.0024x - 0.4603$   $R^2 = 0.8479$ ), whereas no significant relationship was described between the weekly rate of adjustment of  $\tau$  and the increase of  $\dot{V}O_{2max}$ . **Discussion**  $\tau$  of  $\dot{V}O_2$  kinetics modifies rapidly during endurance training, in agreement with previous results (3). The progressive acceleration of  $\dot{V}O_2$  kinetics was not paralleled by the acceleration of  $Q'$  response as  $\tau$  of  $Q'$  kinetics was not affected by ET. The weekly rate of change of  $\tau$  was significantly correlated with the increase of VT. This suggests that the modifications of  $\tau$  induced by ET are of peripheral origin. **References** (1) J.A. Zoladz, et al. (2006) *J Physiol Pharmacol* 57, suppl 10, 67.84 (2) H. B. Rossiter et al. (2006) *JAP* 100, no. 3, 764-770 (3) Y. Fukuoka, et al. (2002) *Pflugers Arch* 443, 690-697

## RECOVERY FROM AN EXHAUSTIVE INTERMITTENT EXERCISE IS NOT ENHANCED BY CARBOHYDRATE-PROTEIN VS. ISOENERGETIC CARBOHYDRATE SUPPLEMENTATION

Denuziller, J.

*UFR STAPS*

**Recovery from an exhaustive intermittent exercise is not enhanced by carbohydrate-protein vs. isoenergetic carbohydrate supplementation** DENUZILLER J, BABAULT N, DELEY G Centre d'Expertise de la Performance Gilles Cometti, Faculté des Sciences du Sport, Dijon, France **Introduction** In many sports, such as combat sports, athletes are required to compete repeatedly on the same day. Fights, i.e. high-intensity intermittent exercises, are separated by recovery periods lasting 40 to 60 minutes, necessitating rapid repletion of muscle glycogen stores. Over years, lots of studies tested nutritional strategies to maximize glycogen resynthesis following exercise and showed that consumption of carbohydrate beverage (CHO) within 30 min after exercise was the most beneficial (Ivy et al. 1988). Several studies also suggested that the addition of proteins in CHO beverage (CHO + P) might improve muscle glycogen resynthesis, particularly if the supplement is limited in time (Berardi et al. 2006). The present study therefore aimed to assess the effects of CHO and CHO + P recovery drinks after high-intensity intermittent exercises separated by 45 minutes. **Methods** Twelve young healthy male subjects physically active participated in this study. The study was composed of three testing sessions separated by at least seven days. Each session corresponded to a different beverage intake: (i) Carbohydrate beverage (CHO), (ii) Carbohydrate + protein beverage (CHO + P), and (iii) Water. Each session was composed of three high-intensity intermittent exercises separated by 45 minutes of passive rest. Each of the three exercises consisted in four Wingate Anaerobic Test (WAnT) separated by 30 seconds of passive rest. Measures in countermovement jump and blood lactate concentration were repeated immediately before and after each of the three high-intensity intermittent exercise. Peak power and mean power developed during each WAnT were also recorded. Results Whatever the beverage, jump height and lactate concentration were still altered at the beginning of the second and third intermittent exercises in comparison with pre values ( $P < 0.05$ ). However, the consumption of CHO+P permitted a greater recovery for the counter-movement jump ( $P < 0.05$ ). The average peak power and mean power calculated for the three intermittent exercises were not modified by beverages consumption. **Discussion** Performances decreases suggest a great fatigue, mainly attributable to peripheral alterations as shown by lactate concentration. Although, CHO+P intake allowed a greater recovery of vertical jump performances between the first and the second exercise, values measured after 45 minutes of passive rest were still depressed in comparison with pre values. None of the beverage enhanced lactate elimination. In association with the depressed performance, this result suggests that when fatigue is too important, the consumption of recovery beverages is not helpful. **References** Berardi JM et al. (2006) *Med Sci Sports Exerc* 38: 1106-1113. Ivy JL et al (1988) *J Appl Physiol*. 65: 2018-2023.

## OPTIMAL Q FACTOR AND LABORATORY TIME TRIAL PERFORMANCE

Disley, B.X., Li, F.X.

*University of Birmingham*

**Introduction:** The manipulation of the horizontal distance between the cranks on a bicycle (Q Factor) has received little attention in scientific research, compared with other variables such as crank arm length and saddle height. A standard Q Factor is approximately 150mm for a road bicycle. Optimisation of Q Factor for the individual cyclist is critical for improved performance. Wider Q Factors ( $\geq 150$ mm) have been shown to be less efficient than narrower Q Factors ( $\leq 120$ mm) during submaximal pedalling at 60%  $\dot{V}O_2$  max (Disley & Li, 2011), however the effect of manipulating Q Factor during a maximal time trial (TT) is unclear. **Aims:** The aim of the study was to determine whether 24min laboratory time trial performance was affected by a change in Q Factor. It was hypothesised that the best performance would be reached at a Q Factor  $< 150$ mm, and that deviation from the optimal Q Factor would result in a decrease in performance. **Methods:** 10 trained cyclists performed four maximal 24min TTs on an adjustable bicycle which allowed a change in Q Factor. 4 Q Factors were used: 90, 120, 150 and 180mm. The order of trials was randomised and participants instructed to complete the TTs at maximal intensity. **Results:** No general effect for Q Factor on average power output during the TTs was found ( $p = .470$ ). However, when normalised to individual best TT performance, power output decreased at both higher and lower Q Factors resulting in an inverted U shape ( $R^2 = 0.710$ ), where the best performance occurred at  $144.0 \pm 8.7$ mm. A change in Q Factor of 22.3mm results in a drop in power of 3.6%. **Conclusions:** The Q Factor that resulted in best TT performance differed between participants, suggesting that there is an optimum Q

Factor for every cyclist. Deviation from optimal Q Factor cost the athlete 13.1w on average in the present study. It is therefore important to identify individual's optimum Q Factor for maximum performance. References: Disley, B.X., Li,F.-X., "The Effect of Q Factor on Cycling Performance" European College of Sport Science Congress 2011 Contact details: f.x.li@bham.ac.uk

## 14:45 - 15:45

### Poster presentations

#### PP-PM44 Biochemistry, Training & Testing

##### EXERCISE DOES NOT INCREASE HSP72B'

Ruell, P.A.1, Simar, D.2, Periard, J.D.1, Best, S.1, Caillaud, C.1, Thompson, M.W.1

*1 The University of Sydney, 2 The University of NSW*

**Introduction** Hsp70B' is a basic variant of heat shock protein 72 (Hsp72) that is found in human but not rodent cells and tissues. It is the product of a separate gene to Hsp72 and is highly inducible with low or no basal expression under unstressed conditions. Hsp72 is a member of the heat shock protein family found in all organisms and characterized by its cytoprotective role. In the serum Hsp72 appears to function as a danger signal to the cell, initiating an inflammatory response. While it is well known that plasma Hsp72 increases during exercise (2), the response of Hsp70B' has not been determined. **Methods** Seven physically active males aged  $32 \pm 3$  years with a body-weight of  $75.5 \pm 3.4$  kg undertook an incremental treadmill running test to determine their maximum oxygen uptake (VO<sub>2</sub>max). Approximately one week following the determination of VO<sub>2</sub>max subjects ran on the treadmill at 72% VO<sub>2</sub> max in warm conditions (30°C, 40% relative humidity) for 1 hour. Rectal temperature was measured on a portable data logger. Blood samples were collected before, after 60min of running and 1 hour post-exercise and serum was analyzed for Hsp70B' using a commercial Elisa kit. Results Rectal temperature increased from  $36.81 \pm 0.11^\circ\text{C}$  to  $39.39 \pm 0.17^\circ\text{C}$  ( $p < 0.001$ , before vs immediately post). Serum Hsp70B' did not change over time ( $0.71 \pm 0.16$ ,  $0.80 \pm 0.17$  and  $0.80 \pm 0.16$  ng/ml at pre, immediately and 1h post). **Discussion** These findings are in agreement with gene studies which found that Hsp70B' mRNA was not increased in leucocytes by exercise (1). While Hsp72 and Hsp70B' have similar genes (77% sequence identity), the protein product appears to respond differently to exercise stress in humans. References Sonna LA, Wenger CB, Flinn SD, Sheldon HK, Sawka MN, and Lilly CM. Exertional heat injury and gene expression changes: a DNA microarray analysis study. *Journal of Applied Physiology*. 2004;96:1943-53. Walsh RC, Koukoulas I, Garnham A, Moseley PL, Hargreaves M, and Febbraio MA. Exercise increases serum Hsp72 in humans. *Cell Stress & Chaperones*. 2001;6(4):386-93.

##### THE EFFECTS OF EXERCISE ON BETA ENDORPHIN AND ALCOHOL URGES IN ALCOHOLIC PATIENTS

Jamurtas, A.Z., Zourbanos, N., Georgoulas, P., Mouzas, O., Bletsou, A., Souliou, S., Psifos, V., Oikonomou, D., Theodorakis, Y.

*University of Thessaly*

**Introduction** The consumption of alcohol was considered since ancient time a pleasant and socially acceptable habit. Euphoric feelings due to alcohol consumption are associated with the release of opioids (Giannoulakis). However, alcohol abuse can have many medical consequences which can be harmful for both physical and mental health and can have detrimental effects in social, professional and personal life of the abuser. At the same time alcohol abuse is responsible for increases in criminal behavior and the higher incidence of accidents. Furthermore, alcohol is believed to be responsible for the majority of deaths caused by drugs. **Methods** The purpose of the present study was to examine the effects that physical exercise has on beta endorphin levels and on the urge for alcohol on individuals which participate on rehabilitation programmes. Nine participants (8 men and 1 woman) volunteered to participate in an exercise session on a cycle ergometer. The intensity of the exercise was low (50-60% of maximum heart rate) and the duration lasted 30 minutes. Prior to and following exercise the participants filled out questionnaires indicating their urge towards alcohol consumption and blood was drawn for beta-endorphin assessment. **Results** The results from the present study showed that exercise resulted in significant ( $p < 0.001$ ) increases in the levels of beta-endorphin (pre:  $1.57 + 0.39$  pmol/L, post:  $4.8 + 1.6$  pmol/L) with a trend towards significant decrease in alcohol urge following the exercise. **Discussion** In conclusion, the results from the present study do not support a decrease in alcohol urge following an exercise bout of low to mild intensity. However, the trend towards lower alcohol urge is important and further studies need examine whether there is a link between exercise and prevention of alcohol abuse. References Giannoulakis, C. (2004). Endogenous opioids and addiction to alcohol and other drugs of abuse. *Current Topics in Medical Chemistry*, 4(1), 39-50.

##### THE EFFECTS OF SUPPLEMENTATION WITH OMEGA-3 FATTY ACIDS ON REDOX STATE OF YOUNG FOOTBALL PLAYERS

Djordjevic, D.1, Nestic, M.1, Barudzic, N.1, Vuletic, M.1, Zivkovic, V.1, Puzovic, V.1, Cubrilo, D.1, Jakovljevic, V.1

*Department of Physiology, Faculty of Medicine, University of Kragujevac, Serbia*

**Introduction** Recent investigations in the field of exercise physiology pay special attention to finding and understanding the mechanisms of the inflammatory response, oxidative stress and their mutual effects (1). It was shown that supplementation with omega-3 fatty acids, eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3) may be important factor of antiinflammatory response to intensive exercise (2). Despite the many antiatherosclerotic benefits of n-3 fatty acids, there remains a theoretical concern that these fatty acids may increase the fatty acid unsaturation index, consequent to the incorporation of EPA and DHA into membranes and lipoproteins, leading to increased lipid peroxidation (3). Thus the aim of our study was to assess the changes in redox state of young football players after two months of supplementation with either n3- or n6- polyunsaturated fatty acids (PUFA). **Methods** Forty-eight young football players (age  $18.7 \pm 1.1$ ) were subjected to venous blood sampling after an overnight post before and after experimental period of two months (preparatory period) during which players took supplementation with either n3-PUFA, n6-PUFA or placebo and performed their regular football training. Redox state analysis included measurement of levels of: superoxide anion radical, hydrogen peroxide, nitrites as markers of nitric oxide, thiobarbituric acid reactive substances as index of lipid peroxidation, reduced glutathione, superoxide dismutase and catalase activity. **Results** Analysis of data using the two way ANOVA repeated measures (within subjects factor „time“ and

between subjects factor „supplementation”) showed that two months after the beginning of the study players had significantly lower levels of superoxide anion radical, hydrogen peroxide and glutathione, while activities of superoxide dismutase and catalase were higher („time”:  $P < 0.05$ ). However, those differences were not dependent on kind of supplementation that they have taken („time\*supplementation”:  $P > 0.05$ ). Discussion Since observed changes in redox state of football players were not dependent on kind of supplementation they have consumed, we hypothesize that players' improved redox state was a consequence of well programmed football training during preparatory period. The absence of changes in the levels of lipid peroxidation suggests that supplementation with omega-3 fatty acids does not induce oxidative stress. References Pedersen BK and Hoffman-Goetz L. (2000). *Physiol Rev*, 80,1055–1081. Bloomer RJ, Larson DE, Fisher-Wellman KH, Galpin AJ, Schilling BK. (2009) *Lipids Health Dis* 8, 36. Mori TA. (2004). *Redox Rep* 9, 193–197.

### THE EFFECTS OF HORMONE ON AMPK-ACTIVATED PROTEIN KINASE IN H460 LUNG CANCER CELLS

Su, M.Y., Hsieh, S.Y., Chang, J.M.

*Development Center for Biotechnology*

**Introduction** For improving the cancer disease, exercise has been widely accepted with its benefit, but the mechanism of action between exercise and cancer has not been elucidated yet. AMP-activated protein kinase (AMPK) is a key regulator in energy homeostasis, and increased AMPK activity by exercise is speculated as key role between exercise and cancer. Our pervious study has appeared the different profiles on AMPK activity following serum stimulation compared with glucose stimulation in H460 lung cancer cells. Accordingly, we used different hormones, which are secreted during exercise, as stimulator in cell culture to elucidate the relationship among hormone, AMPK and lung cancer cell for investigating whether exercise influences cancer development through alteration of AMPK activity. Methods H460 lung cancer cells were incubated with DMEM medium containing 10 % serum, and then epinephrine, growth hormone, insulin and glucagon were added to H460 cell culture, respectively, for analyzing the cell viability, AMPK activity and AMPK protein amount at 3, 6, 12, 24, 48 h. Results Epinephrine and growth hormone significantly increased cell viability about 7 % at 3 h and 24 h, respectively ( $p < .05$ ). Insulin significantly increased cell viability ranging from 7 to 11 % at 3, 12, 24 and 48 h ( $p < .05$ ). Glucagon significantly increased cell viability 8 % and 5% at 3 and 12 h, respectively ( $p < .05$ ). Furthermore, each hormones used in this study suppressed AMPK activity between 26 to 50 % at first 3 h, and elevated AMPK activity between 57 to 148 % at later 48 h. Discussion According to the signaling role of AMPK, many studies has established the regulatory effects of AMPK that were induced by hormone in various tissues (Lim et al., 2010; Dzamko and Steinberg, 2009), but it remains unclear in cancer cells. In this study, we found that AMPK activity induced by each hormones was observed as a biphasic response, in which was not consistent with the change of cell viability. The similar tendency of AMPK activity induced by different hormones implied that AMPK could be stimulated with the same mechanism. It was not apparent time-dependant manner in cell growth for hormones stimulation, but each hormones used in this study induced significant increase in cell growth at different time points. The increase of cell growth by hormone stimulation is coincident with the results of other studies (Wong et al., 2011; Thaker et al., 2006), but it should be notice the influence of AMPK activity. We demonstrated that the cell growth was affected by hormone and this effect might be deduced through the regulation of AMPK. References Lim CT, Kola B, Korbonits M. (2010). *J Mol Endocrinol*, 44(2), 87-97. Dzamko NL, Steinberg GR. (2009). *Act Physiol*, 196, 115-127. Wong HP, Ho JW, Koo MW, Yu L, Wu WK, Lam EK, et al. (2011). *Life Sci*, 88(25-26), 1108-1112. Thaker PH, Han LY, Kamat AA, Arevalo JM, Takahashi R, Lu C, et al. (2006). *Nat Med*, 12(8), 939-944.

### INFLAMMATION AND LOSS OF MUSCLE FUNCTION IN ELDERLY

Ostapiuk-Karolczuk, J., Kasperska, A., Zurek, P., Dziubek-Rogowska, W., Dabrowska, G., Rynkiewicz, M., Rynkiewicz, T., Zembron-Lacny, A.

*Faculty of Physical Culture Gorzow Wlkp. University of Physical Education Poznan*

**INFLAMMATION AND LOSS OF MUSCLE FUNCTION IN ELDERLY** Ostapiuk-Karolczuk J.1, Kasperska A.1, Zurek P.1, Dziubek-Rogowska W.2, Dabrowska G.2 Rynkiewicz M.1, Rynkiewicz T.1, Zembron-Lacny A.1 1. FPC Gorzow Wlkp. USPE (Poznan Poland), 2. USPE (Wroclaw, Poland). **Introduction** One of the most serious consequence of aging is the loss of skeletal muscle mass and strength. This degradation called sarcopenia leads to decreasing the functional status and impairing mobility causing increased risk of musculoskeletal injuries and loss of independence. The underlying cellular changes involve increased level of pro-inflammatory cytokines responsible for activation of processes in consequence leading to muscle cell degradation and apoptosis (Francheschi et al.,2007).The purpose of the study was to investigate whether high level of IL-1 $\beta$  and TNF $\alpha$  are associated with loss of muscle mass and function in the elderly. **Methods** Participants: 16 well-functioning males over 60 years old and 20 healthy, non-smoking and untrained males aged 20-22 years. Body composition were estimated using a bioelectrical impedance floor scale (Tanita, Japan). Measurements of muscular strength, power and work were obtained at 60o/s and 180o/s using Biodex Unit (Biodex Medical System Inc.). In blood serum levels of pro-inflammatory cytokines IL-1 $\beta$  and TNF $\alpha$  were measured. Results Significant changes in the body composition were concerned particularly the percentage of fat content (FAT%) and fat mass (FM). Free fat mass (FFM) was on similar level in both investigated groups. The level of both pro-inflammatory cytokines was significantly higher in elderly compared to the young men. Results also demonstrate considerably higher knee extension and flexion peak torque, work and power in young males compared to the elderly. Discussion It has been estimated that only 25% persons under age of 70 and 40% of those aged 80 or older may suffer sarcopenia (Marzetti and Leeuwenburgh, 2006). Our results have shown that there were no significant differences between body weight and FFM between young and older males however, there were strong differences in total strength, average power and total work between investigated groups. Muscles of elderly are clearly weaker. This may be a result of higher level of IL-1 $\beta$  and TNF $\alpha$  which increase the risk of muscle strength loss through their catabolic effects (Schaap et al., 2006). Higher level of pro-inflammatory markers is often observed in healthy older person and it is responsible for occurrence of chronic low-grade inflammation which is termed “inflamm-aging” (Francheschi et. al., 2007). Furthermore, this phenomenon may be related to an age-related disabilities to generate higher knee extensor and flexor torque. References Marzetti E, Leeuwenburgh C.(2006) *Exp Gerontology*, 14: 1234-1238 Schaap LA., Pluijm SMF., Deeg DJH., Visser M. (2006) *Am J Med* 119: 526.e9-526.e17 Francheschi C, Capri M, Monti D, Giunta S, Olivieri F, Sevini F, Panourgia MP, Invidia L, Celani L, Scurti M, Cevanini E, Castellani GC, Salivoli S. (2007). *Mech Ageing Dev* 128:92-105

## SENSORY-PERCEPTION AND CONTROL OF DISPLACEMENT DURING SWIMMING AND WALKING IN BLIND SUBJECTS

Scurati, R., Michielon, G., Longo, S., Invernizzi, P.L.

*Faculty of Exercise Sciences - University of Milan*

**Introduction** In blindness, in place of visual information, alternative feedbacks are needed to supply the control of the movement, such as sensory-perception. In swimming, specific sensory-perception abilities are crucial to build the "feeling the water" and to reduce drag. They can be evaluated by gliding test (Invernizzi et al., 2010). Visual feedback is closely related to balance and to the control of direction during displacement (Danion et al., 2000). This study aimed to relate the sensory-perception abilities, measured by gliding test, to the control of the displacement during swimming and walking, in blind subjects. **Methods** Ten blind subjects (28.4±12.9 years, 65.5±10.1 kg, 166±10 cm, 23.6±3.5 kg/m<sup>2</sup>) volunteered to participate in the study. The deviation from the displacement along the straight direction was assessed (scoring from -5 to 5) during 25m front crawl (FC) and during 25m backstroke swimming (BA). In a gymnasium set, the deviations from the straight direction during 25m of free walking were scored (from -5 to 5). Finally, the length of the swimming glide in a streamline position, pushing-off from the wall, was measured. Three trials for all test have been performed. The sum of the absolute values of the deviations and the mean of the measures of gliding have been considered. **Results** The deviation from the straight direction was higher in BA than in FC swimming ( $p < 0.05$ ,  $11.20 \pm 2.10$  vs,  $9.70 \pm 1.49$ , AU±SD). Significant correlation was found between FC and BA ( $r = -0.76$ ,  $p < 0.05$ ), between gliding and FC deviation ( $r = -0.70$ ,  $p < 0.05$ ) and between gliding and BA deviation ( $r = -0.74$ ,  $p < 0.05$ ). Gliding did not correlate with walking deviation ( $r = 0.27$ ,  $p > 0.05$ ). **Discussion** Blind subjects managed the swimming direction worse in BA than in FC, as previously found in swimmers (Invernizzi et al., 2010). Being not high-level swimmers, the subjects of this study moved their arms with an outer trajectory, making it more difficult in BA than in FC the control of the direction and deviating opposite to the dominant arm. Gliding, such as expected, correlates with swimming, supporting the relationship between the sensory-perception and the ability in governing the swimming. On the contrary, even if more than 6% of subjects walked perfectly straight, other feedbacks would be more crucial during walking than in gliding, such as balance and acoustic feedbacks. **References** Danion F, Boyadjian A, Marin L (2000). Control of locomotion in expert gymnasts in the absence of vision. *J Sports Sci.*, 18(10):809-14. Invernizzi PL, Longo S, Tadini F, Scurati R (2010). Swimming in eyesight deprivation: relationships with sensory-perception, coordination and laterality. XIth International Symposium "Biomechanics and Medicine in Swimming", Oslo, 326-328.

## YO-YO INTERMITTENT RECOVERY TEST LEVEL 1 AND FIELD TESTS FOR WHEELCHAIR BASKETBALL PLAYERS

Yoda, T., Sorimachi, M., Kawanishi, M., Yasumatsu, M., Kobayashi, K., Iso, S.

*Dokkyo University*

**YO-YO INTERMITTENT RECOVERY TEST LEVEL 1 AND FIELD TESTS FOR WHEELCHAIR BASKETBALL PLAYERS** Yoda, T.1, Sorimachi, M.2, Kawanishi, M.3, Yasumatsu, M.3, Kobayashi, K.2, Iso, S.2 1:Dokkyo Univ (Soka, Japan), 2:Waseda Univ (Tokorozawa, Japan), 3:Rikkyo Univ (Niiza, Japan) **Introduction** Wheelchair basketball players have to take high aerobic and anaerobic fitness because they have to perform to push and pull the wheel hard, to stop completely, to turn quickly, and to maneuver the ball repeatedly (Molik et al., 2010). An individual's ability to repeatedly perform high-intensity exercise in able-bodied players is widely measured with the Yo-Yo intermittent recovery test level 1 (YYIR1) (Bangsbo et al., 2008). We tried to apply the YYIR1 to wheelchair basketball players and describe their physical fitness required for the game. **Methods** Ten male wheelchair basketball players participated in this study. We used the YYIR1 and its modification to wheelchair basketball players (YYIR1-WB). YYIR1 consists of 2 x 20 m shuttle run with increasing speed with a 10-second period of active recovery between each run. In the YYIR1-WB the distance for the test was shortened (15 m). We also measured the time of the short sprint with or without dribbling a ball, distance of medicine ball throw, and the time for moving along the plus shape (+) or triangle to check the ability of quick direction change. **Results** Most of subjects could not follow the test speed of normal YYIR1, even at the lowest one, and the longest distance achieved was only 280 m. On the other hand, in YYIR1-WB, the longest distance was 1560 m and the average distance was  $933 \pm 469$  m. The average time of short sprint was  $4.55 \pm 0.26$  s without dribble and  $4.68 \pm 0.36$  s with dribble. The average distances of medicine ball throw was  $8.71 \pm 0.7$  m. In the tests of direction change, all subjects showed better results in pulling the wheel without turn than in pushing the wheel with turn. According to the Player Classification System, players are classified (Class I, II, III, and IV) based upon the players' functional capacity to play (Class I is the most disabled). The score of present measurements were higher for the Class III and IV than the Class I and II. **Discussion** For setting up the workout menus in training, the level of player's physical ability should be well recognized by team staffs. Therefore, at first we did YYIR1 that was developed for the test in the normal players. However, the present subjects could not follow the test speed, and we modified it by shortening the distance so that the subjects could follow the test. The score of the modified test was well correlated with their physical condition. Therefore, the test could be used for the evaluation of physical fitness in wheelchair basketball players. **References** Bangsbo J, Iaia FM, Krstrup P. (2008). *Sports Med*, 38(1), 37-51. Molik B, Laskin JJ, Kosmol A, Skucas K, Bida U. (2010). *Res Quart Exerc Sport*, 81(1), 69-73.

## PREDICTED VO<sub>2</sub> ON 6 MINUTES WALK TEST FOR FAP LIVER TRANSPLANTED PATIENTS

Tomás, M.T., Santa-Clara, H., Bruno, P.M., Monteiro, E., Barroso, E., Sardinha, L.

*Faculty of Human Kinetics; Lisbon Higher School of Health Technologies; Lisbon Hepatobiliopancreatic and Transplantation centre*

**Introduction** Physical function is limited post-liver transplantation and exercise training can improve exercise capacity following transplantation but previously assessment of functional capacity is necessary. The 6 minute walk test (6MWT) is routinely used for studying patient's exercise capacity and is less expensive and time consuming than a Cardiopulmonary Exercise Test (CPXT). There have been some studies looking at the relationship between 6MWT and peak VO<sub>2</sub> in patients but few presented an adequate equation for predicted peak VO<sub>2</sub> from 6MWT to transplanted patients and none for Familial Amyloidotic Polyneuropathy (FAP) liver transplanted patients (FAPTx). The aim of this study was to compare the validity of 6 equations as predictors of VO<sub>2</sub> from the 6MWT and compare it with directly measured VO<sub>2</sub> in patients FAPTx. **Methods** Patients were recruited to participate in this study if they were FAPTx between 2-12 months post-transplant. Forty-eight patients (28 men and 20 women;  $34 \pm 7$  yr; body mass index  $21.9 \pm 3.9$ ;  $4.2 \pm 2.1$  months post transplant) gave their informed consent and participated in this study. All subjects had superficial sensory alterations (tactile, thermal, and painful) of the lower limbs, especially of the feet, had a permanent pacemaker and were sedentary. This study protocol was approved by the Hepatobiliopancreatic and Transplantation Centre of Curry Cabral Hospital at Lisbon and by the Faculty of Human Kinetics Institutional Review Board. Patients performed the 6MWT according to American Thoracic Society guidelines and VO<sub>2</sub> was measured in field using a portable gas analyzer (K4 b2, Cosmed, Rome, Italy). Intraclass Correlation Coefficient (ICC) was used to evaluate absolute agreement among measured values and previously reported peak VO<sub>2</sub> predictive equations. **Results** The results of 6MWT showed a VO<sub>2</sub> measurement of  $17.7 \pm 4.0$  ml/kg/min (highest VO<sub>2</sub> on the last 2 min) for a walked distance of  $512.2 \pm 136.4$  m. The highest value for heart rate on 6MWT was  $124 \pm 15$  bpm. ICC

between directly measured values and the VO<sub>2</sub> predicted from reported equations was between 0.332 and 0.667 ( $p < 0.001$ ). Discussion None of the equations that predicted VO<sub>2</sub> through 6MWT showed to be suitable for FAPT<sub>x</sub> with differences between measured and predicted VO<sub>2</sub> ranging from -7.86 ml/kg/min to 10.38ml/kg/min. All equations, except one, underestimated VO<sub>2</sub> with FAPT<sub>x</sub> patients. It is important to continue studies with this population with more patients to find a new equation that can predict VO<sub>2</sub> from 6MWT specifically for FAPT<sub>x</sub> population.

### **A COMMON INDIRECT SUBMAXIMAL TEST FAIL TO ESTIMATE THE MHC ISOFORM IN LATISSIMUS DORSI MUSCLE FIBERS.**

Moro, T., Pacelli, F.Q., Toniolo, L., Canato, M., Cancellara, P., D'Alpaos, E., Reggiani, C., Paoli, A.  
*University of Padova*

**Introduction** It is well known that there are three major muscle fiber types and corresponding Myosin Heavy Chain (MHC) isoforms (ie, MHC I, IIa, and IIx) in human skeletal muscles (Schiaffino & Reggiani 2011). For athletes may be useful knowing the predominance of fiber's type in muscles to optimize training stimulus. Charles Poliquin hypothesized that the number of repetitions at 85% of 1RM is correlated with fibers distribution; in particular Poliquin stated that if the number of repetition was less than 5 reps the prevalence of fibers was IIx, if it was equal to 5 the prevalence of fibers was IIa and if the repetition was more than 5 muscle contained more I (Poliquin C. 1997). This kind of test is widely diffuse among body builders and athletes. The aim of this study was to validate Poliquin's theory. **Methods** Eighteen healthy volunteers participated in 8-week progressive resistance training for upper limbs muscles. Pre and posttraining, one repetition maximal test and the maximal number of repetitions at 85% of 1RM were assessed; muscle samples from latissimus dorsi were obtained with a fine needle biopsy technique (Paoli et al. 2010) The composition in MHC isoforms of bundles of muscle fibers or single muscle fibers was determined on 8% polyacrylamide slab gels after denaturation in SDS (SDS-PAGE). Three bands were separated in the region of 200 kD, corresponding (in order of migration from the fastest to the slowest) to MHC-1, MHC-2A and MHC-2X. **Results** Data collected before the training shown that only six subject (35,3%) presented a correlation between the number of repetition and the MHC isoform and only four subjects (31,3%) presented the same correlation after 8-week of RT. There wasn't any significant correlation between fiber type composition and number of repetitions performed at 85% 1 RM. **Discussion** Our data refute the method suggested by Poliquin to estimate muscle fiber type. Moreover we hypothesize that the limit of 5 repetitions suggested to identify fast twitch fibers is too restrictive. More data are needed to identify a correlation between muscle fiber composition and a submaximal test. **References** Schiaffino S, Reggiani C. (2011). *Physiol Rev*, 91(4), 1447-531. Paoli A, Pacelli QF, Toniolo L, Miotti D, Reggiani C. (2010). *J Surg Res*, 164(2), e257-63. Poliquin C. *The Poliquin Principles*. Dayton Pubns & Writers Group ed. 1997 Andersen JL, Aagaard P. (2010). *Scand J Med Sci Sports*, 20(2), 32-8. Jansson E, Sjodin B, Tesch P. (1978). *Acta Physiol Scand*, 104(2), 235-7.

### **HEAT DISSIPATION EVALUATION IN EXERCISE BY INFRARED THERMOGRAPHY**

Ludwig, N., Formenti, D., Gondola, M., Gargano, M., Alberti, G.  
*state university of milan*

**INTRODUCTION** Heat dissipation during sport exercise is very important to improve athlete performance. An help to physiological mechanism of generation and transport of heat in the muscle under stress and in surrounding districts, is given by IR thermography to evaluate the surface heat dissipation locally. Thermography is useful because of its high sensitivity (0.05°C) and global representation of thermal process. Its use is recommended for the athletic evaluation because it is a non-invasive technique that doesn't need any contact with the skin, avoiding physic and psychologic conditioning (Merla et al., 2010). **METHODS** We tested two groups of female subjects: 9 athletes and 9 sedentaries (mean age 19.39±3.26 y, weight 53.82±5.36 kg, height 1.64±0.06 m). They performed an exercise (standing calf raise with both feet) that limits the work to one group of muscle (gastrocnemius and soleus) and allows a perfect visibility for a correct thermographic shoot. It consists to raise and lower heels (rate 1 s) without over load (N.S.C.A., 2010). Thermal images was recorded (1 Hz frame-rate) during 14 minutes (2 min. of pre-exercise to determinate basal temperature, 2 min. of exercise, 10 min. of recover). Two Regions of Interest (ROI) were selected following anatomical and functional correspondence with the muscles involved in exercise, one on each calf (Zaidi et al., 2007). The data were analyzed with a dedicated software for thermal images. The considered parameter was the mean temperature over an area of 2 mmq of the hottest spot in the calf. **RESULTS** Both groups show a minimum in temperature after few seconds of the exercise. The calves temperatures increase with linear trend during the whole exercise and in the first minutes of recover, but with a different slope. Temperature variation in 2 min. recovery-time of the athletes is 1.07°C, while for the group of sedentaries is 0.76°C. **DISCUSSION** From these preliminary results is clear that IR thermography is a valid diagnostic method in evaluation of heat dissipation during and after physical exercise. The different slopes of the temperature trends during exercise and the two minutes post exercise indicate that calves of athletes dissipate more heat than calves of sedentaries. It can be explained with a better muscular efficiency in trained subjects, used to do exercise, and probably due to a less fat mass in the calves of athletes than in calves of sedentaries (Merla et al., 2010). **REFERENCES** Merla, A., Mattei Peter A., Di Donato L., Romani G. (2010). *Ann. Biomed. Eng.* 38:158-163. N.S.C.A. (2010). *Esercizi per l'allenamento in palestra*. Calzetti-Mariucci. Zaidi H., Tair R., Fohanno S., Polidori G. (2007). *Acta Bioeng. Biomech.* 9:47-51.

### **INFLUENCE OF EMG SIGNAL DETERMINATION ON THE RELIABILITY OF SOME EMG PARAMETERS OFTEN USED FOR THE EVALUATION OF EXPLOSIVE FORCE PRODUCTION**

Trost Bobic, T., Sarabon, N., Markovic, G.  
*School of Kinesiology*

**INFLUENCE OF EMG SIGNAL DETERMINATION ON THE RELIABILITY OF SOME EMG PARAMETERS OFTEN USED FOR THE EVALUATION OF EXPLOSIVE FORCE PRODUCTION** Trošt Bobić, T.1, Šarabon, N.2, Marković, G.1 1: School of Kinesiology, University of Zagreb, Croatia, 2: Science and Research Centre, University of Primorska, Koper, Slovenia **Introduction** The aim of this study was to asses if the method used for EMG signal onset determination would affect inter- and intra-session reliability of multiple electromyographic (EMG) indexes often used to asses explosive force production of m. soleus (EFPs). **Methods** Thirty-seven physical education students (22.5±1.3 years) where included in the intra-session, while ten (22.7±0.9 years) where included in the inter-session reliability study. Sitting on a custom made dynamometer, participants were asked to perform three unilateral maximal voluntary isometric plantar flexions (MVIC) of the right foot stressing explosive force production. EMG signals of m. soleus where recorded by means of surface bipolar electrodes. In order to test if the method used for EMG signal onset determination would affect inter- and intra-session reliability of EFPs indexes, firstly, the Hodges and Bui method for EMG signal onset determination was used, and inter- and intra-session reliability was calculated for 27 EFPs indexes. The same



procedure was repeated with the four most reliable indexes, setting onset of EMG signal: 1) at 3% MVIC, 2) at 3% MVC - 5ms, and 3) at 3% MVIC - 70 ms (Aagaard et al., 2002). Three components of reliability were calculated: systematic bias, within-individual variation, and retest correlation (Hopkins, 2000). Results Intra-session reliability - The within-individual variation (expressed as CV), did not differ dramatically between different onset methods for MVIC normalized root mean square (R), average EMG value (A) and time integral (I) calculated in the time interval of 200ms. The within-individual variation of the rate of EMG rise (RER), calculated in the time interval of 75ms resulted significantly lower when the onset was set on 3%MVC - 70ms (27.59 %, CI: 23.45 - 33.54 %), than when it was set on 3% MVC (117.33 %, 99.70 - 142.59 %). ICC values followed the same trend. Inter-session reliability - Again, only the within-individual variation of the RER0-75 index resulted significantly lower when the onset was set on 3%MVC - 70ms (39.71 %, CI: 28.47 - 65.55 %), than when it was set on 3% MVC (151.38 %, 108.55 - 249.89 %), indicating greater inter-session reliability when the first method is used. Discussion Contrary to previous findings (Hodges & Bui, 1996), the method of EMG onset determination did not influenced the reliability of all the indexes tested. On the other hand, it influenced noticeably the reliability of the RER0-75 index. References Aagaard, P. et al., (2002). *J Appl Physiol*, 93(4):1318-26. Hopkins WG (2000). *Sports Med*, 30(1):1-15. Hodges PW, Bui BH (1996). *Electroencephalogr Clin Neurophysiol*, 101(6):511-9.

## EFFECT OF TRAINING CESSATION ON MUSCULAR PERFORMANCE: A META-ANALYSIS

Bosquet, L., Berryman, N., Dupuy, O., Mekary, S., Arvisais, D., Mujika, I.

*Université de Poitiers*

Laurent BOSQUET 1,2, Nicolas BERRYMAN 1,2, Olivier DUPUY 1,2, Said MEKARY 2, Denis ARVISAIS 2, Inigo MUJIKKA 3 1. Laboratoire MOVE (EA 3813) – Université de Poitiers – France 2. Département de kinésiologie – Université de Montréal – Canada 3. USP Araba Sport Clinic – Vitoria – Spain Purpose: to perform a meta-analysis of the effect of training cessation on maximal force, maximal power and muscular endurance. Methods: Studies were eligible for inclusion if: 1) they implemented a training intervention followed by a training cessation period and give relevant details about the procedures, 2) the outcome included valid tests and measures of the upper or lower limb muscular performance in healthy humans, and 3) the paper included the number of participants and all necessary data to calculate effect sizes. One hundred and five of 265 studies were included in the analysis. Standardized mean difference in muscular performance was calculated and weighted by the inverse of variance to calculate an overall effect and its 95% confidence interval. Subgroup analyses of moderators variables including population and training cessation characteristics was performed in the presence of statistical heterogeneity (as measured by the I<sup>2</sup>). Results: The overall standardized mean difference indicated a detrimental effect of training cessation on all components of muscular performance, since we found a moderate decrease in muscular endurance (SMD [95% CI] = -0.64 [-0.82 to -0.45], p<0.01, I<sup>2</sup>=13.0%) and a small decrease in maximal force (SMD [95% CI] = -0.42 [-0.46 to -0.38], p<0.01, I<sup>2</sup>=78.8%) and maximal power (SMD [95% CI] = -0.23 [-0.32 to -0.14], p<0.01, I<sup>2</sup>=67.8%). The effect of training cessation was found to be larger in older people (≥ 65 years old) for maximal force and muscular endurance, but not for maximal power. The effect of training cessation was also larger in inactive people for maximal force when compared with recreational or competitive athletes, but not for maximal power or muscular endurance. We did not found any difference between males and females, whatever the type of muscular performance. We performed a metaregression analysis that did not revealed any relationship between the exact duration of training and the magnitude of the effect of training cessation on muscular performance, since the slope was not different from 0. In contrast, the slope of the relationship between the magnitude of the effect of training cessation and the exact duration of training cessation was significantly different from 0, whatever the type of muscular performance, thus suggesting a close association between both variables. Conclusion: training cessation decreases maximal force, maximal power and muscular endurance. Subgroup analysis of moderator variables suggest an effect of age, training status and duration of training cessation. This meta-analysis provides a framework that can be useful for athletes and coaches to optimize the planification of training load as well as the choice of appropriate training contents during the taper period.

14:45 - 15:45

## Poster presentations

### PP-PM45 Health & Fitness: Physical Activity 1

#### FITOC : COMPARISON OF DAILY PHYSICAL ACTIVITY IN NORMAL AND OVERWEIGHT CHILDREN

Kreuser, F., Roettger, K., Gollhofer, A., Korsten-Reck, U.

*Institute of Sport and Sport Science*

Introduction: The Freiburg Intervention Trial for Obese Children (FITOC) is an interdisciplinary program for obese children (age: 8-11 years). The program includes 3 sports lessons a week nutrition and behaviour training. One of the main problems of overweight children compared to normal weight children is the absence of regular daily physical activity and the increase of screen time hours in combination with sedentary behavior (Metcalfe et al., 2010). To investigate if the intervention program enhances regular physical activity we compared FITOC participants to normal weight children. Methods: Daily physical activity of overweight (n=25) and normal weight children (n=21) was measured by direct accelerometry during three weekdays and two weekend days. Data was divided into "active" and "passive" time and 8 different activity levels. Anthropometrical data (weight, height, BMI, BMI-SDS) and leisure time/screen time entertainment questionnaire were obtained. Results: Median daily activity of weekdays shows no differences between normal and FITOC children (p=0.81). For passive times no significant differences were found (p=0.33). For weekend accelerometry revealed a tendency of more activity in normal-weight versus overweight children (p=0.07). Overweight children spend significant more time per day in screen time entertainment (PC and video games) than normal weight children (p=0.003) on weekdays and weekend. Conclusion: Results do not show differences in regular daily physical activity time between normal weight and overweight children who participate in FITOC. Only during the weekend normal weight children spend more time active than FITOC children. Regarding the sedentary behavior, overweight is related to higher screen time hours (Peart et al., 2011). Due to an intervention including 3 sports lessons a week obese children enhances their daily physical activity and can approximate to the daily activity of normal weight children on weekdays. To establish "healthier" leisure time habits (more PA, less screen-time) special strategies for obese children are required. References: 1. Metcalfe BS, Hosking J, Jeffery AN, Voss LD, Henley W, Wilkin TJ. Fatness leads to inactivity, but inactivity does not lead to fatness: a longitudinal study in children (EarlyBird 45). *Arch. Dis. Child*.

2010 . 2. Peart T, Velasco Mondragon HE, Rohm-Young D, Bronner Y, Hossain MB. Weight Status in US Youth: The Role of Activity, Diet, and Sedentary Behaviors. *Am J Health Behav.* 2011 Nov;35(6):756–64.

### CHANGES IN HEART RATE, RATE OF PERCEIVED EXERTION, NUMBER OF STEPS AND WALK DISTANCE DURING WALKING WITH/WITHOUT A DOG IN JAPANESE ADULTS

FURUMOTO, K.1,3, HAYASHI, S.1, TAKAGI, Y.1, SAITO, T.1, SAITO, K.1, ONODERA, S.2

*1 Graduate School, Kawasaki University of Medical Welfare, 2 Kawasaki University of Medical Welfare, 3 Kurashiki University of Science and The Arts*

Introduction Dog owner has health benefits as a result of increased physical activity through dog walking (Thorpe RJ et al., 2006; Hayley C. et al., 2008; Oka et al., 2009). Dog is the most popular pet also in Japan. Few studies have examined the association between the amount of physical activity and dog walking in Japan. The objective of this study was to investigate changes in heart rate, rate of perceived exertion, number of steps and walk distance during walking with/without a dog in Japanese adults. Methods Japanese healthy adult and their dogs volunteered to participate in this study. After resting on sitting down for 5 minutes (R1), the subjects walked with/without their dogs for 20 minutes (WK). After walking, they rested on sitting down for 10 minutes (R2). R-R interval was measured between R1 and R2 using the sport heart rate monitor (Polar). Heart rate (HR) was calculated using the HR variability real-time analyzing system MemCalc/Tarawa (Suwa Trust Co.) Rate of perceived exertion (RPE) was asked at the end of WK and R2 using the Borg scale. Number of steps and walk distance were recorded with the small triaxial activity-meter (Kenz) during WK. Results In both condition (walking with/without dog), no significant differences were found in the amount of change of HR between R1 and R2, RPE at WK and R2, number of steps and walk distance during WK. Discussion Only 30% of Japanese adults participate in the recommended level of physical activity. Various variety interventions need for increasing the physical activity level of population. The walking speed with a dog was controlled by a dog owner. Because, pulling power of a small or medium dog during dog walking didn't influence the walking speed of dog owner. And some dogs were trained in the loose leash walking. This study indicates that a dog walks according to their owner's walking speed. And the approach for physical activity promotion with dog would be useful for increasing the owner's physical activity level. References Thorpe RJ et al.(2006) *J Am Geriatr Soc*, 54(9), 1419-1424 Hayley C. et al.(2008) *Am J Public Health*, 98(1), 66-69 Oka K, Shibata A (2009) *J Phys Act Health*, 6, 412-418

### PHYSICAL ACTIVITY FOR HYPERTENSIVE PERSONS

Oviedo, G.R., Bellomío, C., Guerra Balic, M.E.

*Universitat Ramon Llull*

PHYSICAL ACTIVITY FOR HYPERTENSIVE PERSONS Oviedo, G. R.1; Bellomío, C.2; Guerra Balic, M. E.1 1: FPCEE Blanquerna. URL (Barcelona, Spain), 2: FM. UNT (Tucumán, Argentina) Introduction Arterial Hypertension (AH), one of the most prevalent diseases, is increasingly associated with all-cause of cardiovascular mortality. Aerobic exercise programs prevent the development of hypertension and decrease blood pressure (BP) in adults with normal BP and those with hypertension (Pascatello et al., 2004). Studies have shown that BP, regardless of their values, was reduced in those who participated in regular physical activity (PA) programs, with mean decreases equal to 7.4/5.8 mm Hg in hypertensive and 2.6/1.8 mm Hg in normotensive. (Kelley, Kelley & Tran, 2001) Methods The objective was to study the effectiveness of a PA program on the BP and fitness levels changes on pre and hypertensive adults. Participants were 16 (9 men, 7 women) 52.8±9.7 years old with pre-HT and HT patients following the JNC 7 Report classifications. The PA program was realized during 16 weeks, 1 hour 3 times a week, consisting of aerobic activities complemented by strength training. The evaluation was made before and after PA activity program. We calculated descriptives of each variable and a test-retest using SPSS v.19. In each case, a confidence interval of 95% was used. Results Basal systolic blood pressure (SBP) was reduced 13,43±6.76 mm Hg (p=0,0001); SBPpeak increased 1,56±7,46 mm Hg (p=0,415); basal diastolic blood pressure (DBP) was reduced 10,31±7,40 mm Hg (p=0,00005); DBPpeak increased 5,56±11,03 mm Hg (p=0,062); basal heart rate (HR) was reduced 12,18±6,93 bpm (p=0,000004); HRmax increased 7,18±8,03bpm (p=0,00275); VO2peak increased 9,06±4,91 ml/Kg/min. (p=0,00055); fat reduction was 2,79±0,72 % (p=0,000000001); BMI decreased 2,43±0,88 points (p=0,000000145); triglycerides were reduced 17,23±17,86 mg/dL (p=0,00456); cholesterol was reduced 15,69±13,45 mg/dL (p=0,00122); HDL-c increased 8,83±6,09 mg/dL (p=0,00021); LDL-c decreased 11,84±12,60 mg/dL (p=0,00539); weight decreased 6,94±2,86 Kg (p=0,00000007). Discussion The impact of physical activity was positive, reducing arterial BP values, increasing the fitness level values and diminishing risk factors of cardiovascular diseases. It will be necessary to control diet, hydration and lifestyle, increase the number of participants and increase PA monitoring among general population and among health professionals. References Pascatello, L. S., Franklin, B. A., Fagard, R., Farquhar, W. B., Kelley, G. A., & Ray, C. (2004). Exercise and Hypertension. *American College of Sports Medicine*, 533-553. Kelley, G. A., Kelley, K. A., & Tran, Z. V. (2001). Aerobic exercise and resting blood pressure: a meta-analytic review of randomized, controlled trials. *Preventive Cardiology*, 4 (2), 73-80.

### EFFECTS OF A COMBINED PHYSICAL ACTIVITY- AND BEHAVIOR INTERVENTION ON OVERWEIGHT CHILDREN

Wagner, P., Müller, K., Grützmacher, N., Wulff, H.

*University of Leipzig*

Introduction Against the background of the global problem obesity and regarding the fact that, in Germany, 15 % of the children suffer from overweight and 6% are obese (Kurth & Schaffrath Rosario, 2007), effective interventions preventing overweight are necessary. In this context, physical activity has to be considered as a resource enhancing health and wellbeing. However, there is a lack of studies concerning effects of long-term interventions on physical and psychosocial aspects of overweight children (Summerbell et al., 2005). Therefore, the purpose of the present study was to examine effects of a combined physical activity- and behavior intervention in the setting of a sports club on overweight children and their level of physical activity, level of quality of life, physical and psychosocial resources as well as the reduction of risk factors (Wagner, 2010). Methods At the beginning, in the middle, and at the end of the structured 30-week intervention, including a weekly physical activity class of 90 minutes and 3 parents workshops, data giving evidence about anthropometric (BMI-SDS), physical aspects (KATS-K), psychosocial aspects (self-concept, FSK1), and quality of life (KINDL) as well as data concerning the level of physical activity and inactivity (HBSC-index) of the 8 to 12 years old children (IG: n= 17; CG: n= 20) have been collected. Results The results indicate significant main effects on physical (increased values of speed and strength) as well as the behavior aspects (HBSC-index), psychosocial aspects and quality of life (increased values of health related quality of life; self-concept and self-efficiency) as well as on several risk factors of overweight (reduction of BMI-SDS). Discussion With the help of the program, participants realized that there was a

need to change their way of life and that they were able to put these changes into practice. The positive effects on the children's quality of life and their level of physical activity serve as a good basis for continuous changes in their behavior. Additionally, the setting of a sports club simplifies the process of continuing different types of physical activity. References Kurth, B.-M. & Schaffrath Rosario, A. (2007). Die Verbreitung von Übergewicht und Adipositas bei Kindern und Jugendlichen in Deutschland. Ergebnisse des bundesweiten Kinder- und Jugendgesundheits-surveys (KIGGS). Bundesgesundheitsblatt, 50 (5/6), 736-743. Summerbell, C., Waters, E., Edmunds, I., Kelly, S., Brown, T. & Campbell, K. (2005). Interventions for preventing obesity in children (Cochrane Review). Cochrane Database Systematic Review 3, CD001871. Wagner, P. (2010). SafariKids auf Entdeckungstour – ein ressourcenorientiertes Bewegungsprogramm zur Prävention von Übergewicht bei Kindern. Bewegungstherapie und Gesundheitssport, 26, 52-57.

### COMPARISON OF OBJECTIVELY MEASURED PHYSICAL ACTIVITY LEVELS OF YOUTH SOCCER PLAYERS BETWEEN FRANCE, ENGLAND & GREECE

Krommidas, C.1, Van Hoye, A.2, Fenton, S.A.M.3, Galanis, E.1, Bosselut, G.2, Duda, J.L.3, Keramidis, P.1, Nicaise, V.2, Barrett, T.G.3, Zourbanos, N.1, Heuze, J.P.2, Papaioannou, A.1

1: University of Thessaly, (Trikala, Greece), 2: Université Joseph Fourier (Grenoble, France), 3: University of Birmingham (Birmingham, UK)

Introduction Soccer is one of the most popular sports across the world with approximately 265 million players. Soccer plays a significant role in the prevention of cardiovascular diseases and different causes of mortality (e.g., Krstrup, Aagaard, Nybo, Petersen, Mohr, & Bangsbo, 2010). Therefore, the purpose of this study was to examine possible differences in objectively measured physical activity (PA) levels, BMI and aerobic capacity between French, Greek and English youth soccer players and to examine whether participants meet the recommended guidelines of 60 minutes of moderate to vigorous PA (MVPA) per day needed to accrue health benefits. Methods 356 players (M age: 11.51 ± 1.45 y. old) from Greece (N=133), France (N= 98), and England (N=125) wore the GT3X accelerometer for 7 days. A 15 second epoch, Freedson equation and a minimum of three valid days (8 hours of wear) were chosen to accurately catch PA intensities. Body weight and height were objectively measured. The 20m multistage shuttle run test was used to measure aerobic capacity (Leger & Lambert, 1982). Results The mean of MVPA per day in the whole sample was 123.29 minutes (SD=46.31). One-way ANOVA revealed no significant differences among the three countries in minutes per day spent engaged in sedentary behaviour (<1.5 METs), moderate PA (3 to 4 METs), moderate PA (4 to 6 METs), MVPA (>3 METs), BMI index and 20m shuttle run fitness test (ps>.05). However, there were significant differences (p<.05) found for light (1.5-3 METs) and vigorous PA (>6 METs). Specifically, UK players displayed lower scores in light PA than in the other two countries, while Greek players had significantly higher vigorous PA than French. Discussion Results indicated that there were no significant differences in sedentary behavior and MVPA levels of youth soccer players among the three countries. There were however, differences between countries with respect to PA intensities. In addition, players across the 3 countries met the guidelines of "60 minutes of MVPA per day" and have normal BMI for their age. This underlines the potential role organised sport (particularly soccer) could play in increasing PA practice and ensuring children meet the recommended PA guidelines. References Krstrup, P., Aagaard, P., Nybo, L., Petersen, J., Mohr, M., & Bangsbo, J. (2010). Scand J of Med & Sci in Sports, 20(Suppl. 1), 1–13. Leger, L. A., & Lambert, J. (1982). European J of Applied Physiology, 49, 1-12.

### "THE EFFECT OF STAIR DESCENDING VERSUS STAIR ASCENDING EXERCISE ON HUMAN HEALTH: THE SMARTESCALATOR PROJECT"

Panayiotou, G.1, Theodorou, A.A.1, Paschalis, V.3, Nikolaidis, M.G.2, Giakas, G.3, Koutedakis, Y.3

1: European University Cyprus (Nicosia, Cyprus), 2: Center For Research And Technology, Thessaly (Volos, Greece), 3: University of Thessaly (Volos, Greece).

Introduction Several studies provide evidence that eccentric exercise, except for its muscle-damaging nature, can induce health-promoting effects that may improve quality of life (Theodorou et al. 2011; Paschalis et al. 2011; Nikolaidis et al. 2008). Based on the evidence derived from these studies, participation in activities including eccentric muscle work such as stair descending may be able to confer multiple beneficial effects on human health and it seems to be a promising life style factor for the elderly and people with chronic diseases like heart failures. Methods 20 males were allocated randomly into two equal-sized groups, the stairs descending group and the stairs ascending group. Volunteers performed two exercise bouts (descending and ascending stair) on an automatic escalator that has been designed and developed from our group. Exercise bouts were separated by 6 weeks. In each of the two sessions, volunteers had to accomplish 5 sets of 5 min of stair descending or ascending exercise. Speed was set at 60 stairs/min for both groups (total 1500 steps). Muscle performance indices (isometric torque, range of motion, delayed onset muscle soreness and creatine kinase) and blood lipid profile (plasma triacylglycerols, total cholesterol, high-density lipoprotein cholesterol and low-density lipoprotein cholesterol) were assessed before, immediately after and at 2 and 4 d post exercise after both exercise sessions. Results All muscle indices used in the present study were elevated at day 2 only after the first exercise session in the descending stairs group indicating severe muscle damage. No indices of muscle damage appeared after the second bout of exercise. After the first exercise session, triacylglycerols decreased only in the descending stairs group at day 2. For the rest blood lipid profile indices, there was a trend for favourable changes only after the first exercise session for the stair descending group. Discussion The present results revealed that stairs descending training compared to stairs ascending exercise induced greater muscle damage. The repeated bout of stair descending training induced significantly less changes in indices of muscle damage than the first bout. Except triacylglycerols in stair descending group, no significant changes have been observed in lipid profile after both protocols. This fact might implies that a more prolonged exercise protocol is needed before favorable changes in blood profile appear as reported after intense eccentric exercise (Paschalis et al. 2011). References Paschalis V et al. Med Sci Sports Exerc. 2011; 43(1):64-73. Theodorou AA et al. Am J Clin Nutr. 2011; 93(6):1373-83. Nikolaidis MG et al. Med Sci Sports Exerc. 2008; 40(8):1483-9.

### TEST-RETEST RELIABILITY STUDY OF A SELF-ADMINISTERED QUESTIONNAIRE ABOUT PHYSICAL ACTIVITY PATTERNS OF PORTUGUESE ADOLESCENTS

Botelho, G., Ferrao, A., Aguiar, M.

Coimbra College of Agriculture, Polytechnic Institute of Coimbra

TEST-RETEST RELIABILITY STUDY OF A SELF-ADMINISTERED QUESTIONNAIRE ABOUT PHYSICAL ACTIVITY PATTERNS OF PORTUGUESE ADOLESCENTS Goretii Botelho<sup>1,2</sup>, António Ferrão<sup>3</sup> and Marco Aguiar<sup>3</sup> 1: Department of Food Science and Technology, Coimbra College of Agriculture, Polytechnic Institute of Coimbra, (Coimbra, Portugal), 2: CERNAS Research Unit, Coimbra College of Agriculture, (Coimbra, Portu-

gal, 3: University of Trás-os-Montes and Alto Douro (Vila Real, Portugal). Introduction Questionnaires are tools to obtain reliable and useful information in nutritional and physical activity (PA) studies of adolescents around the world. The Quantification de l'Activité Physique en Altitude Chez le Enfants (QAPACE) developed by Barbosa et al. (2007) and the HBSC – Health Behavior in School-Aged Children survey (2001-02) are valid tools to assess PA in population studies. This study aimed to determine the test-retest reliability of a new questionnaire entitled "Questionnaire to Assess Physical Activity and Sedentarism, QAPAS" modified and improved from the QAPACE and the HBSC to evaluate PA patterns of Portuguese adolescents. Methods The developed questionnaire comprised 20 questions and was self-administered. Reliability was assessed by test-retesting 22 males and 19 females, randomly selected (11.10±0.70 years), after an eight-day interval. These 41 adolescents represent 2.9% of the population (1403 students from 7 public schools) under study. Pearson correlation and Cohen's kappa test were performed using SPSS software v. 20.0. Results Pearson's correlation between answers of the two periods were statistically significant for all the 58 items and the r-values were above 0.600 ( $p < 0.01$  and  $p < 0.001$ ). A great fraction of these correlations ranged from 0.900 to 1.000, thus showing that questions were appropriate. Moreover, Cohen's kappa test also demonstrated an high concordance level between the answers of the adolescents, with 51 items (from 58 items) above 0.600. Discussion The questionnaire developed in the study complies with the requirements of reproducibility. In fact, the internal consistency of answers evaluated during the test-retest study proved to be good. Moreover, inter-answer reliability determined through Cohen's kappa test was above 0.700 in 65.5% of questionnaire items. Thus, QAPAS can be applied to the whole adolescents' population. References Barbosa N, Sanchez C, Vera J, Perez W, Thalabard J, Rieu M (2007). Journal of Sports Science and Medicine, 6, 505-518. HBSC, US Department of Health and Human Services. Health Behavior in School-Aged Children, 2001-2002 doi:10.3886/ICPSR04372.v2. Funding: CERNAS Research Unit is supported by National Funds through FCT - Foundation for Science and Technology under the project "PEst-OE/AGR/UI0681/2011".

### MATCH RUNNING PERFORMANCE IN JAPANESE OLDER SOCCER PLAYER

Ishizaki, S.I, Yasumatsu, M.2

*Shibaura Institute of Technology*

Introduction Time-motion analysis of soccer games, many researchers have been analyzing quantity of the distance covered in soccer players (Bangsbo et al. 1991). However, the previous data used for their analysis were collected only from players in top-level soccer club or national teams. Actually, there was no studies used the data from older soccer players. Therefore, the purpose of this study was to examine running performance in Japanese older soccer players. Methods This study was carried out with eight games for Over-70 years old soccer league. Twenty-one amateur Japanese soccer players (age: 71.9±/-1.5 years, height: 166.7±/-4.1 cm, body mass: 64.9±/-7.5 kg, BMI: 23.3±/-2.5) participated in this study, including defenders (n=7), midfielders (n=7), and forwards (n=7). All players were filmed during the entire match (40 min.). The digital video cameras (HDR-XR550V, Sony, Japan) were positioned at the side of the pitch, at the level of midfield line, at a height of about 30m and at a distance of about 30m from a touchline. The digital movies were later replayed on a monitor. Then, total distance and running speed were analyzed using Track Performance software (Sports Code, Australia). This software system was applied most effectively with the use of a drawing tablet (PTK-1240, Wacom, Japan) connected to laptop computer. The locomotion categories were used for standing (0~2km/h), walking (2~7km/h), jogging (7~9km/h), low-speed (LS) running (9~13km/h), moderate-speed (MS) running (13~16km/h), high-speed (HS) running (16~22km/h), sprinting (>22km/h). These locomotion categories were chosen in accordance with Randers et al. (2010). Results & Discussion The mean total distance covered in 40 min. was 3502.5 ±/504 m and ranged from 2468m to 4566m. The average distance covered (absolute & relative data) consisted of standing (118.0m, 18.0%), walking (1653.0m, 57.3%), jogging (537.0m, 10.1%), LS running (729.5m, 10.0%), MS running (332.0m, 3.5%), HS running (127.5m, 1.1%), and sprinting (0m, 0%). There was significant difference between the first (1848.1 ±/276.0 m) and the second (1654.3 ±/240.5 m) half of the total distance covered (absolute data) ( $P < 0.05$ ). In addition, relative data in the second half regarding standing was significantly increased compared to the first half ( $P < 0.05$ ). On the other hand, jogging, LS running, MS running were significantly decreased compared to the first half ( $P < 0.05$ ). Therefore, in Japanese older soccer players, it was suggested that fatigue accumulated during the games affected faster running speed especially in the second half. References 1. Bangsbo, J., et al., Activity profile of competition soccer. Can. J. Sport Sci., 16: 110-116, 1991 2. Randers, M. B., et al., Application of four different football match analysis systems: a comparative study. J. Sports Sci. 28: 171-182, 2010

### A "START TO SWIM" PROGRAM FOR HEALTH-ENHANCEMENT PURPOSE: A DELPHI STUDY

Mouton, A., Warnotte, J., Cloes, M.

*Ulg (Liège, Belgium)*

Introduction Popularity of "start to run" or "start to cycle" programs increases with the evidence that regular physical activity contributes to the prevention and management of a wide range of chronic diseases (Rippe and Angelopoulos, 2010). Nevertheless, start to swim programs could lead to even more health-enhancing outcomes (Chase et al., 2008). The aim of this study was to obtain a "start to swim" model program by means of a two-round Delphi study. Methods In the first round, 10 key-experts in sport physiology (n=4) or in swimming coaching (n=6) outlined possible relevant components of the "start to swim" program in a semi-structured interview. Initial exclusion criterion, program set-up, program key principles, program progression and final goals were interrogated. Then, a facilitator provided an anonymous summary of the experts' suggestions from the previous round as well as the arguments they provided for their choice. In the second round, experts were asked to comment on this summary before providing a final form to this program. Results After two rounds, the experts agreed on a collective and coached intervention with 2 sessions per week and a progressive replacing of the coach by a group leader during a 4 months program. People without medical contraindication and able to swim 25 meters could take part to this program. The final goal-setting is personal and based on each individual progression and motivation. Sessions are endurance-oriented and divided between traditional swimming sessions and diversified aquatic activities. In order to support this active lifestyle in a long-term basis, referring to swimming clubs or other aquatic activities associations are performed by the coach at the end of the program. Discussion The start to swim program take into consideration behavioural and social aspects necessary for a successful adoption and maintenance of physical activity (Khan et al., 2002). Consistent with previous findings, a group-based program (Cox et al., 2008) with individually adapted-goals (Marcus and Forsyth, 2003) could lead to a long-term adherence to exercise. Future studies should include systematic evaluation of the "start to swim" program before translation into the community. References Chase NL, Xuemei S., Blair SN (2008). Int J Aquat Res Educ, 2(3), 213-223. Cox KL, Burke V, Beilin LJ, Derbyshire J, Grove R, Blanksby BA, Puddey IB (2008). Prev Med, 46(6), 511-7. Kahn EB, Ramsey LT, Brownson, RC, Heath GW, Howze EH, Powell, KE, Stone, EJ, Rajab, MW, Corso P (2002). Am J Prev Med, 22(4), 73-107. Marcus BH, Forsyth LH (2003). Motivating people to be physically active. Champaign, IL: Human Kinetics. Rippe JM, Angelopoulos TJ (2010). Am J Lifestyle Med, 4, 205-208.

14:45 - 15:45

## Poster presentations

### PP-PM46 Health & Fitness: Exercise

#### A TRAINING PROTOCOL INTEGRATED OF PILATES- AND YOGA-BASED EXERCISES FOR WOMEN WITH BACK PAIN

Bellafiore, M., Battaglia, G., Caramazza, G., Fantauzzo, V., Bianco, A., Palma, A.

*University of Palermo*

A TRAINING PROTOCOL INTEGRATED OF PILATES- AND YOGA-BASED EXERCISES FOR WOMEN WITH BACK PAIN Bellafiore, M.1,3, Battaglia, G.1,3, Caramazza, G.2,3, Fantauzzo, V.1, Bianco, A.1,3, Palma, A.1, 3. 1: DISMOT (Palermo, Italy), 2: PhD in "Human Diet and Nutrition" (Palermo, Italy), 3: Regional Sport School of Sicily CONI (Olympic National Italian Committee, Italy). Introduction Pilates and Yoga are body-mind activities recently become very popular in Italian fitness gyms. Their outcomes have been studied separately and it has been reported that both reduce low back pain affecting either the physiological and mental aspects (Posadzki et al., 2011; Tilbrook et al., 2011). However, few evidences are present in the scientific literature. The aims of our study were to test the influence of a training protocol including exercises of Pilates Matwork and Yoga Poses on several fitness parameters as muscle strength and spine flexibility in women with back pain; and whether improvements in these factors were associated with a decrease in symptom frequency. Methods Twenty one women (age:  $37.8 \pm 8.2$  years; weight:  $60.1 \pm 7.4$  kg; height:  $163 \pm 6$  cm; BMI:  $22.4 \pm 3.2$ ) were recruited to participate in a 8-month training protocol for 1 hour 3 times per week under the guide of the same instructor for all length of training period. This protocol consisted of an initial step of 10 min aimed at activating the muscles involved in the central step of training (35 min), which included Pilates mat exercises (Marmaid, Hundred, Swimming, Spine twist, ecc.), followed by a final step of 15 min of Yoga Poses. The exercise difficulty, the number of sets and repetitions gradually increased during the training period. Before, during (4 months) and after 8 months of exercise training, fitness tests were performed (sit and reach test, trunk lift, sit up, push up, squat). We used the visual rating scale (VRS) to select participants with a frequency of low back pain ranging from 'occasionally' to 'always'. One-way ANOVA test with Bonferroni's correction and Chi-squared test were used to analyze significant differences ( $p < 0.05$ ). Results After 4 and 8 months of the training period, we found a significant improvement in the low back and hamstring flexibility; abdomen, upper- and lower-body strength ( $p < 0.001$ ). These changes were associated with a bigger number of participants who showed a significant reduction of low back pain frequency ( $p < 0.05$ ). Discussion The training protocol integrated of Pilates- and Yoga-based exercises appears to be practicable, safe and repeatable for long time by women with back pain. Muscle isometric contractions and stretching induced by Pilates and Yoga methods can reduce the onset of low back pain in women. References Posadzki P, Lizis P, Hagner-Derengowska M. (2011). Complement Ther Clin Pract, 17, 85-9. Tilbrook HE, Cox H, Hewitt CE, Kang'ombe AR, Chuang LH, Jayakody S, Aplin JD, Semlyen A, Trehwela A, Watt I, Torgerson DJ. (2011). Ann Intern Med, 155, 569-78.

#### CARDIORESPIRATORY RESPONSE TO ZUMBA DANCING

Mamen, A.1,2, Sødem, A.3, Sødem, P.3

*1 University College of Health Sciences Campus Kristiania, Oslo, 2 Sogn og Fjordane University College, Faculty of teacher education and sport, Sogndal, 3 Nesbru trim & helse, Nesbru, Norway*

Introduction Zumba(R) dancing has become a popular form of fitness training worldwide. The music is inspired by Latin rhythms and incorporates a wide variety of musical genres, old and new. The activity differs from traditional Aerobics exercise in more use of core muscles and a more advanced choreography. It has been argued that the higher level of difficulty may compromise training efficiency, at least for beginners. The aim of this presentation is to describe the cardiorespiratory response to Zumba(R) dancing by Zumba(R) instructors and ordinary participants with different levels of experience with Zumba(R) dancing. Methods Two instructors (one male and one female) and two participants (females), one well used to Zumba(R) dancing, performed the same session taking 60 min to complete. During their work out they wore a MetaMax II metabolic analyser (Cortex Biophysik, Leipzig, Germany) on their back for recording cardiorespiratory variables. Results are presented as mean values unless otherwise noted. Results The oxygen uptake rose to a peak value of  $39.7$  ml/kg/min, whereas the mean uptake was  $27.1$  ml/kg/min. The highest values were found among those most experienced with the activity. Breathing frequency levelled off after about 15 min of exercise at  $\sim 40$  breaths/min. Respiratory Exchange Ratio likewise showed a similar pattern with a relatively stable value of  $\sim 0.95$  the last 30 min of the session. Breathing efficiency, expressed as  $E_{QO_2}$ , showed individual differences, the most experienced subject showed lower values, and better breathing economy, than the inexperienced participant. By and large, the instructors showed higher exertion than the participants, and the experienced participant again more than the less experienced. The energy expenditure was calculated to be  $\sim 400$  kcal. Discussion The peak  $VO_2$  was 80% of maximal capacity, the mean value 60% of max. In group exercises like Aerobics and Spinning(R), peak values of  $>90\%$  of max and average values of 70% have been found (Mamen, 2001). Also the breathing frequency and  $E_{QO_2}$  indicate that exertion was substantial. Zumba(R) dancing should therefore be suitable for cardiorespiratory fitness training. The difference seen between the experienced and not so experienced subjects indicates that beginners may need some time to practice before the full potential of the exercise is reached. The particular movement pattern in Zumba(R) may make it especially suitable for people who enjoy dancing and who are not afraid of moving in new and unfamiliar ways. References Mamen, A. (2001). Energy expenditure in Spinning(R) training. 34. Int. Congress of Physiological Sciences; Christchurch, New Zealand, 2001-08-26 - 2001-08-31.

#### BIOPHYSICAL CHANGES IN AQUA-SKY EXERCISE WITH DIFFERENT MUSICAL CADENCES: INSTRUCTORS EVALUATION

Morouco, P., Neves, L., Tavares, J., Amaro, N.

*POLYTECHNIC INSTITUTE OF LEIRIA*

Introduction The Aquatic Exercise Association (AEA, 2011) recommends music with a rhythm of 125-150 beats per minute (b.min-1), for water aerobic classes. Other authors suggest that for healthy and physically active subjects, the instructors should opt for rhythmic cadences between 136 and 158 b.min-1 (Barbosa et al., 2010). Several studies aimed to assess the physiological responses during the execution of basic water aerobics exercises. However few are those that focused an instructor's perspective. Therefore, the aim of the

present study was to assess biophysical changes in Aqua-Sky at two different cadences. Methods Six aquatic fitness male instructors (29.3±2.7years-of-age; bmi 25.0±2.5kg.m<sup>-2</sup>; more than 3 years of experience) took part in the study. Tests were performed on land, where the practical sessions of water aerobics take place. Each subject after a warm-up, completed two trials (30min rest) of Aqua-Ski with different rhythmic cadencies (130b.min<sup>-1</sup>,140b.min<sup>-1</sup>). Each trial had 6min duration, permitting the stabilization of the physiological parameters studied. It was asked to the subjects to perform the exercise as in real class situation, according to the pattern recommended by the technical literature (AEA, 2011), and also mentioned in scientific work (Barbosa et al., 2010). Heart rate was measured every 5-s (Polar). Blood lactate concentrations from the lobule of the left ear were measured with a portable device (Lactate-Pro) at two different moments: pre-test and post-test. For the kinematical analysis a digital camera (Casio Exilim F1, 60fps) was placed on a sagittal plane 3 meters from the area of execution. Calibration volume (3m<sup>3</sup>) was used to allow Utilius Easy Inspect (CCCsoftware) analysis. The distance between foot-supports was estimated using the digitalization of the anatomic reference point of the right medial malleolus when the foot was completely in contact with the floor for two moments (i) most posterior and (ii) most anterior. Results No significant differences in maximum and medial HR were obtained between repetitions (p>0.05). The [La<sup>-</sup>] showed a small increase with the rhythmic cadence of 140b.min<sup>-1</sup>. Subjects maintained the amplitude of support, and consequently an increase in segmental velocity. Discussion Similar results were verified in the analysis of other exercises (e.g. jumping-jacks and side-kicks). The increase in rhythmic cadence from 130b.min<sup>-1</sup> to 140b.min<sup>-1</sup> does not cause an acute physiological response in water aerobics instructors when practiced in the location where they administer their sessions. Additionally, increase in movement rate keeping the same displacement, is the common procedure to higher cadences. References Aquatic Exercise Association (2011). Global Resource in Aquatic Fitness, Florida. Barbosa et al. (2010). J Strength Cond Res, 24(1), 244-250.

### EFFECTS OF CIRCUIT RESISTANCE TRAINING ON HEART MORPHOLOGY AND FUNCTION, CARDIOVASCULAR RISK FACTORS AND SERUM INFLAMMATORY CYTOKINES LEVELS IN SEDENTARY WOMEN.

Ferreira, F.C., Nunes, J.E.D., Verzola, R.M.M., Baldissera, V., Perez, S.E.A.

*Federal University of São Carlos*

**Introduction** The risk factors for cardiovascular disease often cluster together, most notably increase in body fat mass (overweight/obesity) mainly in central adiposity, dyslipidemia, hypertension, and insulin resistance, showing increase of circulating cytokines and low degree of inflammation. Exercise can elicit cardiac benefits and benefits or damage on the immunologic system. This study aimed to analyze the effects of circuit resistance training (CRT) on body mass (BM), lean mass (LM), fat mass (FM), trunk fat mass (TFM), percentage of FM (%FM) and TFM (%TFM), left ventricular mass (VM), relationships VM/body surface (BS), VM/BM, VM/LM, final diastolic volume (FDV), final systolic volume (FSV), and systolic volume (SV) in rest, relationship double product [heart rate (HR).systolic blood pressure (BP)]/load of cycle-ergometer at the anaerobic threshold (DP/L), fasting glucose (FG), lipid profile and serum cytokine levels in sedentary women, 39.71 ± 3.8 years old (n=14). **Methods** The women played 3 sessions/wk, 2 rounds in 9 stations, one set of 8-12RM for 10 wks. In pre and post CRT, were analyzed the body composition by DXA, heart parameters by EchocardiDoppler; BP by sphygmomanometer, HR by frequency counter, FG and lipid profile by enzymatic colorimetric methods, serum cytokines levels by flow cytometry (IL-1β; IL-6; IL-8; IL-10, IL-12p70 and TNF, in 96h rest, and 5 min, 24h and 48h post 2nd and last session of training) and the nutritional standard by 24-h dietary recall in period. Used Friedman's with Tukey post hoc tests for cytokines and nutritional standard, and Student's t test or Wilcoxon's test for others variables (α=0.05). **Results** Values: mean±SD. The %FM reduced markedly (37.1±10.8-31.2±6.1) with 1.5Kg only in TFM (8.86±2.9-7.33±1.9). There were increases in the LM (35.94±4.9-39.13±4.9), LVM (139,57±11,9-145,9±17,6g), LVM/BS and LVM/BM, maintenance of LVM/FF, reducing DP/L (218.98±85.7-155.96±45.2) and tendency to increase of VSF, SV and FSV. Reduction in FG (92.0±8.5-74.0±3.5mg/dl), CT (193.4± 33.6-183.2±29.4) and HDL (54.71±10.3-47.79±8.8), without changes in others variables. **Discussion** The proposed CRT improved cardiovascular health of women, improving glucose uptake, reducing the CT, the total body fat and central (trunk) which is more linked with cardiovascular disease and low-grade inflammation with increased levels of circulating cytokines (Ren and Kelley, 2009), which was not observed in present work. Cardiac hypertrophy coupled with the upward trend of the VSF and VS, probably helped in better cardiovascular performance during the anaerobic threshold in ergometer, with a smaller increase in DP/L for the same load. **References** Ren J, Kelley RO (2009). Obesity, 17, 1114-1123.

### DIFFERENCES IN BONE STRENGTH IN THE RADIUS AND TIBIA IN ADOLESCENT CYCLISTS.

Gómez-Bruton, A., González-Agüero, A., Gómez-Cabello, A., Matute-Llorente, A., Morales, S., Guillén-Ballester, A., Olmedillas, H., Casajús, J.A., Vicente-Rodríguez, G.

*GENUD research group, Universidad de Zaragoza, Spain.*

**INTRODUCTION:** Many studies have been performed with dual energy X-ray absorptiometry (DXA) techniques demonstrating that cycling training is associated with decreased bone mineral density (BMD) and lower bone mass acquisition during growth periods (1). However, bone strength indexes and therefore, fracture risk have a high relationship with structural aspects of the bone such as cortical thickness and bone cross-sectional area, among others, which cannot be calculated with DXA parameters. Therefore the aim of this study was to evaluate bone strength at the radius and tibia, in adolescent cyclists compared with controls. **MATERIALS AND METHODS:** Peripheral quantitative computed tomography (pQCT) measurements were taken at the tibia and radius of 20 male adolescent cyclists and 17 sex and age-matched active peers. Stress strain index (SSI) and resistance to fracture load (FRC\_LD) were calculated in X and Y axis. Bone strength index (BSI) (2) and polar strength strain index (SSIPol), which is an estimate of bone strength to bending and torsion were also calculated. Student's t-tests were applied to evaluate differences between cyclists and control groups. **RESULTS:** Cyclist group showed lower BSI at radius (76±17 vs. 89±21 mg2/mm4) and tibia (309±44 vs. 377±74 mg2/mm4) than the control group. Also lower FRC\_LD (3467±560 vs. 4091±1056 N) and SSI (963±155 vs. 1136±293 N) at the tibia Y axis were found in the cyclist group compared with the control group (all p<0.05). **DISCUSSION:** Cyclists showed lower bone strength indexes than their active peers, mainly at the tibia. Therefore the relative risk of suffering osteoporotic fractures of this group of adolescents may be augmented later in life. In addition, we should not forget the increased risk of fall during cycling practice, which could increase the risk of bone fracture in these athletes also due to weaker bones. Future interventions are needed in order to increase the bone strength of this population and hence eliminate the negative effects that this sport may have on bone development. **REFERENCES** 1. Olmedillas H. et al. Plos one 2011. 2. Kontulainen S.A. et al. J Musculoskeletal Neuronal Interact 2008.

## EFFECTS OF RESISTANCE TRAINING ON BASAL METABOLIC RATE, BODY COMPOSITION, AND SLEEP PARAMETERS IN HEALTHY ELDERLY

Boscolo, R.A., Santana, M.G., Viana, V.A.R., Grassmann, V., Tufik, S., De Mello, M.T.

*Universidade Federal de São Paulo*

**Introduction** During the process of aging, neurochemical, morphological and functional changes occur such as the decline of some characteristics of sleep, of fat-free mass and of basal metabolic rate (BMR). These factors may possibly be related because the decrease in basal metabolic rate is due to the decrease in fat-free mass. Physical training can minimize such effects and/or bring positive results to sleep pattern, body composition and metabolism. The aim of this study was to evaluate the effects of resistance training on BMR, body composition and sleep parameters, and to verify their possible relationship in elderly men. **Methods** The sample consisted of 37 elderly men (65-75 years old) randomly assigned into two groups: control (CG) and resisted (RG). The protocol included 72 sessions of progressive resistance training (three times weekly), and evaluation of basal metabolism, body composition, sleep and food consumption. **Results** Muscle strength increased in all muscle groups in the RG. In the morphological variables, CG increased fat mass and decreased fat-free mass in the final evaluation, however RG remained with the same variables of body composition. The BMR and daily energy consumption remained unchanged in both groups during the evaluations. Sleep variables are statically altered, CG increased total sleep time, arousals, and score of Pittsburgh index, while stage 1 of NREM sleep was significantly reduced. There was association of causality between fat-free mass, stage 1, and BMR with the final model of regression ( $BMR = 539.81 + 21.99 \text{ fat-free mass, kg} - 26.01 \text{ stage 1, \%}$ ), explaining 34% change in BMR. **Discussion** Although not altering the relationships between BMR, sleep parameters and body composition, the results suggest that resistance training was effective, increased muscle strength, maintained fat-free mass and BMR and improved the quality of sleep in healthy elderly, reflecting a quality of life more active for a healthy longevity. Some studies suggest that the prevalence of sleep problems and daytime sleepiness is less in physically active individuals (Sherril et al., 1998) and resistance training also found, in addition to increased neural activity and muscle, improvement in other aspects such as the quality of sleep (Ferris et al., 2005), enabling the elderly and greater autonomy in their daily provision (Perrig -Chiello et al., 1998). **References** Ferris LT, Williams JS, Shen C, O'Keefe KA, Hale KB (2005). *Sports Sci Med* 4: 354-60. Perrig-Chiello P, Perrig WJ, Ehlers R, Staehelin HB, Krings F (1998). *Age Ageing* 27: 469-75. Sherrill DL, Kotchou K, Quan SF (1998). *Arch Intern Med* 158: 1894-8.

## COMPARABLE EFFECTS OF SLOW RESISTANCE TRAINING AND BRISK WALKING ON BODY COMPOSITION AND BONE STATUS IN SEDENTARY YOUNG WOMEN

KIMURA, Y., OHKI, K., NAKAGAWA, N., YAMAZAKI, S., SATO, T.

*Reseach Center for Fitness and Health Sciences*

**Introduction** Regardless of age or gender, children and adults who maintain an active lifestyle have significantly greater body composition and bone mass than sedentary counterparts. The aim of the present study is to evaluate the effects of resistance training (RT) and walking exercise (WK) on body composition, bone and mental health status in sedentary young women. **Methods** Thirty-five subjects (Mean age 20.8 yrs.) were divided into RT group (n=12), WK group (n=13) and control group (CN; n=10). RT group trained four exercises (squat, bent-leg sit-ups, push-up, back extension) using body weight as a load, with slow maneuver four times per week. WK group instructed to wear a pedometer, and walked briskly, more than 10,000 steps a day four times per week. We evaluated body composition, bone status (ultrasound parameters of the calcaneus and urinary deoxypyridinoline (DPD) levels), and mental health, at baseline and after 12 weeks of training session. **Results and Discussion** RT showed significant changes in fat mass (-5.9%), waist (-4.3%), hip (-2.6%), thigh (-2.8%) and upper arm (-2.5%) circumferences, and triceps (-2.9%), abdominal (-10.2%) and thigh (-9.5%) thickness. WK showed significant changes only in thigh (-2.3%) circumference, and abdominal (-5.7%) and thigh (-7.6%) subcutaneous fat thickness. RT showed significant changes in ultrasound parameters, such as speed of sound (+0.4%) and stiffness (+1.1%). WK showed small changes in these three items, but the changes were not significant. There was a significant decrease in DPD (-1.2%) only in RT. A significant improvement in RT was seen in regard to subjective health (+9.7%), everyday feelings (+12.2%), human relations (+10.8%) and subjective happiness (+8.9%). The subjective health (+9.2%) and subjective happiness (+8.0%) increased significantly in WK. CN shows no significant changes in any measurements. **In conclusion**, 12 weeks of RT (squat, bent-leg sit-ups, push-up, back extension, using body weight as a load) or WK (walked briskly, more than 10,000 steps/day) in sedentary young women has affected body composition, bone status and mental health. RT was more effective in increasing body composition variables and bone status markers, in addition to improving mental health profile. These findings suggest that RT can promote better adaptations than WK isolated during intervention period.

## EFFECT OF TWO DIFFERENT ABDOMINAL EXERCISES ON RESPIRATORY MUSCLES

Cavaggoni, L., Parisi, Y., Ongaro, L., Alberti, G.

*Università degli Studi di Milano, Italy*

**BACKGROUND AND PURPOSE** The abdominal muscles have an important role in control and movement of the lumbar spine and pelvis. The contraction of the lumbo-pelvic muscles is dependent on the type of movement of the trunk and arms [1,2]. Its stability is important to transfer force and to return to balance after destabilization. Only a few studies have investigated the effects on respiratory parameters and respiratory muscle fatigue during abdominal exercises [3]. The aim of this study was to analyse the effects of two types of abdominal exercises on abdominal muscle force, and on the main respiratory parameters. **METHODS** 16 male subjects were randomly divided into two treatment groups for 5 weeks: the Training Group (TG) performed 4 static abdominal exercises in an extended position of the trunk. Arms and legs were extended, with emphasis on a vocal sound emission with the muscular chains stretched. The Control Group (CG) performed traditional exercises like sit-up, crunch with trunk rotation and flexion, and lateral bridge. We measured the respiratory parameters like FVC, FEV1 and PEF with the spirometer Pony Fx (Cosmed, Roma, Italy), and the dynamic abdominal endurance with ACSM Curl-up (Cadence) test. **RESULTS** Compared to the CG group, the TG group performed much better in all parameters. In the Curl-up test with the TG group, we found significant differences ( $p < 0.05$ ) with an improvement of 34% from pre and post conditions. FVC, FEV1 and PEF also showed a significant difference ( $p < 0.05$ ) with a mean average increase of 10%. With the CG group, we found a minor improvement in the Curl-up test with statistical differences ( $p < 0.05$ ) but much less than the TG group. With regards to respiratory parameters, we found no statistical improvements with the CG group ( $p > 0.05$ ). **DISCUSSION** The abdominal exercises performed in an extended position with the muscular chain stretched induce many more improvements than traditional exercises. The use of the voice to produce a sound conducts a contraction of the transversus along with an active recruitment of the respiratory muscles. The role of the diaphragm produced a high transdiaphragmatic pressure which increased the function of the abdominal muscles. We suggest to athletes and common

people to practice this type of exercise, combined with traditional ones, because they lead to an increase of core stabilization, pulmonary function and a correct spinal posture. REFERENCES [1]Allison GT, Morris SL, Lay B (2008). J Orthop Sports Phys Ther. 38(5):228-37 [2]Urquhart DM, Hodges PW, Story IH (2005). Gait Posture. 29:5-301. [3]Gomez CL, Strongoli L. M., Coast J.R.(2009). Journal of Sports Science and Medicine .8, 543 – 547.

### DIFFERENCES IN CALCANEAL ULTRASOUND PARAMETERS IN ADOLESCENT CYCLISTS VS. CONTROLS.

Gómez-Bruton, A., González-Agüero, A., Gómez-Cabello, A., Matute-Llorente, A., Morales, S., Guillén-Ballester, A., Olmedillas, H., Casajús, J.A., Vicente-Rodríguez, G.

*GENUD, Research Group, Universidad de Zaragoza*

Differences in calcaneal ultrasound parameters in adolescent cyclists vs. controls. Gómez-Bruton A1, González-Agüero A1, Gómez-Cabello A1; Matute-Llorente A1, Morales S1, Guillén-Ballester A 1, Olmedillas H 1, Casajús JA1, Vicente-Rodríguez G 1 1GENUD research group, University of Zaragoza, Spain. INTRODUCTION: Studies performed with dual energy X-ray absorptiometry techniques demonstrated that cycling training is associated with decreased bone mass acquisition during growth periods(1) which could lead to osteoporosis later in life. Other cheaper and innocuous techniques such as quantitative ultrasound (QUS) have not yet been used to evaluate bone parameters in a cyclist population. Therefore, the aim of this study was to evaluate bone parameters measured with QUS in a population of adolescent cyclists and to compare them with a control group (CG). MATERIAL AND METHODS: 19 male adolescent cyclists and 17 male age-matched controls participated in the study. QUS values (speed of sound [SOS] and broadband ultrasound attenuation [BUA]) of both heels were measured at the calcaneus with an Aquiles equipment (Lunar Achilles InSight). Stiffness Index (SI) was also calculated from a combination of SOS and BUA. Student's t-tests were applied to evaluate differences between cyclists and CG. RESULTS: Compared with the CG, cyclist group showed lower values of SOS (1589±35 vs. 1612±35 m/s), BUA (110 vs. 122 dB/MHz) and SI (98±18 vs. 113±15) for the right foot; and also lower SOS (1587±33 vs. 1624±36 m/s), BUA (107±12 vs. 122±12 dB/MHz) and SI (95±15 vs. 116±16) for the left foot (all p≤0.05). ANCOVA results adjusting for age, height and weight did not modify the results. DISCUSSION: Cyclists group showed lower QUS parameters for bilateral calcanei than the CG even after adjusted for age, weight and height. Therefore, properties such as composition and geometry of the bone might be affected by cycling training. Hence the relative risk of suffering osteoporotic fractures in this determined population may be augmented later in life. Moreover, the increased risk of fall during cycling practice could increase the risk of bone fracture in these athletes due to weaker bones. Future studies using QUS in a larger sample are needed in order to confirm these results. 1. Nicholson PF. Ultrasound and the biomechanical competence of bone. IEEE Trans Ultrason Ferroelectr Freq Control. 2008.

14:45 - 15:45

## Poster presentations

### PP-PM47 Molecular Biology 2

#### DIFFERENT ADAPTATIONS OF ACTN3 & ACTN2 GENE EXPRESSION TO 8 WEEKS PROGRESSIVE RESISTANCE TRAINING IN SPRAGUE-DAWLEY RATS

Khaledi, N., Gaeini, A.A., Fayazmilani, R.

*University of Kharazmi -Shahid beheshti University*

Introduction Alpha (α)-actinins are located in the skeletal muscle Z-line and form actin-actin cross-links(Frank et al 2006). The human ACTN3 gene encodes the protein α -actinin-3, a component of the contractile apparatus in fast skeletal muscle fibers. Kathryn et al (1999) identified a common polymorphism in ACTN3 (R577X) that results in absence of α -actinin-3 in more than one billion people worldwide, despite the ACTN3 gene being highly conserved during human evolution. They demonstrated that ACTN3 genotype influences elite athletic performance (North et al 2008). However, the response of α-actinin to exercise training is little understood. Methods Forty female Sprague-Dawley rats were assigned randomly to a control (C; n = 18) or exercise training (T; n = 22) group. This study examined the effects of 8 weeks progressive resistance training on α-actinin-2 and α -actinin-3 expression levels, in the flexor hallucis longus muscle (FHL) . In addition, changes in the myosin heavy chain (MyHC) composition were assessed. Real-time PCR & Immunohistochemistry techniques were used to measure gene expression levels & MyHC composition, respectively. Results Results showed that α -actinin-3 gene expression levels increased in T animal's muscle. (P < 0.05).However, no significant difference was found in α -actinin-2 expression levels between C and T animals. Subsequent MyHC analyses of all muscle showed a MyHC shift with direction from IIb to IIx. Discussion The results of this study demonstrate that progressive resistance training alters the expression of α-actinin3 at the cellular levels in skeletal muscle (P < 0.05).Ogura et al (2008) demonstrated that α-actinin- 3 levels adapt to changes in skeletal muscle characteristics along with hind limb unloading and transformation of muscle fiber type. These results are in line with our finding. This study demonstrate probably α -actinin-3 has an important function to produce and progress of force in sarcomere in response to resistance training. References Frank D, Kuhn C, Katus HA, Frey N. The sarcomeric Z-disc: a nodal point in signalling and disease. J Mol Med. 2006 Jun;84(6):446-68 North K. Why is alpha-actinin-3 deficiency so common in the general population? The evolution of athletic performance. Twin Res Hum Genet. 2008 Aug;11(4):3-84-94 Vincent B, Windelinckx A, Nielens H, Ramaekers M, Van Leemputte M, Hespel P, et al. Protective role of alpha-actinin-3 in the response to an acute eccentric exercise bout. J Appl Physiol. 2010 Aug;109(2):564-73 Ogura Y, Naito H, Kakigi R, Ichinoseki-Sekine N, Kurosaka M, Katamoto S. Alpha-actinin-3 levels increase concomitantly with fast fibers in rat soleus muscle. Biochem Biophys Res Commun. 2008

#### ACE AND ACTN3 GENOYPTE IN KOREAN POWER PERFORMANCE

Kim, C.1, Kwon, I.S.2, Kim, H.J.3, Cho, J.Y.2

*1 Korea National Sport University, 2 Korea National Sport University, 3 Korea National University of Education*

INTRODUCTION: There has been intensive research on the ACE ID or ACTN3 R577X polymorphism in the athletic trait of power performance due to the phenotypic influence of their genotypes on skeletal muscle power or muscle fiber structure(Hagberg et al. 2011). How-



ever, there is in need to identify the impact of combined association of ACE and ACTN3 on human performance because power performance is genetically determined by polygenic profiles (Rodríguez-Romo et al., 2010; Santiago et al., 2010). This study aimed to examine whether the combination of ACE and ACTN3 is associated with power performance in Korea. **METHODS:** For this study, 106 top-class power athletes (top-class group), 158 elite power athletes (elite-class group) and 676 healthy adults (control) aged 18-39 yrs were recruited and their genotypes were analyzed. **RESULTS:** The top-class group showed higher frequencies of II genotype and I allele in ACE and also higher frequencies of RR genotype and R allele in ACTN3 (Top-Class vs. Control: 41.4% vs. 32.1% for II genotype, 67.1% vs. 57.7% I allele,  $p < 0.05$ ; 42.3% vs. 29.0% for RR genotype, 65.3% vs. 54.8% for I allele,  $p < 0.05$ ). In polygenic profile, the top-class group had significantly higher frequencies of combined-II/ID+RR/RX genotype than control (Top-Class vs. Control: 82.9% vs. 66.7% for II/ID+RR/RX,  $p < 0.05$ ). The combined-II/ID+RR/RX genotype showed the possibility of success in the top-class muscle power performance with odds ratio of 2.3 times (CI:1.4-4.1,  $p < 0.05$ ). **DISCUSSION:** These results suggested that ACE and ACTN3 should be in interaction with each other to affect muscle-power performance in an additive form. Also, multigenic profile of ACE and ACTN3 can predict muscle performance with homogeneous dominant combined genotype (II/ID+RR/RX) having high success. **References** C Santiago, JR Ruiz, CA Muniesa, M Gonzalez-Freire, F Gomez-Gallego. *A Lucia*. 2010. *Scand J Med Sci Sports*. 20, e188-94. G Rodriguez-Romo, JR Ruiz, C Santiago, C Fiuza-Luces, M Gonzalez-Freire, F Gomez-Gallego, M Moran. *A Lucia*. 2010. *Eur J Appl Physiol*. 110, 1099-1106. JM Hagberg, T Rankinen, RJ Loos, L Perusse, SM Roth, B Wolfarth. C Bouchard. (2011) *Med Sci Sports Exerc*, 43, 743-752.

## RECOVERY TIME COURSE OF HSPB1 GENE EXPRESSION IN RAT SKELETAL MUSCLE FOLLOWING DAMAGING EXERCISE

Fayazmilani, R.1, Gaeini, A.A.2, Khaledi, N.3 Kordi, M.R.2, Hedayati, M.4

1:Shahid Beheshti University, 2:The University of Tehran, 3: Kharazmi University, 4:Shahid Beheshti University of Medical Science

**Introduction** In recent years, the use of cold water immersion (CWI) following heavy training sessions has become common among athletes aiming to reduce soreness, although there isn't any strong scientific rationale behind this method. HSP25 as one of the stress proteins that have been shown to play an important role after damage and following remodeling process in skeletal muscle (Koh, 2002) have been discussed in this study. The purpose of this study was to investigate the expression of Hspb1 after damaging exercise followed by CWI in different recovery time courses. **Methods** Male Wistar rats ( $n=168$ ;  $W=300 \pm 10$ gr) were divided into two groups of exercise (Ex) and exercise followed by cold water immersion (Ex+CWI). Each group divided to seven subgroups for seven time-courses (0, 0.5, 3, 24, 48, 72, and 168 hours after exercise). Eccentric exercise consist of 45min downhill running on treadmill (20 m/min,  $-17^\circ$ ) and CWI consist of 10min immersion in  $-10^\circ\text{C}$  water. Hspb1mRNA level was measured in Soleus muscle using Real-Time PCR and the protein level of HSP25 using WB and ELISA methods. **Results** We observed that the level of HSP25 in exercised muscles was increased significantly in all time courses except 168 h ( $p < 0.05$ ). The increment pattern was the same in both groups. Although, in Ex group, HSP25 level reach to its peak level 48 h post exercise, while the peak time course for Ex+CWI group was 72 h post exercise. Gene expression of Hspb1 increased 3 h post-exercise in both groups, although Hspb1mRNA level in Ex+CWI, 48h hr post-exercise was significantly less than Ex. **Discussion** Delay in recovery late phase increase of HSP25, which may overlap with secondary damage time course, suggests that CWI may postpone this phase. Also, the level of expression after CWI was higher that could be occurred due to more myofibrillar damage (Koh, 2002). Besides, decrease in Hspb1 gene expression 48 h following CWI may suggest suppression of cellular mechanisms in this regard (Peiffer et al., 2009; Paulsen et al., 2007). Furthermore, the level of HSP25 one week after exercise in Ex+CWI group, equal to control level indicate that CWI may suppress the acute adaptation of Hspb1 in skeletal muscle which exists in Ex group (Yamane et al., 2006). **References** Koh TJ. (2002). *Exerc Sport Sci Rev*, 30(3), 117-21. Paulsen G, Vissing K, Kalhovde JM, Ugelstad I, Bayer ML, Kadi F, et al. (2007). *Am J Physiol Regul Integr Comp Physiol*, 293(2), 844-53. Peiffer JJ, Abbiss CR, Watson G, Nosaka K, Laursen PB. (2009). *J Sports Sci*, 27(10), 987-93. Yamane M, Teruya H, Nakano M, Ogai R, Ohnishi N, Kosaka M. (2006). *Eur J Appl Physiol*, 96(5), 572-80.

## EFFECTS OF RESISTANCE EXERCISE INTENSITIES AND BLOOD FLOW SUPPLY ON REGULATORS OF MYOGENESIS IN HUMAN SKELETAL MUSCLE

Popov, D.1, Furalyov, V.2, Kravchenko, I.2, Miller, T.1, Bachinin, A.1, Kurochkina, N.3, Moroz, A.3, Vinogradova, O.1

1: SSC RF Institute for Biomedical Problems RAS (Moscow, Russia), 2: A. N. Bach Institute of Biochemistry RAS (Moscow, Russia), 3: Lomonosov Moscow State University (Moscow, Russia)

**Introduction** Choosing an optimal contractile activity protocol associated with resistance exercise for improving an increase in muscle mass is an important task for a rehabilitation medicine and a sporting activities. The aims of the present study were to compare an expression of myogenesis regulators in human skeletal muscle 1) after moderate-intensity resistance exercise with (MI) and without (with blood flow restriction) relaxation (MIWR) and 2) after high-intensity (HI) and MI resistance exercise. **Methods** Seven men adapted to strength training performed three resistance exercise sessions three times on separate days in a randomized order: 1) MIWR (8 x 12 knee extensions without relaxation, 50% 1RM, 7 min recovery), 2) MI (8 x 12 knee extensions, 50% 1RM, 7 min recovery), 3) HI (8 x 12 knee extensions, 75% 1RM, 7 min recovery). The duration of muscle activity during exercise in different sessions was equalized. The venous blood samples were taken before, during and 15 min after exercise sessions for determination of lactate, glucose, cortisol (C), testosterone (T), growth hormone (GH), insulin (I) and insulin-like growth factor 1 (IGF-1) concentrations. The vastus lateralis muscle biopsies were collected before, 40 min, 5 and 22 h after the exercise session and analyzed by qPCR for mRNA expression of IGF-1EA, IGF-1EC (MGF), Myostatin, MyoD, p21 and MyHC-2x. **Results** The lactate concentration after MIWR was 7.9(6.6-8.7) mM that was significantly higher ( $p < 0.05$ ) than after both HI: 5.8(5.0-7.3) mM and MI: 2.6(2.5-4.3) mM sessions. The concentrations of glucose, I, IGF-1 after exercise did not change and did not differ between sessions. The concentrations of C after HI and after MIWR were higher ( $p < 0.05$ ) than after MI. The decrease ( $p < 0.05$ ) of T concentration was found after MIWR only. MIWR led to a decrease ( $p < 0.05$ ) of Myostatin mRNA abundance at 40 min and 22 h of recovery: 0.35(0.23-0.78)- and 0.2(0.01-0.5)-fold relative to initial level, respectively. Myostatin mRNA abundance decreased ( $p < 0.05$ ) 22 h after HI: 0.1 (0.08-0.23)-fold relative to initial level, and did not change during recovery after MI session. Difference ( $p=0.06$ ) of myostatin mRNA abundance was found between HI and MI at 5 h of recovery: 0.6(0.16-1.27)- and 1.3(0.28-6.6)-fold relative to initial level, respectively. MyHC-2x mRNA abundance increased at 5 h of recovery after MIWR: 2.75(0.88-16.7)-fold relative to initial level, and did not change during recovery after HI and MIWR. The expression of IGF-1EA, IGF-1EC (MGF), MyoD and p21 mRNA did not change during recovery and did not differ between exercise sessions as well. **Discussion** The current study demonstrated that in skeletal muscle of men adapted to strength training 1) the decrease of myostatin mRNA abundance after MIWR was comparable with the decrease of myostatin mRNA abundance after HI. 2) Myostatin mRNA expression during recovery was associated with intensity of resistance exercise, if it was performed without blood flow restriction. The work is supported by RFBR grant # 12-04-01668-a.

## PROTEOMIC COMPARISON OF HIGH AND LOW RESPONDERS TO ECCENTRIC EXERCISE

Hody, S.1, Croisier, J.L.2, Leprince, P.1, Wang, F.3, Rogister, B.1

*University of Liège*

Introduction Intense and unaccustomed eccentric exercise can produce muscle damage associated with elevation of muscle protein levels in the blood and development of muscle soreness and stiffness (Howell et al. 1993). It is well documented that the blood level of creatine kinase (CK) after eccentric exercise shows a marked interindividual variability (Clarkson and Ebbeling, 1988). Nevertheless, the reasons for this wide susceptibility are still unknown. The present study compared the muscle proteome of healthy human subjects characterized either by high or low elevation of plasma CK activity after an eccentric protocol. Methods Six untrained men ( $23 \pm 0.9$  y) performed 3 sets of 30 maximal eccentric contractions of the knee extensor muscles of the right leg (on a Cybex Norm dynamometer) at the angular velocity of  $60^\circ \cdot s^{-1}$  and throughout constant motion amplitude of  $100^\circ$ . The plasma CK activity was determined spectrophotometrically before and 24 hours after exercise. Needle biopsies of the rectus femoris muscle were obtained from the volunteers four weeks before (control) and 24 hours after the injuring unilateral protocol. The muscles samples were subjected to a proteomic 2D-DIGE analysis coupled with mass spectrometry protein identification. Results Subjects were classified into HR and LR groups by using the median of the plasma CK activity measured one day post-exercise (5199 IU/l). Mean values of the post-test plasma CK level were significantly different between HR ( $15106 \pm 6359$  IU/l,  $n=3$ ) and LR ( $1203 \pm 1230$  IU/l,  $n=3$ ) groups ( $p < 0.05$ ), with no significant difference in basal values (respectively,  $102 \pm 11$  IU/l and  $129 \pm 22$  IU/l). The proteomic comparison of both groups under control condition revealed that glycolytic enzymes and fast isoforms of contractile or structural proteins were more abundant in HR muscles than those of LR. One day after the eccentric protocol, the HR group showed a differential expression of only four proteins while the LR group presented a modulation of seventeen proteins compared to control condition. Discussion This study suggests that the higher susceptibility of HR muscles to eccentric exercise could be explained, at least in part, by a predominant fast glycolytic phenotype. In addition, the greater number of proteomic modifications observed for the LR subjects could reflect a better ability to adapt in response to lengthening protocol. References Clarkson PM, Ebbeling C (1988). *Clin Sci (Lond)*, 75(3): 257-261. Howell JN, Chleboun G, Conatser R (1993). *J Physiol*, 464: 183-196.

## ACE I/D AND ACTN3 R577X POLYMORPHISMS, BODY COMPOSITION AND SOMATOTYPE IN TOP-LEVEL ITALIAN GYMNASTS.

MASSIDDA, M.1, TOSELLI, S.2, BRASILI, P.2, CALO, C.M.1

*1: University of Cagliari (Italy), 2: University of Bologna (Italy)*

Introduction ACE I/D and ACTN3 R577X polymorphisms have been associated with elite athletic status, and recently with differences in muscle strength and power, body fat and bone mineral density in human (Puthuchery et al. 2011; Yang et al. 2011). Purpose The purpose of this study was to analyze the influence of ACE I/D and ACTN3 R577X polymorphisms on body composition and somatotype of elite Italian gymnasts. Methods Nineteen athletes of the Artistic Gymnastic Italian National Team ( $n=10$  males,  $n=9$  females) who were competitive at Olympic levels were genotyped for ACE I/D and ACTN3 R577X. The athletes had been gymnasts for an average of 14.3 years, and they trained for  $31.2 \pm 2.5$  h/week. The analysis was computed for each gender separately. Correlations were computed by mean of Pearson's  $r$  test. Differences between genotypes and phenotypes were determined using one-way analysis of variance (ANOVA). Results None of the tested athletes was deficient for the  $\alpha$ -actinin-3 protein (XX genotype). In females, we found a significant negative correlation between ACTN-3 and triceps skinfold ( $r = -.92$ ), and endomorphy ( $r = -.83$ ). Gymnasts carrying RR genotype showed higher values of body fat parameters than those with RX genotype ( $P = 0.41$ ). ACE polymorphism was significantly correlated with thigh ( $r = .91$ ) and triceps ( $r = .84$ ) skinfolds. Athletes carrying DD genotype showed higher values of skinfolds thickness than those with ID and II genotypes ( $P = 0.17$ ). In males, only the R577X polymorphism displayed a significant correlation with arm ( $r = .74$ ) and thigh ( $r = .80$ ) muscle area (TMA and AMA, respectively), mesomorphy ( $r = .83$ ) and femur diameter ( $r = .81$ ). Particularly, gymnasts with RR genotype showed significant higher values of AMA ( $RR = 85.7 \pm 8.7$  vs  $RX = 72.6 \pm 9.1$  cm<sup>2</sup>;  $P = 0.04$ ) and TMA ( $RR = 200.2 \pm 8.7$  vs  $RX = 178.4 \pm 10.8$  cm<sup>2</sup>;  $P = 0.008$ ), mesomorphy ( $RR = 7.0 \pm 0.5$  vs  $RX = 5.6 \pm 0.5$ ;  $P = 0.002$ ) and femur diameter ( $RR = 9.5 \pm 0.2$  vs  $RX = 8.9$  mm;  $P = 0.02$ ) with respect to those with RX genotype. Discussion Our results suggested a possible effect of ACTN3 on muscle mass in males, while in female gymnasts both genes seem to have a small influence on body fat. In line with other previous researches (Massidda et al. 2009), it can be confirmed that the presence of a functional ACTN3 in fast-twitch muscle fibers might improve the potential to achieve better performance level in male and possibly female gymnasts, while ACE does not seem beneficial for gymnastic performance in both sex. References Massidda M, Vona G, Calò CM (2009). *Genet Test Mol Biomarkers*, 13, 377-380. Puthuchery Z, Skipworth JR, Rawal J, et al. (2011). *Sports Med*, 41, 433-448. Yang N, Schindeler A, McDonald MM et al. (2011). *Bone*, 49, 790-798.

## MECHANICAL STRETCHING OF ARTIFICIALLY AGED MYOBLASTS IN PHYSIOLOGICALLY RELEVANT 3-DIMENSIONAL BIOENGINEERED CONSTRUCTS

Sharples, A.P., Player, D.J., Martin, N.R.W., Stewart, C.E., Lewis, M.P.

*Muscle Cellular and Molecular Physiology Research Group (MCMPRG), Institute for Sport and Physical Activity Research (ISPAR Bedford), University of Bedfordshire, Bedford, UK.*

Degeneration of skeletal muscle (SkM) with age (sarcopenia) is a major contributor to functional decline, morbidity and mortality. However, it is often difficult to embark on exercise interventions in already frail and diseased elderly individuals. Creating an in-vitro model of in-vivo muscular ageing using three dimensional (3D) bioengineered structures that incorporate a representative extracellular matrix, are under tension and display morphological, histological and transcript expression of mature SkM (Smith et al. 2011) would: 1) More accurately represent a more physiological tissue and; 2) provide greater experimental manipulation to mechanically stretch, perform gene knockdown, chemically inhibit, transfect and introduce pharmacological interventions. Overall, with the aim to elucidate cellular and molecular underpinnings for the deterioration of muscle mass with age and provide future targets for therapy. The present study implemented an already published cellular model that uses 'artificially aged' myoblasts, where multiple population doubled (MPD) murine myoblasts are compared with low population doubled cells (CON) originally used to derive the MPD cells (Sharples et al. 2011). MPD cells have been previously shown to display reduced regeneration in monolayer cultures vs. CON (Sharples et al. 2011) with similar morphology, transcript and signalling processes observed in cells isolated from elderly human muscle (Bigot et al. 2008; Beccafico et al. 2010) and measured in biopsies (Cuthbertson et al. 2005; Leger et al. 2008). Both MPD and CON cells were seeded into 3D type I collagen matrices under uniaxial tension and allowed to attach and differentiate over 14 days. These constructs were then tethered to a custom built ten-

sioning culture force monitor for intermittent mechanical stretching (10% resting length) for 10 reps followed by a 90 secs rest (1 set). 3 sets were completed in total, followed by 3 min rest with the whole cycle repeated 4 times. CON bioengineered constructs, immediately post intermittent loading, had significantly increased transcript expression of IGF-I, IGF-IEa, MGF, myogenin and decreased IGFBP5 vs. MPD constructs ( $P \leq 0.05$ ) that had no change in these transcripts, with the exception of MGF (yet a smaller magnitude increase vs. CON constructs). Interestingly, mechanical stretch in MPD constructs significantly reduced myostatin and TNF- $\alpha$  mRNA expression vs. no-stretch controls ( $P \leq 0.05$ ). In conclusion, CON bioengineered constructs responded positively to the intermittent mechanical stretch with the up-regulation of hypertrophic genes whereas artificially aged constructs had an impaired response. Mechanical stretch also down-regulated genes associated with atrophy in artificially aged constructs. The present study suggests that artificially aged myoblasts in physiologically relevant 3D bioengineered constructs can be used to study exercise induced phenotypes associated with ageing muscle.

## 14:45 - 15:45

### Poster presentations

#### PP-PM48 Neuromuscular Physiology 3

##### EFFECTS OF LOAD ON MUSCLE ACTIVATION AND OXYGENATION DURING REPEATED ELBOW FLEXIONS

Sarrazin, S., Baudry, S., Duchateau, J.

*Université Libre de Bruxelles*

Effects of load on muscle activation and oxygenation during repeated elbow flexions Sarrazin, S., Baudry S., Duchateau J. Laboratory of Applied Biology, Université Libre de Bruxelles (Belgium). Introduction The maximal number of repetitions that an individual can perform decreased with the intensity of the load along a non linear function that suggests differences in mechanisms contributing to limit the duration of the effort (Shimano et al. 2006). A possible limiting factor with the increase in load magnitude is the impairment of muscle oxygenation resulting from a progressive reduction in muscle perfusion caused by the increase in intramuscular pressure in response to greater motor unit recruitment (Felici et al. 2009). The present study investigated the contribution of neural adjustments and muscle oxygenation in the maximal number of dynamic contractions performed depending on load magnitude. Methods The task required lifting and lowering a load of 20, 40, 60 or 80% of one repetition maximum (1RM) until failure with the elbow flexor muscles, over a range of motion of 40 degrees. The surface electromyograms (EMG) of biceps brachii, brachioradialis and triceps brachii were recorded. Muscle oxygenation (TOI) and haemoglobin concentration (nTHI) of biceps and triceps brachii were assessed by near-infrared spectroscopy. Results The number of repetitions was greater for the 20% load ( $154 \pm 82$ ,  $P < 0.001$ ) compared with 40% ( $36 \pm 9$ ), 60% ( $20 \pm 6$ ) and 80% ( $8 \pm 3$ ) loads. The EMG of elbow flexor muscles increased during tasks performed with loads up to 60% of 1RM but decreased for the 80% load. The TOI in biceps brachii decreased to a greater extent ( $P < 0.001$ ) for the 80% load (-49.1%) compared with 20% load (-19.9%). Step-wise multiple-regression analyses revealed that factors related to muscle activation limited the number of repetitions for loads up to 60% of 1RM whereas factors involving both muscle activation and oxygenation predicted the maximal number of repetition for the 80% load. Discussion The maximal number of repetitions during repeated contractions against the different loads is mainly limited by neural factors (muscle activation). For load of 80% of 1RM, however, oxygenation appears to contribute also to this limitation. The reduced oxygenation observed at such load may be caused by an increased intramuscular pressure that was high enough to impair muscle perfusion during the lengthening phase of the movement compared with lower loads. In conclusion, these results allow a better understanding of the limiting factors of the number of repetitions during different loadings used in strength training. References Felici F, Quaresima V, Fattorini L, Sbriccoli P, Filligoi GC, Ferrari M. (2009), *J Electromyogr Kinesiol.*; 92: 1-11. Shimano T, Kraemer WJ, Spiering BA, Volek JS, Hatfield DL, Silvestre R, Vingren JL, Fragala MS, Maresh CM, Fleck SJ, Newton RU, Spreuwenberg LP, Häkkinen K. (2006), *J Strength Cond Res.*; 20: 819-23.

##### EFFECT OF FATIGUE OF THE ANKLE DORSIFLEXOR MUSCLES ON BALANCE CONTROL

Booghs, C., Baudry, S., Duchateau, J.

*Université Libre de Bruxelles*

Effect of fatigue of the ankle dorsiflexor muscles on balance control Booghs, C., Baudry, S., Duchateau, J. Laboratory of Applied Biology, Université Libre de Bruxelles (Belgium). Introduction Upright standing involves the integration of afferent information from vestibular, visual, and proprioceptive systems that are modulated depending on the context (Peterka, 2002). For example, a decrease in balance stability is accompanied by a decrease in the amplitude of the Hoffmann (H) reflex indicating a decrease in muscle spindle afferents input at the spinal level (Earles et al. 2000). Moreover, upright stance depends on ankle stiffness generated partly by plantar and dorsiflexor muscles activation. Therefore, changes in the force capacity of the main ankle dorsiflexor muscles could alter balance. The present study investigated the effect of fatigue of the ankle dorsiflexor muscles on balance stability and soleus H-reflex modulation. Methods Eight adults performed 5 sets (1 min apart) of lifting and lowering a load of 30% of their maximum until failure with the ankle dorsiflexor muscles, over a range of motion of 30 degrees. Before and immediately after the fatiguing task, subjects were asked to stand on one leg on a force platform for 90s during which H reflexes and Mmax (maximal M wave) in the soleus were elicited by electrical stimulation of the tibial nerve. Surface electromyogram (EMG) of the soleus, medial and lateral gastrocnemii, and tibialis anterior were recorded during balance and fatigue tasks. Results The fatiguing task reduced the maximal isometric voluntary force of the ankle dorsiflexor muscles (-43%,  $p < 0.001$ ) but did not influence significantly the excursion of the centre of pressure ( $p > 0.05$ ). Immediately after the fatiguing task, the average EMG (aEMG) of the calf muscles was increased (+15%,  $p < 0.05$ ) during the balance task whereas the aEMG for the tibialis anterior did not change. As a consequence, the cocontraction ratio (tibialis anterior/calf muscles) tended to decrease ( $p = 0.08$ ). The soleus H reflex (normalized to the Mmax that did vary after the fatiguing task) was significantly increased immediately after the fatigue task (+23%,  $p < 0.001$ ), as well as the H reflex/Soleus aEMG ratio (+11%,  $p < 0.05$ ). Discussion Even though fatiguing the ankle dorsiflexor muscles did not alter unipodal stability, the results show that stronger calf muscle contractions are required to control balance after fatigue. Moreover, the increased H-reflex/soleus aEMG ratio, while the cocontraction ratio was slightly decreased, might be due to a reduction in reciprocal inhibition from tibialis anterior to soleus immediately after the fatigue task. This study indicates that balance control when the ankle

dorsiflexor muscles are fatigued requires neural adjustments in calf muscle activation to maintain stability. References Earles DR, Koceja DM, Shively CW. (2000). *Int J Neurosci*; 105:1-13. Peterka RJ (2002). *J Neurophysiol*; 88:1097-118.

### **MOTOR UNITS DISCHARGE RATE AND TORQUE VARIABILITY DURING STEADY ISOMETRIC CONTRACTIONS PERFORMED WITH THE DORSIFLEXOR MUSCLES**

Klass, M.1, Jesunathadas, M.2, Enoka, R.M.2, Duchateau, J.1

*Université Libre de Bruxelles; University of Colorado*

Motor units discharge rate and torque variability during steady isometric contractions performed with the dorsiflexor muscles Klass M<sup>1</sup>, Jesunathadas M<sup>2</sup>, Enoka RM<sup>2</sup>, and Duchateau J<sup>1</sup> <sup>1</sup> Laboratory of Applied Biology, Université Libre de Bruxelles, Belgium <sup>2</sup> Department of Integrative Physiology, University of Colorado, USA Introduction The purpose of this study was to record the discharge characteristics of tibialis anterior motor units and torque variability over a range of target torques, (1) to compare them with data obtained in first dorsal interosseus muscle and (2) to improve the ability of a motor unit model to predict experimentally measured torque variability across a wide range of torques. Methods The discharge characteristics of tibialis anterior motor units were measured in one session and the variability in the torque exerted by the foot during steady isometric contractions performed with the dorsiflexor muscles at several target torques was recorded during a second session to avoid fatigue. The discharge times of 44 motor units were recorded from 10 individuals (32.9 ± 6.75 yrs; 9 men) and the variability of ankle dorsiflexion torque was measured from 11 volunteers (30.0 ± 4.71 yrs; 9 men). Results and discussion The coefficient of variation for dorsiflexion torque was significantly less than that for the force exerted by the index finger abduction at targets of 2, 50, 70, and 85% of MVC torque ( $P \leq 0.001$ ). The relative discharge variability of most (55%) motor units of the tibialis anterior decreased exponentially as torque increased above recruitment threshold torque. The mean coefficient of variation for interspike interval for all motor units was  $15.9 \pm 9.61\%$  at recruitment and  $12.2 \pm 4.55\%$  at the greatest torque at which motor units could be identified. The relative discharge variability at recruitment was positively related to the recruitment threshold torque. Although these associations were somewhat similar to those reported for first dorsal interosseus, the discharge rate variability of tibialis anterior motor units was not the main factor contributing to a close approximation between the simulated and experimental coefficients of variation for dorsiflexion torque. The ability of the model to approximate the experimentally observed torque variability over the operating range of the dorsiflexors was achieved only when the relation between motor unit twitch torques and contraction times was changed from a power function to a weak linear relation. These results indicate that the discharge variability of tibialis anterior motor units is of lesser significance in influencing torque variability of the dorsiflexors. References Barry BK et al. *J Neurophysiol* 97: 3206-3218, 2007. Fuglevand et al. *J Neurophysiol* 70: 2470-2488, 1993. Moritz et al. *J Neurophysiol* 93: 2449-2459, 2005. Van Cutsem M et al. *Can J Appl Physiol* 22: 585-597, 1997.

### **PRESERVED DORSAL-FLEXION TORQUE AND FATIGABILITY AFTER CYCLING TO EXHAUSTION IN VARIOUS ENVIRONMENTAL CONDITIONS**

Girard, O., Racinais, S.

*ASPETAR - Qatar Orthopaedic and Sports Medicine Hospital*

Background: Previous studies have demonstrated that plantar flexors are subjected to fatigue after cycling to exhaustion. Although it's possible that fatigue in ankle dorsal flexor also exists, literature is scarce. A question that remains unresolved is also to determine whether the degree of end-exercise fatigue is conditioned by the nature of the environmental challenge. Purpose: To investigate the effect of cycling to exhaustion in conditions of various environmental temperature [neutral (22°C/30%rH) versus warm (35°C/40%rH)] and altitude [sea level (FIO<sub>2</sub> 0.21) versus reduced oxygen content (FIO<sub>2</sub> 0.15)] stress on dorsal-flexion torque and fatigability. Methods: Eleven physically active males cycled to exhaustion at constant workload (66% of their maximal aerobic power) in four different environmental conditions [Neutral/Sea level (Control), Warm/Sea level (Hot), Neutral/Reduced O<sub>2</sub> content (Hypoxia) and Warm/Reduced O<sub>2</sub> content (Hot+Hypoxia)]. Dorsal-flexion torque was measured from brief (5 s) and sustained (2 min) maximal voluntary isometric contractions (MVC) before and 5 min after exercise. Results: Compared to Control (average performance: 66 min and 17 s), time to exhaustion was reduced ( $P < 0.05$ ) in Hot (-35%) and Hypoxia (-36%), while Hot+Hypoxia (-51%) further decreased performance. During brief MVC, there was no significant ( $P > 0.05$ ) main effect of exercise on force production capacity (29.4±1.4, 31.3±2.1, 29.9±1.8 and 27.6±2.0 Nm versus 29.5±1.3, 28.8±1.7, 30.9±2.0 and 29.2±2.5 Nm in control, hot, hypoxia and hot+hypoxia before versus after exercise, respectively), nor any significant effect of temperature or altitude. During the 2 min sustained MVC, torque loss as measured from the onset to the endpoint of the contraction ( $P < 0.001$ ) was similar between all trials (-57%; -59%; -59% and -61% versus -60%; -59%; -52% and -62% in control, hot, hypoxia and hot+hypoxic before versus after exercise, respectively), independently of the environmental temperature or altitude. Conclusion: Combining environmental temperature and altitude challenges alleviate cycling, time to exhaustion performance. However, dorsal-flexion torque and fatigability were affected neither by exercise nor by environmental stress level.

### **ACUTE EFFECTS OF TWO STANDARDIZED WHOLE BODY VIBRATION SESSIONS ON H-REFLEX AND MUSCLE ACTIVATION**

Colson, S.S., Pensini, M.

*University of Nice-Sophia Antipolis*

Introduction A whole-body vibration (WBV) session is characterized by the interaction between the vibration frequency and the peak-to-peak displacement of the platform that determines the WBV acceleration and the load imposed on the neuromuscular system. Although WBV affects neuromuscular performance, it remains unclear whether the effects are due to a modification of spinal reflex excitability because of the discrepant results of the H-reflex reported in the literature (Armstrong et al. 2008; McBride et al. 2010; Ritzmann et al. 2011). Therefore, the aim of this study was to examine the effects of two standardized WBV sessions yielding a similar acceleration on the neuromuscular adaptations of the plantar flexor muscles. Methods 10 active students participated in two randomized interventions. The participants completed a series of 5 bouts (60s of exercise followed by 60s of rest) of unloaded static squatting positions on a vertical vibrating platform. Depending on the intervention, the WBV frequency and peak-to-peak displacement were respectively set at 50 Hz/2mm and 40Hz/4mm. Measurements were performed before and immediately post-intervention. They included maximal voluntary isometric contraction (MVC) of the plantar flexor muscles and electrical stimulation of the tibial nerve for the assessment of maximal voluntary activation, H-reflex, M-wave responses and mechanical twitch. Surface electromyography (EMG) activity was collected from the triceps surae muscle complex. Results No significant difference was observed between the two interventions. MVC, voluntary activation of

the plantar flexor muscles as well as EMG/M-wave values of the triceps surae muscle complex were significantly reduced after the interventions. In addition, doublet peak twitches (at rest and potentiated) were also depressed after the interventions. However, no significant modification of the H-reflex/M-wave ratios was found. Discussion Our data revealed that two WBV sessions with an equivalent maximal acceleration combining a different frequency and peak-to-peak displacement led to identical neuromuscular adaptations of the plantar flexor muscles. Our results also showed that WBV exercise has a depressive impact on MVC and triceps surae muscle's activation. In opposition with previous studies, spinal reflex excitability remained unchanged after our WBV protocols. Within the limits of our experiment, the findings of this study suggest that: 1) the maximal acceleration can be used as an index to quantify the load of a WBV session, and 2) the decrease of MVC observed after WBV exercise is partly ascribable to central activation failure. References Armstrong et al. (2008). *J Strength Cond Res*, 22: 471-476. McBride et al. (2010). *J Strength Cond Res*, 24:184-189. Ritzmann et al. (2011). *Scand J Med Sci Sports*.

### ACTIVATION PATTERNS IN DRAWING ARM MUSCLES AND EFFECTS ON PERFORMANCE IN RECURVE ARCHERS

Eroglu Kolayis, I., Ertan, H., Knicker, A., Soylyu, A.R.

*Sakarya University*

Skill in archery is defined as the ability to shoot an arrow to a given target in a certain time span with accuracy. The discipline is described as a six phase movement in terms of shooting technique by Nishuzono et. al. (1987); Bow Hold, Drawing, Full Draw, Aiming, Release and Follow Through. These phases have details. For example, for collecting good points in the competition; use time effectively, releasing should be stable and same each shooting and strong posture is important. It is investigated to contraction strategies after and before falling of clicker on forearm muscle of archers who have different performance level (Ertan et.al, 2003). The purpose of the study was investigated to activation of drawing arm muscles before and after falling of clicker and the effects on the performance. Methods 4 Female (Age: 28,75+10,5; Training age: 7,75+4,5) and 6 male (Age: 27,6+16,04; Training age: 5+4,24) subject were involved in the study. Each subject participated in one test session and each archer shot 12 arrows and drawing arm Deltoid Posterior, Triceps Brachii, Biceps Brachii, Forearm extensors and flexors EMG activities have been measured in the test. EMG recordings 1 s prior and after the fall of the clicker have been rectified, integrated and normalized. Target scores have been divided in to three section. 10 and 9 as yellow, 8 and 7 as red, below 6 point as blue. iEMG differences among target scores were analysed in one-way ANOVA test. Results According to the results of the study, there were significant differences in Deltoid posterior and Biceps brachii muscle ( $p < 0,05$ ) on the basis of comparisons of the mean values before and after clicker fall. Deltoid Posterior muscle has differences between yellow and blue target scores and red and blue target scores both before and after clicker fall. In biceps Brachii muscle there were statistical differences between red and blue target scores only in before clicker fall. Discussion As a result, differences have been observed in Deltoid posterior muscle in the drawing arm. Deltoid Posterior muscle has an importance for transferring the drawing weight of the bow to the back. In high scores, activity of Deltoid posterior muscle has been increased before clicker fall. But the activity of the Deltoid Posterior after clicker has been increased in low scores. It means that Deltoid posterior activity is important before clicker fall to show good performance and should decrease after clicker. Significant differences in Biceps brachii muscle has been observed between red and blue target scores before clicker fall. It shows that if drawing weight of the bow carried by biceps muscle in drawing arm target points show decrease. References 1. Nishuzono, H. Shibamaya, H. Izuta, T. Saito (1987) "Analysis of Archery shooting Techniques by means of Electromyography. 2. Ertan, H., Kentel, B., Tumer S.T. (2003) Activation Patterns in Fore arm Muscles During Archery Shooting" *Human Movement Science*, 22:37-45

### LACK OF ASSOCIATION BETWEEN CHANGES IN MAXIMAL ISOMETRIC JOINT TORQUE AND CHANGES IN MUSCLE SIZE AND ACTIVATION FOLLOWING 10 WEEKS HEAVY STRENGTH TRAINING IN PREVIOUSLY UNTRAINED MEN

Treize, J., Blazeovich, A.J.

*Edith Cowan University*

Introduction Maximising muscle force is pivotal to the success of both sports performances and activities of daily living. Therefore, identifying the mechanisms that drive changes in muscle force is important. Traditionally, increases in muscle size (particularly CSA) and muscle activation have been thought to promote changes in strength. In this case, there should be a clear association between changes in muscle size and activation and changes in strength (i.e. significant  $R^2$  values). Despite a substantial number of studies examining the effects of strength training on changes in muscle strength, these associations are rarely examined. The purpose of the present study, therefore, was to assess the relationship between peak muscle torque, muscle size, and EMG amplitude in previously untrained men. Methods Fifteen untrained men ( $29.5 \pm 5.3$  y) participated in a lower limb heavy resistance training protocol for 10 weeks (total of 20 sessions). The regime included 3 sets of 6 repetitions of leg press, leg extension and hamstring curl exercises. Before and 3-5 days after the training, muscle CSA, unilateral knee torque, peak muscle activity and peak twitch torque were assessed. Torque variables included the maximal voluntary peak torque (PTMVC) and peak potentiated twitch torque (PTTW) as indicators of contractile capacity, torque per cross sectional area (T/CSA) as an indicator of specific torque, and the ratio of the potentiated and unpotentiated twitch torques (TRATIO) to identify possible changes in phosphorylation efficiency of the muscle fibres. Muscle activity was defined by the average quadriceps EMG amplitude (EMGQUAD), antagonist EMG amplitude (EMGGBF) and the vastus lateralis EMG-to-Mwave ratio (EMG/MVL) ratio. Muscle cross sectional area was assessed at 30%, 40% and 50% of the thigh (CSA30, CSA40 and CSA50) using extended field of view ultrasonography. Changes in these variables over time were compared by three separate one-way ANOVAs with repeated measures, and coefficients of determination (linear model) were used to examine associations between the variables. Results Peak torque and muscle size (CSA30, CSA40 and CSA50) increased following training ( $P < 0,05$ ), whilst changes in other measures were not statistically significant but showed substantial inter-individual variability. Changes in muscle size (CSA40 and CSA50) and activation (EMGQUAD) were moderately associated ( $0.27 < r^2 < 0.5$ ).

### COMPARISON OF BILATERAL SYMMETRY IN RECTUS FEMORIS CONTRACTION PROPERTIES BETWEEN ELDERLY AND YOUNG SUBJECTS

Harley, S.

*University of Primorska*

Background: Numerous studies have described the important role of the rectus femoris (RF) in gait and posture. Studies in sarcopenia report that particularly the quadriceps, seems to be affected by age-related loss of muscle mass and a decline in maximum strength. Aim: This study aimed to compare bilateral symmetry of muscle contraction properties of the RF between elderly and younger subjects in

order to better understand the effects of aging on RF function and associated effects on gait and posture. Materials and methods: Thirty nine healthy elderly subjects (mean age  $77 \pm 10$ , BMI  $28 \pm 7$ ) and 50 healthy young subjects (mean age  $29 \pm 5$ , BMI  $24 \pm 4$ ) were randomly selected to participate in the study. Tensiomyography (TMG) was used to measure muscle contraction time (Tc), reaction time (Td), relaxation time (Tr), maximum radial displacement (Dm) and contraction sustain time (Ts). Lateral symmetry was determined as the absolute difference between TMG parameters of the left and right RF. An unpaired t-test was used to determine statistical significance between results obtained from both groups. Results: Significant differences were found for Dm ( $\Delta Dm=5.19$  mm,  $p<0.0001$ ), Td ( $\Delta Td=2.58$  ms,  $p=0.001$ ), Tc ( $\Delta Tc=3.26$  ms,  $p=0.018$ ) and Ts ( $\Delta Ts=34.31$  ms,  $p=0.026$ ) between elderly and young subjects. For lateral symmetry, only Td was found to be significantly different ( $\Delta$  lat Td=1.95 ms,  $p=0.014$ ). Discussion: Previous studies have correlated Dm with muscle strength. The significantly lower Dm scores in the elderly study group indicate a significant loss in muscle strength. The significantly longer Td in elderly subjects may be due to lower potentiation levels and reduction of type II fibres in the RF. The significantly larger lateral differences in Td, found in elderly subjects, may suggest that the left and right RF reach their proper activation level at different times during the stance-to-swing transition and posture responses. Type II fiber atrophy could be associated with the longer Tc in elderly subjects. The significantly longer Ts in the elderly group may be indicative of a shift in muscle fibre composition to a higher type I/type II ratio. Conclusion: Using TMG, significant differences in RF contraction properties between elderly and young subjects were found. These findings are consistent with documented age-related change in muscle function and fibre ratios, attributed to the process of sarcopenia. Although it is not possible to make statements connecting RF muscle function with age-related gait and posture response changes, based on TMG measurements alone, it could be an effective modality in assisting the assessment of the effects of sarcopenia on superficial skeletal muscles and associated changes in posture and gait.

### NEUROMUSCULAR FATIGUE MEASURES AFTER PROLONGED CONCENTRIC - ECCENTRIC ISOKINETIC QUADRICEPS ACTIVITY

Knicker, A.J., Schmieder, Ph., Fricke, H., Edeler, Ch., Rojas, S., Strüder, H.K.

*German Sport University Cologne*

Introduction In experimental protocols fatigue has been studied during isometric contractions or in pre/post fatigue conditions. (Cairns et al. 2005; Knicker et al. 2011). Our study wanted to reveal central and peripheral fatigue during long lasting maximum concentric eccentric contraction conditions for quadriceps muscles in isokinetic mode. Methods 37 healthy male subjects took part in the study. Isometric (ICC) torque, muscle activation, resting twitch responses were measured with the subjects sitting upright on a dynamometer in three different knee angle positions both before and after 50 fatiguing isokinetic (40 deg./s), knee flexions (eccentric) (ECC), knee extensions (concentric) (CCC) at submaximal (75%) effort over a knee angle ROM of 80deg. Bipolar Surface EMG readings were obtained from selected quadriceps femoris muscles during all contraction conditions. Results During ICC the fatigue protocol caused a shift of voluntary and stimulated torque-angle relations towards lower knee angles. Level of activation decreased by app. 36% in the pre / post fatigue comparison with biggest deviations in the most extended knee position. During ECC and CCC a steady decline of mean and maximum torque values could be identified in the course of contractions until a stable level of generated torque was achieved after 20 to 30 repetitions for CCC and 15 to 25 repetitions for ECC. Post fatigue values ranged from 32,4% to 63,6% compared to pretest. Decreased EMG median frequencies for all muscles were identified in the pre – post comparison of ICC in all knee angles and during ECC and CCC in phase to the time course of decline of torque values. Central fatigue was estimated via twitch interpolation under ICC, ranged from 13,7% to 31,3% and was evident in the most extended knee position. Discussion Peripheral and central fatigue effects could be identified as a consequence of the underlying contraction protocol. The exercise protocol caused severe declines of force output which can be attributed to inhibition of MUAPs as the force decrease was accompanied by a pronounced downshift of the EMG median frequency due to a) deteriorated excitation-contraction coupling at cellular level, b) actin-myosin interactions. As the target force output was 75% of maximum effort the muscles compensated the loss of contraction force by recruitment of additional MUs. Central fatigue can develop in all structures above the neuromuscular interface and can also involve motivational aspects. References Cairns, S. et al. (2005). Evaluation of models used to study neuromuscular fatigue. *Exerc SportSciRev*. Knicker, A. et al. (2011). Interactive Processes Link the Multiple Symptoms of Fatigue in Sport Competition. *SportsMed*.

### EFFECT OF SHORT-TERM CONCURRENT TRAINING ON INTRAMUSCULAR FAT

Ugrinowitsch, C., de Souza, E.O., Roschel, H., Laurentino, G.C., Brum, P.C., Bacurau, A., Tricoli, V.

*School of Physical Education and Sport, University of Sao Paulo*

Introduction Some endurance training methods seem to affect intramuscular fat content. However, less attention has been devoted to unravel the changes in intramuscular fat content when endurance training (i.e. interval training) is combined to strength training (i.e. concurrent training). Thus, the purpose of this study was to test the effects of short-term concurrent training on intramuscular fat stores. Methods Twenty eight participants were divided into a control group (CG – 24.1 $\pm$ 7.1 yrs, 66.5 $\pm$ 5.1 kg, 172.7 $\pm$ 7.1 cm), strength training group (STG – 26.7 $\pm$ 7.1 yrs, 74.5 $\pm$ 21.4 kg, 170.4 $\pm$ 4.9 cm), endurance training group (ETG – 24.1 $\pm$ 7.1 yrs, 66.6 $\pm$ 5.7 kg, 172.7 $\pm$ 7.1 cm), and concurrent training group (CTG – 22.9 $\pm$ 3.6 yrs, 75.7 $\pm$ 10.2 kg, 176.9 $\pm$ 9.5 cm). Intervention groups trained for eight weeks. Quadriceps cross-sectional magnetic resonance imaging, leg press 1RM and VO<sub>2</sub>max were performed pre- and post-training. Intramuscular muscular fat was assessed through spectral analysis of the magnetic resonance image of the vastus-lateralis cross-sectional area. Results STG and CTG increased strength significantly after training compared to the GC and ETG ( $p<0.001$ ). VO<sub>2</sub>max enhanced only in the ETG group after training ( $p<0.05$ ). The cross-sectional area presented a main time effect increasing from the pre- to the post-training assessment ( $p=0.05$ ). There were no significant changes in intramuscular fat content as assessed through spectral analysis of the vastus lateralis muscle cross sectional area from pre- to post-training (CG: 253.2 $\pm$ 12.9 – 264.8 $\pm$ 17.8; STG: 246.4 $\pm$ 16.5 – 258.3 $\pm$ 9.6; ETG – 218.4 $\pm$ 96.3 – 219.4 $\pm$ 112.4; and CTG 260.8 $\pm$ 13.4 – 246.4 $\pm$ 16.5). Discussion The endurance training protocol (i.e. interval training) employed in the present study did not change intramuscular fat stores both in the endurance training and concurrent training groups. Maybe a longer duration and lower intensity endurance exercise program is more effective to change intramuscular fat stores than high intensity interval training. References McCarthy, JP, Pozniak, MA and Agre, JC. Neuromuscular adaptations to concurrent strength and endurance training. *Med Sci Sports Exerc* 34: 511-519, 2002. Leveritt, M, Abernethy, PJ, Barry, BK and Logan, PA. Concurrent strength and endurance training. A review. *Sports Med* 28: 413-427, 1999.

### MUSCLE MORPHOLOGY AND PERFORMANCE IN SPRINTING, JUMPING AND THROWING

Methenitis, S.1, Zaras, N.1, Stasinaki, A.1, Spengos, K.1, Papadopoulos, C.1, Karampatsos, G.1, Krekoulia, M.1, Krase, A.1, Kavouras, S.2, Georgiadis, G.1, Manta, P.1, Terzis, G.1

1: University of Athens, 2: Harokopio University of Athens

Introduction Sprinting, throwing and jumping are three commonly used human explosive activities (Newton & Kraemer 1994). Performance in such activities relies upon a wide range of muscles' morphological factors (Cormie et al. 2011). Indeed, significant correlations exist between muscle morphology and performance in these activities. However, the impact of each one of these parameters on sprinting, throwing and jumping is not clear. The purpose of the present study was to identify the impact of selected muscle morphological parameters on sprinting, throwing and jumping performance in novice participants. Methods Sixty eight novice males performed in random series the following tests: 60m sprint, countermovement and squat jumps, squat underhand and one-arm standing throws. Body composition was evaluated via dual x-ray absorptiometry. Vastus lateralis (VL) thickness (VLT), pennation angles (VLPA) and fascicle lengths (VLFL) were determined with ultrasonography. Thigh muscles cross sectional area (TMCSA) was estimated with skinfold thickness. VL's fiber type composition was histochemically determined in muscle samples (n=37). Results Pearson's r coefficients revealed low to moderate correlations between performance and morphological factors ( $r$ : 0.246 - 0.783,  $p < 0.05$ ). Canonical correlation analysis revealed higher correlations between the combination of selected morphological factors and sprinting ( $r_c = 0.650$ ,  $p = 0.03$ ), throwing ( $r_c = 0.782$ ,  $p = 0.006$ ) and jumping performance ( $r_c < 0.856$ ,  $p = 0.000$ ). Cross loadings revealed that the order of significance for the muscle morphological factors in sprinting was: lower body lean mass (LLBM; 0.499), VLPA (0.476), TMCSA (0.406), VLT and VLFL (0.386 and -0.387) and % CSA of Type IIX fibers (-0.354), for throwing: LLBM (0.750), body mass index (BMI; 0.721), TMCSA (0.670), VLT (0.511), type IIA % CSA (0.459) and VLFL (0.384), and for jumping: LLBM (0.800), TMCSA (0.534), BMI (0.512), type IIA % CSA (0.439), VLT (0.401) and VLFL (0.392). Discussion It appears that performance in sprinting, throwing and jumping depends primarily on lower body lean mass and secondary to VL's architecture characteristics and fiber type composition. References Cormie P, McGuigan MR, Newton RU (2011). Sports Med, 41 (1):17-38. Newton RU, Kraemer WJ (1994). Strength & Cond. J., 16 (5):20-31.

### NEUROMUSCULAR AND PERCEPTUAL FATIGUE IN ENGLISH MALE HANDBALL PLAYERS DURING INTERNATIONAL COMPETITION

Moss, S.1,2, McWhannell, N.1, Twist, C.1

1: University of Chester; 2: England Handball Association

Introduction Elite handball tournaments require players to compete on successive days with limited recovery time between matches. This scheduling can result in player fatigue, which may have potential consequences on match performance. Therefore, the purpose of this study was to investigate the demands imposed on England squad players competing in the U19 European Open Championships, and the subsequent impact of competition on neuromuscular and perceptual fatigue. Methods Fourteen handball players (age  $17.1 \pm 0.73$  years) competing for England agreed to participate. The tournament consisted of eight matches played over five days, with players competing in two matches on days one, three, and four, and one match on days two and five. Player loading was quantified through measurement of heart rate (HR) during matches and session rating of perceived exertion (sRPE), taken 30 minutes after each match. Neuromuscular function was measured using a maximal 10 m sprint performed after matches one, five, and eight and flight time during a counter-movement jump (CMJ), performed immediately before and after each match. Subjective measures of fatigue, sleep quality, general muscle soreness, stress and mood were monitored daily using a 1 (negative) to 5 (positive) likert scale. Individual component scores were also totalled to give an overall rating of player well-being. Results Average playing time, sRPE and HR during matches was  $20:20 \pm 4:19$  min,  $148.3 \pm 41.6$  AU and  $86 \pm 3\%$  of maximal HR, respectively. Sprint time over 10 m increased during the tournament ( $P < 0.001$ ), with values of  $1.84 \pm 0.7$  s,  $1.89 \pm 0.6$  s, and  $1.98 \pm 0.12$  s, on day one, five and eight, respectively. Similarly, there was a trend for a decrease in CMJ flight time during the tournament ( $P = 0.06$ ). Overall well-being decreased during the tournament ( $P = 0.008$ ), with values of  $20.08 \pm 1.98$ ,  $18.17 \pm 1.53$ ,  $18.17 \pm 1.03$ ,  $17.83 \pm 1.7$  at baseline, day two, four and five, respectively. Analysis of individual components revealed increased fatigue on day four compared to baseline ( $P = 0.04$ ), and increased muscle soreness, which was different to baseline on days two, three, four and five ( $P = 0.001$ ), as well as between day three and day five ( $P = 0.03$ ). Discussion The physiological loading and limited recovery time between matches during an international tournament caused progressive decrements in neuromuscular performance and well-being in English handball players. This information should be used to identify how players fatigue during competition, as well as providing important information for coaches on effective interchange strategies to optimize individual and team performance.

14:45 - 15:45

### Poster presentations

#### PP-PM49 Training & Testing 9

### THE INFLUENCE OF TRAINING AND DETRAINING PERIODS ON FREE HORMONES, BODY DIMENSIONS AND EXPLOSIVE POWER IN YOUNG SOCCER PLAYERS

Moreira, A., Mortatti, A., Arruda, A.F.S., Freitas, C.G., Aoki, M.S., Crewther, B.T.

University of São Paulo, Swansea University, Ceará Federal University.

THE INFLUENCE OF TRAINING AND DETRAINING PERIODS ON FREE HORMONES, BODY DIMENSIONS AND EXPLOSIVE POWER IN YOUNG SOCCER PLAYERS Moreira, A.1, Mortatti, A.5, Arruda, A.F.S.1, Freitas, C.G.1, Aoki, M.S.2, Crewther, B.T. 3, 4. 1: School of Physical Education and Sport, USP (São Paulo, Brazil), 2: School of Arts, Sciences and Humanities, USP (São Paulo, Brazil), 3: Hamlyn Centre, Imperial College (London, UK), 4: Health and Sport Portfolio, College of Engineering, Swansea University (Swansea, UK), 5: Physical Education and Sports Institute, Ceará Federal University (Fortaleza, Brazil). Introduction Some authors have proposed that testosterone (T) helps to signal acute and chronic changes in neuromuscular capacity for explosive performance (Crewther et al. 2011). During puberty, T increases markedly in

boys such that both physical development and performance could be associated with changes in endocrine status (Naughton et al., 2000). However, training factors add to the complexity of understanding the development of young male athletes. Therefore, the study aim was to assess the effect of training and detraining on free hormones, body dimensions and explosive power in elite young soccer players. Methods 26 elite young ( $12.7 \pm 0.2$  yr) soccer players were monitored across a 12-week preparatory training phase, a 7-week competitive and a 2-week detraining phase. Salivary free T and cortisol (C) concentrations, body dimensions and countermovement jump height (CMJ) were assessed before (T1) and after (T2) the pre-season phase, and after the competitive (T3) and detraining phases (T4). As a marker of maturity status, years from peak height velocity (YPHV) was verified. None of the players reached PHV during the study period. Results Salivary T was higher at T4 compared with T2 and T3 ( $p < 0.05$ ), but no significant changes in salivary C were noted. Increments in height and body mass were verified throughout the investigation. We also verified significant increments in CMJ height from T2 to T3, but performance declined after the detraining period (to T1 values). Estimated YPHV changes (nearer from estimated PHV) revealed expected maturational development. Discussion Increases in free T concentrations mirrored expected age-related changes in physical development. The increases in CMJ height and change in years from PHV also coincided with body mass alterations. The detraining phase did not affect morphological and hormonal development, but did influence CMJ performance. Thus, age-related changes in endocrine function and training factors need to be considered in tandem when monitoring youth athletes. References Crewther et al. (2011). *Sports Med*, (41), 103-123. Naughton et al. (2000). *Sports Med*, (30), 309-325

## HEART RATE AND LACTATE FORMATION DURING FLOOR EXERCISE ROUTINE IN COMPETITIVE YOUNG FEMALE GYMNASTS.

Mattei, C.1, Matta, D.1, Cugusi, L.1,2, Massidda, M.1,3

*University of Cagliari*

**Introduction** The studies of the physiological demands during actual artistic gymnastic (AG) performance are few due to its peculiarities in duration and in nature of activities (Goswami and Gupta, 1998). In fact, the movements performed by females on the four apparatus are characterized by quick postural change causing profound effect on bodily responses (Le Marr, 1983). The aim of this study was to analyze the effects of competitive floor exercise routine on heart rate (HR) and blood lactate (BL) formation in young competitive female gymnasts. **Methods** Ten young gymnasts (mean age  $9.1 \pm 1.4$  yrs) practicing AG at Italian Club were examined. The athletes had been gymnasts for an average of 3.2 yrs, they trained for  $16.2 \pm 1.5$  h/week and they were competitive at National level. The HR (bpm/min) was recorded continuously during a simulation of competition on floor using a telemetric system (Polar Team Pro). All gymnasts performed three floor routine separated each other by four minutes of passive recovery. Three finger prick samples ( $25 \mu\text{L}$ ) for each floor routine were collected and analyzed for BL ( $\text{mmol}\cdot\text{L}^{-1}$ ) before, immediately after, and at 2 minutes (min) of rest period following exercise using a portable lactate analyzers (Arkray Lactate Pro). For the data analysis we have considered the mean parameters' values of the three routine. Results The duration of floor exercise was  $1.26 \pm 2.1$  min. The mean HR during the entire routine was  $176.5 \pm 16.0$  bpm, with mean HR peak of  $191 \pm 18.1$  bpm. For the 42% of the total time of exercise, athletes maintained a very high HR (90-100% of HR max). During the remain time of the floor routine, the HR was comprised between the 80-90% and the 70-80% of the HR max. Gymnasts have produced a low-moderate BL values following each exercise ( $3.2$  to  $5.6 \text{ mmol}\cdot\text{L}^{-1}$ ), that were reverted back to basal values at 2 min rest. **Discussion** Our results showed that cardiovascular load required to young gymnasts during a competitive floor exercise routine is very heavy and it is dominated by anaerobic metabolism. The data suggest the need to develop a training protocol aimed to improve the lactate tolerance of young gymnasts. It would be useful highlight the importance of improve the lactate tolerance specifically if we consider that fatigue in gymnasts is more than a simply metabolic problem, due to its correlation with a higher risk of injuries (Jemni et al., 2003), particularly on floor exercises. **References** Goswami A, Gupta S. (1998). *J Sports Med Phys Fitness*, 38, 317-322. Jemni M, Sands WA, Friemel F, Delemarche P. (2003). *Can J Appl Physiol*, 28, 240-256. Le Marr JD. (1983). *Phys Sports Med*, 11,51.

## THE EFFECTS OF POWER BAND PERFORMANCE TECHNOLOGY ON MOTORICAL ABILITIES OF YOUNG SOCCER PLAYERS

Puzovic, V.1, Djordjevic, D.1, Djurovic, M.2, Jakovljevic, V.1

*1 Medical Faculty University of Kragujevac, 2 Football club Red Star (Belgrade, Serbia)*

**Introduction** Athletes are constantly looking for the aids that would help them improve their performance. One of the most popular ergogenic aids is Power Band bracelet. Power Band contains thin polyester hologram, which is broadcasting the natural frequencies associated with the energy field of the human body. According to manufacturer's assertion, it improves balance and muscle strength and flexibility of up to 30%. However, no scientific study confirms this claim. Thus the aim of our study was to investigate the influence of Powerband hologram on balance, flexibility, explosive strength and acceleration of young football players. **Methods** Forty nine football players (age:  $17.4 \pm 1.1$ ) were subjected to: 1) one leg standing balance test, 2) sit and reach test, 3) squat and countermovement jump test and 4) sprint 10, 20 and 30m. Each subject performed each test 3 times: 1) without any bracelet, 2) with placebo bracelet and 3) with Powerband bracelet. Subjects were divided into 2 groups that differed in the order in which they placed bracelets (group A: 1) without bracelet, 2) with placebo bracelet, 3) with Power Band bracelet; group B: 1) without bracelet, 2) with Power Band bracelet, 3) with placebo bracelet) in order to test if warm up and habituation to the task affected results achieved with bracelets. **Results** When wearing both placebo and Power Band bracelet athletes performed better than when not wearing a bracelet in two tests: balance (no bracelet:  $49.60 \pm 5.79$  sec, with placebo bracelet:  $60.04 \pm 6.37$  sec, with Power Band bracelet:  $66.60 \pm 5.99$  sec) and flexibility (no bracelet:  $9.95 \pm 1.12$  cm, with placebo bracelet:  $10.42 \pm 1.11$  cm, with Powerband bracelet:  $10.71 \pm 1.13$  cm). Two way ANOVA repeated measures showed that wearing a bracelet was a factor that influenced results (Power Band vs no bracelet:  $P=0.002$  and  $0.021$  for balance and flexibility retrospectively) and that observed differences in tests results were not dependent on the order in which athletes placed bracelets during performance of tests. **Discussion** Contrary to the results of previously published studies (1-3), our study found that athletes performed significantly better in tests of balance and flexibility when wearing a bracelet. Those effects may be in part based on placebo effect, but the results of Two way ANOVA repeated measures suggests that there may also be the real effect of hologram on athletes energy field. **References** Brice SR, Jarosz BS, Ames RA, Da Costa C. (2011). *J Bodywork Movem Ther*, 15, 298-303. Porcari J, Hazuga R, Foster C, Doberstein S, Becker J, Kline D, Mickschl T, Dodge C. (2011). *J Sports Sci Med*, 10: 230-231. Pisch M, Cappell S, Drzensla M, Hämel J, Neumann H, Ferrauti A. (2011). 16th Annual ECSS-Congress, Abstract book: 425.



## ANALYSIS OF LINEARS SPRINTS PERFORMED WITH A DIFFERENT ARRIVAL TASK IN YOUNG SOCCER PLAYERS

Tessitore, A.

*University of Rome*

Analysis of linear sprints performed with a different arrival task in young soccer players Tessitore A., Capranica L., Messina R., Di Giuseppe F., Lupo C., Condello G. Department of Human Movement and Sport Sciences, University of Rome "Foro Italico", Italy. Introduction In soccer, the attainment of maximal speed in an action could be unnecessary due to the tactical demands of the game (Carling, et al., 2008). Instead, more decisive could be the player's ability to perform short accelerations, as well as decelerations with a quick stop (Tessitore et al., 2008). Thus, the purpose of this study was to evaluate the linear sprinting ability of young players on sprints performed with different arrival tasks: flying and quick stop. Methods Following parental consent, 39 Italian U.12 soccer players (born in 2001 and 2002) four straight sprint tests were administered on a 4th generation artificial grass field, with players wearing soccer shoes. Performance was assessed in a single session with the following order: a flying 15-m sprint with timing gates positioned at 5m, 10m and 15m, and 3 sprints at corresponding distances with a quick stop (QS) arrival (5mQS, 10mQS and 15mQS). Players performed two trials of each test, with at least 2min and 5min rest between trials and tests, respectively. Sprint time was recorded to the nearest 0.01s using a telemetric photocells system (Microgate, Bolzano, Italy). The best score was used for statistical analysis. A 2 (condition: flying and quick stop) x 3 (distance: 5m, 10m, and 15m) ANOVA for repeated measures ( $p < 0.05$ ) was applied. A correlation matrix was calculated between tests. Results As expected, main effects ( $p < 0.0001$ ) emerged for condition and distance with faster flying performances (5m=1.31±0.06s, 10m=2.23±0.10s, 15m=3.09±0.16s), with respect to the quick stop ones (5mQS=1.53±0.12s, 10mQS=2.61±0.18s, 15mQS=3.54±0.23s). Differences between conditions were 0.22±0.08s, 0.39±0.11s and 0.44±0.10s for 5m, 10m, and 15m, respectively. High correlations emerged between the three distances in the two conditions (flying:  $r = 0.88-0.98$ ; quick stop:  $r = 0.79-0.81$ ). Between conditions, correlations tended to increase with increasing sprint distance (5m:  $r = 0.72$ , 10m:  $r = 0.80$ , 15m:  $r = 0.90$ ). Discussion In critical match activities such as being first on the ball, moving into space before an opponent, increasing the ability to perform short decelerations with a quick stop can be very helpful for players. The findings of this study demonstrated as the ability showed in a flying sprint tasks is not as closely related with a sprint with a quick stop task, especially on a short distance (5 m). This aspect opens a question about the necessity to train this ability in a specific manner and to assess it. References Carling C, et al. (2008). Sports Med, 38(10): 839-62. Tessitore A, et al. (2008). Book of abstracts of "VII World Congress of Performance Analysis of Sport", Magdeburg, Germany.

## ANALYSIS OF COMPETITION IN YOUNG SOCCER PLAYERS BETWEEN 16 AND 18 YEARS OLD

Torres-Luque, G., Cachón-Zagalaz, J., Zagalaz-Sánchez, M.L., Calahorro, F.

*University of Jaén*

Introduction There have been many studies evaluating soccer competition in adults, however, these investigations are limited during formative stages, which usually have a control of heart rate (Stoyer et al., 2004). The aim of the study is to assess physiological and physical demands during a soccer competition between players from 16 to 18 years old, intending to provide a better understanding of competition at these ages. Methods Competition assessment consisted of playing a soccer match among 22 players, assessing temporary structure of the game (TS), heart rate (HR), blood lactate concentration ([BL]) and rate of perceived exertion (RPE). The TS was analyzed with a digital camera after establishing Total Time of the Game (TT), Real Time of play (RT) and Non play Time (NT). Control of HR was measured using a Polar Team 2, identifying minimum HR (HRMin), Mean HR (FCMed), Maximum HR (HRMax) and the percentage of maximal HR (%HRMax). To determine [BL] was carried out lactate analyzer LactatePro, completing 5 tests throughout during the game. Finally, every 10 min of the game there was registered RPE using the Borg scale. Results Results were presented for each period. The TT was 45min 15s, RT was 32min 38s and NT was 12min 53s during First Half. During the second, the TT was 45min 18s, RT 31min 29s, NT 13min 47s. The competition involves an average HR Min of 127,25±18,37 lat/min, HRMed 163,07±7,07 lat/min, HRMax 191,50±7,68 lat/min, %HRMax 80,34 ±3,85. The [BL] and RPE during first half were 4,42±1,63 mmol/l and 14,54±1,57 respectively; and 3,44±1,06 mmol/l and 15,07±1,84 during second half respectively. Discussion It shows an average and maximum intensity similar to Stroyer et al. (2004) and lower % of MaxHR in Castagna et al. (2009). [BL] and RPE data do not appear to players at formative stages. [BL] results are lower compared with adults (Schulpis et al., 2009), however RPE are similar (Clarke et al., 2008). In addition, there is a tendency to increase RPE the second half on the first. It is observed that there is a great utility in using tools, subjective (RPE) and objective (HR and [BL]) to assess requirements for these ages during a soccer competition. References Castagna, C., Impellizzeri, F., Cecchini, E., Rampinini, E., Barbero Alvarez, J.C. (2009). Effects of intermittent-endurance fitness on match performance in young male soccer players. J Strength Cond Res. 23(7), 1954-1959. Clarke, N., Drust, B., Maclaren, D., Reilly, T. (2008). Fluid provision and metabolic responses to soccer-specific exercise. Eur J Appl Physiol. 104, 1069-1077. Stroyer, J., Hansen, L., Klausen, K. (2004). Physiological Profile and Activity Pattern of Young Soccer Players during Match Play. Med Sci Sports Exerc. 36 (1), 168-174.

## LONG-TERM PERFORMANCE DEVELOPMENT IN NATIONAL TEAM WOMEN SOCCER PLAYERS DURING THE AGES OF 16 – 21

Sonderegger, K., Tschopp, M.

*Swiss Federal Institute of Sports*

Introduction A certain level of athletic performance is required to become an elite player in women's soccer (1). Some studies with men soccer players show significant development in performance from adolescence to adulthood (2, 3). But no such studies have been conducted for female players. The aim of this longitudinal study was to detect possible changes in anthropometric and physical parameters of elite national team women soccer players from youth to adulthood. Methods Twenty-three members of a Swiss national women's soccer team were tested three times over four years, starting at the age of 16. (U17: age 16.6±0.3, U19: 18.4±0.4, A-Team: 20.7±1.2y). Besides body weight and body height (no body fat measurement), the battery consisted of four physical tests. Speed was assessed with a 40m all-out sprint (t40m) with time measurement intervals of 10m (t0-10m, t30-40m); explosive strength with countermovement jump (CMJ); endurance with the Yo-Yo intermittent recovery test level 1 (YoYo IR1) and trunk muscle strength with a standardised protocol (4). Longitudinal data were analysed with a one-way repeated measures ANOVA (\* $p < 0.05$ ). Results Linear sprinting performance did not significantly improve with increasing age (t40m: U17: 5.99±0.21, U19: 5.97±0.21, A-Team: 5.95±0.24sec). Both time for acceleration (t0-10m) and maximum speed (t30-40m) did not change between the age groups. No significant development was observed in CMJ (U17: 47.3±5.4, U19: 49.1±7.4, A-Team: 49.3±5.3W/kg body weight). YoYo IR1 (U17: 1262±328, U19: 1369±302, A-Team: 1397±346m) as well as trunk muscle strength did not differ among the three measurement points. In contrast, there were significant changes in body weight

(+3.8% from U17 to A-Team), height (+0.5%) and body mass index (+2.6%). Discussion While there were small but significant changes in anthropometric parameters, no significant developments in the measured performance parameters were observed. This contrasts with results in talented men soccer players aged 14 – 18y (2) and aged 12 – 19y (3), which show an improvement in the intermittent endurance capacity and the shuttle sprint performance. Differences in body composition development (increase in fat mass) between men and women in these age groups or differences in training content could explain this. In order to stay in a women's elite national team with a Fifa World Ranking of around 25, maintaining the level of athletic performance one has between 16 and 21 years seems sufficient. References (1) Mohr, M. et al. (2008). *J Strength Cond Res*, 22(2), 341 – 9. (2) Roescher, CR. et al. (2010). *Int J Sports Med* 31(3), 174 – 9. (3) Huijgen, BC. et al. (2010). *J Sports Sci*, 28(7), 689 – 98. (4) Bourban, P. et al. (2001). *Schweiz Z Sportmed und Sporttraum*, 49(2), 73 – 78.

### MAXIMUM AND DYNAMIC STRENGTH DOES NOT DETERMINE SPRINT PERFORMANCE AND VERTICAL JUMP HEIGHT IN YOUNG ELITE FOOTBALL PLAYERS

Li, F.X.1, Bowen, L.1, Taberner, M.2, Ross, F.2, Needham, O.2, Wilson, C.2

1- University of Birmingham / 2- Aston Villa Football Club Academy

**Introduction** Football is often considered an endurance sport; however, strength and power have equal importance in top level performance, as high forces must be generated repeatedly. Power is largely reliant on maximal strength; for example, Wisløff et al. (2004) found that maximum strength half squats determine sprint speed and jump height in elite football players. To date, this relationship has not been tested for in young elite footballers and therefore cannot be generalised to all age groups, as previous data suggests that biological maturity can influence the functional capacity of adolescent football players (Malina et al., 2004). **Aims** The present study aims to examine the relationship of maximal and dynamic strength with sprint speed and jump height in young elite footballers. **Method** Ten young male elite footballers were tested (mean age  $17.2 \pm 0.6$  years, height  $178.0 \pm 6.9$  cm and weight  $71.5 \pm 9.5$  kg). They performed one and three repetition maximum (1RM and 3RM respectively) strength in hexagonal barbell dead lifts, two 10 m and 10 m shuttle run sprints and three vertical jumps. **Results** Regression analyses revealed that 1RM accurately predicts 3RM ( $R^2 = .83$ ,  $p < 0.05$ ). Sprints are also moderate predictors of shuttles ( $R^2 = .54$ ,  $p < 0.05$ ). However, there was no significant relationship between maximal strength or dynamic strength with the sprint and jump variables, or jumps and sprints or shuttles (1RM  $123.0 \pm 20.0$  kg,  $7.1 \pm 1.0$  kg/(kg body weight) $^{0.67}$ ; 3RM  $111.0 \pm 16.8$  kg,  $6.4 \pm 1.0$  kg/(kg body weight) $^{0.67}$ ; vertical jump  $52.3 \pm 7.8$  cm; 10 m sprint  $1.821 \pm 0.1$  s; 10 m shuttle run  $4.229 \pm 0.2$  s). **Discussion** This is the first study to demonstrate that, in top level footballers, the strong correlation of strength with sprint performance and jump height in adults (Wisløff et al., 2004), cannot be replicated in young players. The findings of Malina et al. (2004) suggest that this may be due to the different maturation levels of the players in this study. However further research is needed to establish the precise mechanisms preventing generalisation. Although 1RM and 3RM are strongly related, the explosive power activities are not. This suggests that in young elite footballers, maximal and dynamic strength deadlifts are inappropriate to ascertain sprint, shuttle and jump ability; therefore, an accurate predictor is yet to be established. **References** Malina, R. M., Eisenmann, J. C., Cumming S. P., Ribeiro, B., & Aroso, J. (2004). *Eur J App Physiol*, 91, 555-562. Wisløff, U., Castagna, J., Helgerud, J., Jones, R., & Hoff, J. (2004). *Br J Sports Med*, 38, 285-288.

### EVALUATION OF PHYSICAL FITNESS IN JUNIOR SOCCER PLAYERS

Torres-Luque, G., Calahorra, F., Cachón-Zagalaz, J., Lara-Sánchez, A.J.

University of Jaén

**Introduction** Monitoring and assessment of physical fitness is currently employed to determine the physical state of soccer players at certain times during the season and it provides control and possible adaptation's of planning and training according to the capabilities of players. The footballer, to yield a competitive level requires a combination of qualities. These physical and functional parameters are essential for performance in competition, requiring adequate levels of endurance, strength, flexibility and speed, along with proper coordination, balance, agility and cognitive ability for taking the right decisions during the game (Reilly et al., 2000). In addition, they argue that it would be interesting to control and monitor these variables during the player's development, as they can determine the future athletic performance at this age of formation. **Methods** 29 players were selected to determine their body composition (Inbody 720), maximum strength in bench press, hamstring flexibility (Sit and Reach test), countermovement jump and Abalakov jump (Platform Muscledab 4000), and maximal oxygen consumption (Course Navette test) during 3 days. For statistical analysis SPSS v.15 for Windows was used. **Results** The following results were found. The body fat percentage and body muscle percentage were  $10.94 \pm 3.09\%$  and  $31.52 \pm 1.55\%$  respectively. There was a maximum volume of oxygen consumption of  $61.60 \pm 2.51$  ml·kg $^{-1}$ ·min $^{-1}$ , a maximal aerobic speed of  $14.48 \pm 0.41$  km/h, a maximum strength bench press of  $66.44 \pm 9.82$  kg, a countermovement jump of  $38.08 \pm 3.70$  cm, an Abalakov jump of  $46.22 \pm 5.00$  cm and a hamstring flexibility of  $24.96 \pm 7.26$  cm. **Discussion** The average values of results indicate similar values or slightly lower values compared to elite for body mass index, body fat percentage, maximum volume of oxygen consumption, Abalakov jump and hamstring flexibility. Results are similar in maximal aerobic speed to amateurs and much higher values for maximum strength bench press in amateurs and lower in countermovement jump and body fat percentage (Stroyer et al., 2004; Le Gall et al., 2008). The results show that group values are similar to those found in the literature for junior and young soccer players. **References** Le Gall, F., Carling, C., Williams, M., Reilly, T. (2008). Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. *JSSM*. 8 (3), 468-480. Reilly, T, Bangsbo, J. Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *J Sports Science*. 18, 669-683. Stroyer, J., Hansen, L., Klausen, K. (2004). Physiological Profile and Activity Pattern of Young Soccer Players during Match Play. *Med Sci Sports Exerc*. 36 (1), 168-174.

### CHANGES IN FIELD TEST RESULTS DURING COMPETITIVE SEASON OF YOUNG SOCCER PLAYERS

Vucetic, V., Sukreski, M.

Faculty of Kinesiology

**Introduction:** Because of the game duration and intensities, soccer is mainly dependent upon aerobic metabolism. The studies have shown that football players at a lower level of aerobic capacity ( $VO_{2max}$ ) have much lower average distance, with a more walking and jogging, while players on the higher level of  $VO_{2max}$  cover more distance by running and sprinting (Verheijen, 1997). In most cases, laboratory tests for assess  $VO_{2max}$  are not available in practice, so we're forced to evaluate aerobic capacity with field tests. Two very common field tests in football are multistage fitness test (MST) and Hoff test (HOFF). Correct training program can improve  $VO_{2max}$ , and guided with this thought, we have asked ourselves if there are any changes in the  $VO_{2max}$  at young football players in competitive season. **Methods:** Twenty young football players (Age= $13.0 \pm 0.2$  yrs; H= $156.3 \pm 1.9$  cm; W= $47.7 \pm 2.3$  kg) were taken from the football school

in Croatia. All subjects performed MST and HOFF, as specific football. Tests are conducted approximately every 3 months, at the beginning and end of the spring and autumn season. Based on the results of the tests we estimate VO<sub>2</sub>max for each player. The ANOVA and the Bonferroni test were used to determine differences in observed variables between the four time points. Results: By analyzing the data we obtained statistically significant differences in VO<sub>2</sub>max in both tests. The result (in finish level) of MST in four time points was (9.0±0.2 at 1st; 9.7±0.2 at 2nd; 9.9±0.9 at 3th and 10.8±0.2 at 4th) and estimate VO<sub>2</sub>max (43.2±0.9 at 1st; 45.9±0.7 at 2nd; 46.9±0.8 at 3th and 49.6±0.7 mlO<sub>2</sub>/kg/min at 4th). The result of HOFF (in m) was (1458.1±24.1 at 1st, 1569.9±26.6 at 2nd, 1524.5±26.0 at 3th and 1576.5±24.4 at 4th) and estimate VO<sub>2</sub>max (ml/kg/min) was (55.8±1.2 at 1st; 61.2±1.2 at 2nd; 59.7±1.1 at 3th and 61.7±1.2 at 4th). The trend of body height and weight was regular for all 4 measurements (H1=156.3cm; H2=160.8cm; H3=162.8cm; H4= 167.5cm; W1=47.8kg; W2=18.7kg; W3=162.8kg; W4=167.5kg). Conclusion: Based on the test results we can conclude that change in VO<sub>2</sub>max in young footballers is statistically significant. Although we can see the difference in VO<sub>2</sub>max between MST and HOFF, which is probably a consequence of specific movement structures of HOFF, we can see a trend of growth in one and another for approximately 10.5%. In this study raises the question how great the impact of the growth and development on VO<sub>2</sub>max is and how great is the impact of training on VO<sub>2</sub>max. References: • Astrand, P.O., Rodahl, T. (1986). New York: McGraw-Hill, USA. • Gil, S. et al (2007). JSCR. 21(2).438-445. • Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. (2005). SM 35(6), 501-536 • Verheijen, R. (1997) BPF, Versand, Leer

### STEP FREQUENCY AND RUNNING SPEED IN YOUNG FOOTBALL PLAYERS

Bonfanti, L., Di Palo, G., Arcelli, E., Alberti, G.

*Università degli Studi di Milano*

Introduction Speed is a necessary skill in different sports: its different use is established by technical and physiological model of specific sports. Speed can be considered as a quality influenced by three expressive attitudes that determine the performance: muscular strength, technique and rhythm (1). Literature showed that highest speeds are the best compromise between steps frequency and length (2). The purpose of this study is to check, in young amateur soccer players, whether steps frequency improvements, after a specific workout protocol, could increase the speed in short sprint ability. Methods 29 male young amateur football players (12.43 ± 1.7 years) have been evaluated, splitted into three groups by age: 2000 (G00), 1999 (G99), 1998 (G98). Running speeds (RS), tested by Polifemo photocells and Racetime (Microgate, Bolzano, Italy), and step frequency (SF), evaluated with video analysis by camera at 50 Hz, were assessed. Three tests were performed on 30m distance, with 3 minutes of recovery, in two non-consecutive days, before and after a specific training protocol to improve step frequency. All data were analyzed with Student's t-test for paired data on SPSS v.15 software, and P<0.05 was chosen as the significant rate. Results Maximum values of SF significantly increased of 5% (p<0.01), in particular in G98 (8% and p<0.001). Also the average values of SF significantly increased of 3% (p<0.05), and G98 of 8% (p<0.001). Finally, RS significantly raised of 1% (p<0.05), G98 in particular improved the speed performance of 3% (p<0.001). Discussion Like other studies that have analyzed greater distances (2), this study indicates that a specific training can improve step frequency and speed in short sprint ability. Therefore, to improve short sprint ability, it would recommended to include training of the step frequency in workout plans for young football players. References 1.Cavagna GA, Willems PA, Franzetti P, Detrembleur C. The two power limits conditioning step frequency in human running. J. Physiol. (Lond.). 1991 Giu;437:95-108; 2.Vittori C. L allenamento delle specialità di corsa veloce per gli atleti d'élite. *Atleticastudi; FIDAL, Centro Studi e Ricerche, Roma 2003.*

### EFFECT OF MATCH PLAY ON GROIN INJURY RISK FACTORS IN YOUNG SOCCER PLAYERS

Paul, D.1, Whiteley, R.2, Marques, J.1, Nassis, G.P.1

*ASPETAR-Qatar Orthopaedic and Sports Medicine Hospital*

Introduction The propensity of groin injuries (1.0-1.1 per 1000 playing hours, accounting for 11 to 16% of all soccer injuries) among soccer players has stimulated much interest in the research and applied domain. Risk factors include age, high level of play, previous injury, amongst others (Engebretsen et al., 2010). However, there is limited data pertaining to the effects of match load on groin injury risk factors such as strength and flexibility. Therefore, the aim of present study was to 1) determine the reliability of hip flexibility and strength measures, and 2) identify the effects match play load has on these measures. Method Sixteen elite national level youth team soccer players (15-17 years old) performed strength (adduction and abduction) and flexibility (bent knee fall out test) measures on 2 separate occasions 24hr apart. Reliability was evaluated with the Intraclass Correlation Coefficient (ICC). The same players repeated these tests ~9hrs before and 14hrs after an international friendly match. Minutes played x rate of perceived exertion was used to quantify match play load (Foster et al., 1996). Statistical analysis was performed with paired T-test. Results A moderate ICC was reported for right (0.610) and left leg (0.551) flexibility measures. A low ICC was found for adductor and abductor strength for both legs. Left leg flexibility deteriorated significantly from before to after the match (pre: 16.8±5.3, post: 19.8±5.1cm, mean±SD, p=0.01). A similar trend was shown for the right leg (pre: 17.3±5.1, post: 18.4±5.7cm, p=0.09). An exponential relationship was found between match load and changes in flexibility for the left leg (R<sup>2</sup>=0.26). Discussion The main findings of this study were 1) reliability was moderate for flexibility and low for strength, and 2) a decrease in flexibility was found as a result of match play. With regards to the first finding, it seems greater familiarisation is needed to improve strength test reliability. Despite no evidence of a linear correlation between match load and flexibility measures, it seems that there might be a match load threshold after which flexibility is negatively affected. However, this warrants further investigation using direct recording of match activity (e.g., distance) or physiological load (e.g., time x heart rate). In conclusion, given the time constraints and logistical issues surrounding strength testing, groin flexibility might be a sensitive and reliable measure to detect changes as a result of fatigue. References Engebretsen A, Myklebust G, Holme I, Engebretsen L, Bahr R. (2010). Am J Sports Med, 38(10), 2051-2057. Foster C, Daines E, Hector L, Snyder AC, Welsh R. (1996). Wis Med J, 95(6), 370-374.

14:45 - 15:45

## Poster presentations

## PP-PM50 Physiology 12

**THE RELIABILITY OF MUSCLE OXYGEN SATURATION AND BLOOD VOLUME CHANGES DURING CONTINUOUS AND INTERMITTENT RUNNING EXERCISE**

Ihsan, M., Watson, G., Lipski, M., Abbiss, C.R.

*Edith Cowan University*

THE RELIABILITY OF MUSCLE OXYGEN SATURATION AND BLOOD VOLUME CHANGES DURING CONTINUOUS AND INTERMITTENT RUNNING EXERCISE Ihsan, M.1, Watson, G.1,3, Lipski, M.2, Abbiss, C.R.1: 1: ECU (Joondalup, Australia), 2: GSU (Cologne, Germany), 3: UTAS (Tasmania, Australia) Introduction Near infrared spectroscopy (NIRS) is often used to determine muscle oxygen saturation and blood volume changes during continuous exercise. We are unaware of any study that has established the reliability of NIRS in vastus lateralis (VL) during continuous (CR) and intermittent (INT) exercise. The purpose of this study was to determine the test-retest reliability of muscle oxygen saturation and blood volume responses during CR and INT running. Methods On two occasions, ten subjects performed 30 min of CR at 70% of maximal aerobic speed (MAS), followed by 10 bouts of INT at 100% of MAS. Oxygenation (TOI) and blood volume (tHb) changes in VL were monitored using NIRS. Mean TOI (TOI-Av) and the difference in TOI amplitude change (TOI-Diff) during CR were determined. Muscle de-oxygenation and re-oxygenation rates during INT were determined with (Deoxy-TD, Reoxy-TD) and without (Deoxy, Reoxy) time delay in de-oxygenation (TD-WI) and re-oxygenation (TD-RI). tHb decline (tHb-DR) and recovery rate (tHb-RR) during INT were also determined. The intraclass correlation coefficient with 90% confidence intervals (ICC, 90% CI) and coefficient of variation (CV, %) were determined. Results The reliability of TOI-AV (ICC; 0.90 (0.71-0.97), CV; 3±2%) during CR was better than TOI-Diff (ICC; 0.75 (0.38-0.91), CV; 23±17%). The reliability of Deoxy and Deoxy-TD were similar (Deoxy; ICC; 0.88 (0.67-0.96), CV; 9±7% vs Deoxy-TD; ICC; 0.86 (0.61-0.95), CV; 9±7%). However re-oxygenation rates were more reliable when TD was accounted for (Reoxy-TD; ICC; 0.94 (0.80-0.98), CV; 12±7% vs Reoxy; ICC 0.68 (0.19-0.88), CV; 16±14%). Mean TD-WI (ICC; 0.89 (0.68-0.96), CV; 8±6%) and TD-RI (ICC; 0.85 (0.60-0.95), CV; 6±6%) were moderately reliable during INT. The tHb response during CR (tHb; ICC; 0.96 (0.88-0.99), CV; 7±4%) and INT (tHb-DR; ICC; 0.98 (0.93-0.99), CV; 6±6%, tHb-RR; ICC; 0.97 (0.90-0.99), CV; 7±6%) showed moderate reliability. Discussion Results of this study indicate that TOI and  $\Delta$ tHb during CR are moderately reliable (CV= 3-23%; ICC=0.75-0.90). These results are similar to that reported in the gastrocnemius during running at lactate threshold (R=0.87) and at VO<sub>2</sub>max (R=0.88) (Austin et al., 2005) but considerably lower than in bicep brachii during arm cranking exercise (CV=22-36%) (Muthalib et al., 2010). The reliability of  $\Delta$ tHb and the TD of de-oxygenation and re-oxygenation during INT, which have not previously been investigated, were also moderate (CV= 6-15%). References Austin K G, Daigle K A, Patterson P, Cowman J, Chelland S, Haymes E M. (2005). *Res Q Exerc Sport*, 76(4), 440-449. Muthalib M, Millet G Y, Quaresima V, Nosaka K. (2010). *J Biomed Opt*, 15(1), 0170081

**THE RELATIONSHIP BETWEEN PEAK MUSCLE OXYGEN CONSUMPTION AND MUSCLE OXYGENATION RECOVERY TIME AFTER SUBMAXIMAL EXERCISE**

Ichimura, S., Moriguchi, T.

*Tokyo University of Science*

Purpose We investigated the relationship between pulmonary and muscle oxygen consumption (mVO<sub>2</sub>) and the muscle oxygenation recovery time after exercise to establish a convenient method with less onerous for subjects during estimating the muscle oxygen capacity. Methods Subjects were seven healthy male volunteers (age 26±6yrs; height 169.4±6.7cm; weight 66.0±9.3kg) performed the dynamic knee extension and cycling exercise with stepwise incremental load method. The exercise load during dynamic knee extension exercise was started at 24watts and increased by 12watts every 6 minutes including 3 minutes recovery time (3min Ex + 3min Rec). That during cycling exercise was started at 60watts and increased by 30watts every 6 minutes within 3 minutes recovery time. The each exercise was performed until the subjects reached exhaustion and was performed the twice to evaluate the mVO<sub>2</sub> and muscle oxygenation recovery time, respectively. Pulmonary O<sub>2</sub> uptake and CO<sub>2</sub> output (AE-280, Minato) and muscle oxygenation at the vastus lateralis using near-infrared spectroscopy (HEO-200, Omron) were measured. We performed arterial occlusion on upper thigh proximal to the measurement sites before the start of the exercise for 3 minutes and repeated arterial occlusion immediately after each exercise load for 1 minute to evaluate the mVO<sub>2</sub> at rest and during each exercise load during estimating the mVO<sub>2</sub> (Hamaoka et al. 1996 JAP). The muscle oxygenation recovery time was evaluated the using the half recovery time of muscle oxygenation (T<sub>1/2</sub>reoxy) (Ichimura et al. 2006). Results Pulmonary O<sub>2</sub> uptake, CO<sub>2</sub> output and mVO<sub>2</sub> were increased with the increased load during dynamic knee extension exercise and cycling exercise. In dynamic knee extension exercise, the value of CO<sub>2</sub> output was significantly higher than that of O<sub>2</sub> uptake during 63% of peak workload. In cycling exercise, the value of CO<sub>2</sub> output was significantly higher than that of O<sub>2</sub> uptake during 73.7% of peak workload. T<sub>1/2</sub>reoxy in dynamic knee extension exercise and cycling exercise were not significant increased since 63% and 73.7% of workloads, respectively although the increase of the T<sub>1/2</sub>reoxy observed with increased load. In dynamic knee extension exercise, there was an inverse correlation between the peak mVO<sub>2</sub> and the T<sub>1/2</sub>reoxy after peak workload exercise (r=-0.849, p<0.05). It was observed the tendency of an inverse correlation between the peak mVO<sub>2</sub> and the T<sub>1/2</sub>reoxy during 63% of peak workload (r=-0.726, p=0.06). In cycling exercise, the inverse correlation between the peak mVO<sub>2</sub> and the T<sub>1/2</sub>reoxy after peak workload exercise (r=-0.881, p<0.05) and 73% of peak workload exercise (r=-0.823, p<0.05) were observed. The value of peak oxygen uptake also inverse correlated with T<sub>1/2</sub>reoxy after peak workload exercise (r=-0.941, p<0.01) and 73% of peak workload exercise (r=-0.930, p<0.01). Conclusion We found that the T<sub>1/2</sub>reoxy after maximal exercise relate to the peak mVO<sub>2</sub>, as well as that after submaximal exercise intensities corresponding to the ventilator threshold.

### COMPARISON OF POST-EXERCISE CHANGES IN OXIDATIVE STATUS IN UNTRAINED MEN IN RELATIONSHIP TO FAT CONTENT IN THEIR BODIES

Szygula, Z., Wiecek, M., Maciejczyk, M., Szymura, J., Wiecha, S.

*University School of Physical Education, Krakow*

**Introduction** The elevation of metabolism during exercise leads to enhanced production of free radicals resulting in oxidative stress and damage of cellular constituents. **Aim** The aim of the study was to compare post-exercise changes in oxidative status of plasma in untrained men in relation to the fat content in their bodies. **Methods** Participants: Fourteen untrained non-smoking, healthy men (18-25 yrs old) participated in this study. Body composition and percentage of body fat (PBF) were assessed by the means of bioimpedance device (Jawon Medical Body Composition Analyzer Model ioi 353, Korea) as well as by skinfolds measurements. According to PBF participants were divided into two groups with different body composition: HF – high fat (n=5): PBF = 22.9±2.28%; LBM = 81.66±2.85; VO<sub>2</sub>max = 51.77±5.49 ml/kg/min and NF – normal fat (n=8): PBF 16.04±2.17%; LBM = 60.79±1.2; VO<sub>2</sub>max = 55.44±6.77 ml/kg/min. **Exercise test:** Each participant performed an incremental exercise test on the mechanical treadmill (model) till exhaustion. They started with initial speed of 7 km/h and every 2nd min speed increased by 1.2 km/h. Ventilatory variables such as VE, VT, fR, VO<sub>2</sub>, RQ, and HR were monitored using ergospirometer Medikro-919 (Medikro Oy, Finland). **Blood analysis:** Venous blood samples were collected before and 3 min after exercise. The total oxidative status (TOS), the total antioxidative status (TAS), and lactates concentration were measured in blood plasma using commercially available kits. **Statistical analysis:** Data were expressed as the mean ± SD. Statistical analysis was performed using nonparametric U Mann-Whitney and Wilcoxon tests. The relationship between measurements were tested using the Spearman rank test. Significance was defined as P<0.05. **Results** Statistically significant increase in TOS was observed in both groups after exercise – by 34.2% in group HF and by 29.2% in group NF, whereas an increase in TAS was only minor, by 3.5% and 2.1% in both groups HF and NF respectively. Post exercise values of TAS were statistically greater in group HF comparing to NF. A negative correlation was observed between VO<sub>2</sub>max and post exercise values of TAS (r=-0.57) and positive correlation between PBF and TAS before (r=0.59) and after physical effort (r=0.85). There were no correlations between changes (deltas) of TAS, TAS and PBF. **Conclusions** Physical effort caused significant increase of total oxidative status in both groups, however, the increase was more pronounced in group of people with greater amount of fat in their organisms. The study was financed by NCN; project No N N404 071240

### THE EFFECTS OF CHEST WALL RESTRICTION ON CARDIO-RESPIRATORY RESPONSES, MUSCLE DEOXYGENATION AND PERFORMANCE DURING MAXIMAL EXERCISE

Ishida, K., Katayama, K., Iwamoto, E., Sugiura, H., Hotta, N.

*Nagoya University*

**The Effects of Chest Wall Restriction on Cardio-respiratory Responses, Muscle Deoxygenation and Performance during Maximal Exercise** Ishida, K. 1, Katayama, K. 1, Iwamoto, E. 1, Sugiura, H. 2, Hotta, N. 3 1: Nagoya University (Nagoya, Japan), 2: Nagoya Isen (Nagoya, Japan), 3: Chubu University (Nagoya, Japan) **Introduction** Sometimes while playing sports people have to wear tight fitting equipment or clothing around their chest (e.g. scuba diving, fencing, and kendo). Additionally, patients with restrictive ventilatory impairment and athletes suffering from chest and back pain, who wear corsets, also do exercise. In all of these cases, the movements of the chest wall are restricted to the point that respiration and circulation should be affected during exercise. Only a few investigators (O'Connor et al. 2000, Coast et al. 2002) observed the effects of chest wall restriction on maximal exercise, and they could not reveal the physiological background. The purpose of the present study was, therefore, to elucidate the effects of chest wall restriction on endurance performance, and cardio-respiratory responses and deoxygenation during incremental exercise to exhaustion. **Methods** Nine male subjects performed maximal exercise to exhaustion (MAX) under chest wall restriction (CR) and non restriction control (NR) conditions. CR was achieved by tightening 3 non-stretch fiber belts (5 cm wide) with the traction of 5 kg around the subjects' chest. We confirmed that this restriction caused more than a 30% decrease in the vital capacity of the subjects. In both the CR and NR conditions, the subjects performed cycling exercise tests with an incremental load until exhaustion (start: 20W, 20 W/2 min increase). During exercise we measured oxygen uptake (VO<sub>2</sub>), minute ventilation (VE), tidal volume (TV), respiratory frequency (fr), heart rate (HR), tissue oxygen saturation (SpO<sub>2</sub>), blood lactate concentration (La), and muscular deoxygenation levels by near-infrared spectroscopy. **Results and Discussion** We found that under CR conditions, as compared with NR, 1) peak VO<sub>2</sub> and endurance time were less by about 9%, indicating decrease in maximal performance, 2) VE was greater at the sub-maximal exercise, but the maximal value was lower, 3) TV was less while fr was higher throughout the experiment, 4) SpO<sub>2</sub> became less at a higher exercise intensity during MAX, 5) HR was higher at exhaustion, 6) the muscle deoxygenation rate estimated by near-infrared spectroscopy only tended to decrease more, 7) La was less at the maximal value in MAX, but showed no difference during sub-maximal exercise. These last two data may suggest little involvement of peripheral functions. **Conclusion** These results indicate that endurance performance should be decreased by CR, and this would be attributed directly to impaired respiration due to CR, not to peripheral factors. **References** O'Connor S, McLoughlin P. et al. (2000). *J Appl Physiol*, 89, 2179-2186 Coast JR, Cline CC (2004). *Respirology*, 9, 197-203

### RAPID CARDIOVASCULAR RESPONSES TO BREATH-HOLDING DURING EXERCISE

Perini, R., Capogrosso, M., Donati, S., Sivieri, A., Ferretti, G.

*University of Brescia*

**Introduction** Breath-holding induces a rapid cardiovascular adjustment, eliciting a decrease in heart rate (HR) and a slight but significant increase in blood pressure (BP) within the initial 30 s of both dry and immersed apnea. These responses have been ascribed to augmented vagal and sympathetic activity, respectively. The level of activity of the autonomic nervous system prior to apnea may nevertheless affect the initial cardiovascular responses to breath-holding. Thus, since vagal and sympathetic activities are modified during muscular work compared to rest, we tested the above hypothesis by investigating the HR and BP time courses of short apneas during exercise. **Methods** 8 divers (age 36±7 yrs) performed two apneas, each lasting 30 s: A) sitting at rest; B) pedaling at 30 W on a cycle-ergometer. BP profile was continuously recorded (photo-plethysmography, Portapres) and beat to beat values of systolic and diastolic pressures (Ps and Pd) and HR were obtained. Metabolic rate was measured before and after apnea by a metabolic cart. **Results** A) HR progressively decreased from 98±11 b/min, i.e. about 20 b/min above control value (ctrl), to 83±13 b/min. Both Ps and Pd dropped after 5±1 s, respectively, by 52±14 mmHg and 18±4 mmHg, returning in the following 7-8 s to ctrl (Ps: 140±11 mmHg; Pd: 70±8 mmHg). Then, Ps did not change further, while Pd increased by 14± 6 mmHg (p<0.05). B) metabolic rate was twice as at rest and HR was 18±13 b/min above ctrl. HR did not change throughout the initial 21±5 s of apnea, remaining stable at 113±9.5 b/min (i.e. 15 b/min above exercise steady state

values). Then, HR slightly decreased by 10-12 b/min. Ps and Pd decreased by  $71 \pm 13$  mmHg and  $22 \pm 8$  mmHg, respectively, after  $3 \pm 1$  s, recovering initial values at about 10 s. Then, while Ps remained stable, Pd progressively increased by  $16 \pm 8$  mmHg ( $p < 0.05$ ). Discussion Chronotropic cardiac response to breath-holding was significantly delayed in exercise apnea, possibly due to the reduced vagal tone prior to breath-holding. On the other hand the increase in BP was not different in the two conditions, suggesting similar circulatory responses. These findings are consistent with the hypothesis of separate cardiac and vascular control at the beginning of apnea. The very rapid drop in BP systematically found in the first seconds of apnea is probably expression of the reduction in venous return due to breath-holding.

### **INFLUENCES OF DIAPHRAGM FATIGUE ON MUSCLE SYMPATHETIC NERVE ACTIVITY AND BLOOD PRESSURE DURING SUBMAXIMAL EXERCISE**

Katayama, K., Iwamoto, E., Ishida, K., Koike, T., Saito, M.

*Nagoya University*

**Introduction** It has been reported that high intensity whole body exercise elicits diaphragm fatigue (Romer et al., 2008). The fatiguing diaphragm affects cardiovascular regulation and blood flow distribution during heavy exercise (Dempsey et al., 2008). However, it is still unclear whether diaphragm fatigue leads to alterations in sympathetic nerve activity and blood pressure (BP) during submaximal exercise. The aim of this study was to elucidate the influences of inspiratory muscle fatigue on sympathetic vasoconstrictor outflow and blood pressure during dynamic leg exercise. **Methods** Seven males participated in this study. On day 1, to estimate peak oxygen uptake ( $VO_{2peak}$ ), a maximal exercise test was performed using a cycle ergometer in a semi-recumbent position. On day 2, the subjects performed two 10 min exercises at 40% $VO_{2peak}$  (spontaneous breathing for 5 min and with or without inspiratory resistive breathing for 5 min). Before and immediately after exercise, maximal inspiratory pressure (P<sub>I</sub>max) as an index of inspiratory muscle strength was estimated. On day 3, the subjects performed two 15 min exercises at 40% $VO_{2peak}$  (spontaneous breathing for 5 min, with or without inspiratory resistive breathing for 5 min, and spontaneous breathing for 5 min). During exercise, muscle sympathetic nerve activity (MSNA) and BP were measured. MSNA was recorded via microneurography of the right median nerve at the elbow. Results P<sub>I</sub>max decreased significantly following exercise with resistive breathing, but not without resistance. A progressive increase in MSNA occurred during exercise with inspiratory resistance, accompanied by an augmentation of BP. Discussion A decrease in P<sub>I</sub>max occurred after exercise with inspiratory resistance. The decreased inspiratory muscle strength would be the principle cause of diaphragm fatigue. The diaphragm has an abundance of type IV metaboreceptors, and fatiguing the diaphragm via phrenic nerve stimulation caused an increase in type IV afferent discharge. Furthermore, when metaboreceptors in the diaphragm were stimulated electrically, pharmacologically, or with local lactic acid infusions, efferent sympathetic nerve activity increased and vascular conductance decreased in selected vascular beds. In the present study, the time-dependent increase in MSNA and BP appeared during exercise with resistive breathing. Consequently, these results suggest that the fatiguing diaphragm, and thereby the metaboreflex, has a powerful influence on sympathetic vasoconstrictor outflow during exercise. **References** Dempsey JA, Amann M, Romer LM, Miller JD. (2008). *Med Sci Sports Exerc*, 40, 457-461. Romer LM, Polkey MI. (2008). *J Appl Physiol*, 104, 879-888.

### **PHYSIOLOGICAL BREATH-HOLD BREAKING POINT DURING REPEATED APNEAS IN YOUNG ANEMIC WOMEN**

Triantafyllou, D.

*National & Kapodistrian University of Athens*

**Introduction** Breath-hold time (BHT) consists of an "easy going" and a "struggle" phase separated by a physiological breaking point (PBP) denoting the onset of involuntary ventilatory activity (IVA) (Dejours 1965). Repeated apneic attempts with short intervals improve BHT due to prolongation of both phases (Schagatay et al. 2000). Apnea elicits cardiovascular changes [bradycardia, rise in mean arterial pressure (MAP) and total peripheral resistance (TPR)], known as "diving reflex" (Schagatay et al. 1998). We studied the effect of repeated apneas on BHT, PBP and cardiovascular response during apnea in young women with normal (C) and low (An) hemoglobin concentration ([Hb]). **Methods** Two groups of young ( $20.6 \pm 2.6$  yrs) physically active women, 8 with normal [Hb] ( $12.9 \pm 0.2$  gr/dl), Fe and ferritin levels and 8 with mild iron-deficiency anemia ([Hb]:  $11.3 \pm 0.1$  gr/dl) with no previous diving experience were studied at early follicular phase. Subjects performed 5 apneas with face immersion in cold water ( $12^\circ\text{C}$ ) separated by 2-min rest. BHT, breathing movements via respiratory muscle EMG (BIOPAC) and cardiovascular parameters (Finometer) were recorded during the experimental protocol. Results BHT was similar in the 1st (A1) as well as in the 5th (A5) apnea in An and C, and it was improved by repeated apneas similarly in the two groups (by 23 sec in average from A1 to A5;  $p < 0.01$ ). The PBP, expressed as a percentage of total BHT, was not different in C at A1 (68.4%) and A5 (72.1%), whereas in An it occurred earlier at A5 (56.5%) compared to A1 (74.6%). Despite that An had lower arterial oxygen content (CaO<sub>2</sub>) than C (An:  $14.8 \pm 0.3$  gr/100ml, C:  $17.2 \pm 0.3$  gr/100ml) the two groups did not differ at heart rate, MAP and TPR during the course of 5 apneas. **Discussion** Both control and mildly anemic subjects improved BHT during repeated apneas, but this was achieved differently by the two groups; An exhibited the PBP earlier during the 5th apnea but they could tolerate the struggle phase for longer, thus managing during that last apnea to achieve BHT similar to that of C, who did not change their PBP during the series of the 5 apneas. Moreover, although it has been suggested that anemia modifies cardiovascular regulation especially under stressful conditions (Calbet et al. 2006), the mild level of anemia used in the present study did not affect the magnitude of diving reflex during apnea. **References** Dejours P. (1965). *J Appl Physiol*, 37, 291-296. Schagatay E, Andersson J. (1998). *Undersea Hyper Med*, 25, 13-19. Schagatay E, van Kampen M, Emanuelsson S, Holm B. (2000). *Eur J Appl Physiol*, 82, 161-169. Calbet JAL, Lundby C, Koskolou M, & Boushel R. (2006). *Resp Physiol Neurobiol*, 151, 132-140.

### **DIFFERENCES IN LOCAL AND TOTAL OXYGEN CONSUMPTION DURING INCREMENTAL CYCLING EXERCISE**

Skovereng, K., Ettema, G., van Beekvelt, M.

*Norwegian University of Science and Technology*

**Introduction** The human body depends heavily on oxidative metabolism, which makes the study of oxygen consumption ( $VO_2$ ) an important and interesting field of research. Measurement of whole body  $VO_2$  has been done extensively, but does not necessarily reflect the energy expenditure within the active muscle(s). Measuring local  $VO_2$  is more complicated and has been studied to a far less extent, but several previous studies have reported differences between  $VO_2$  in the local muscles and the whole body during exercise (1, 2). The purpose of this study was to investigate changes in total and local  $VO_2$ , measured simultaneously with pulmonary gas exchange and near-infrared spectroscopy (NIRS) during cycling exercise at various constant-load work rates. **Methods** 18 trained male subjects

(VO<sub>2</sub>peak 55.9 ± 4.5 ml/kg/min) performed an incremental exercise protocol on a cycle ergometer with 5-6 workloads of 5 minutes, until exhaustion. NIRS was used to measure changes in oxyhemoglobin and deoxyhemoglobin in the right vastus medialis and vastus lateralis muscles during cycling and was used in combination with a short-duration vascular occlusion in order to calculate local muscle VO<sub>2</sub>. In order to compare local and whole body VO<sub>2</sub>, values were normalized to percentage of peak values. Results While whole body VO<sub>2</sub> increased linearly with increasing work rate, local VO<sub>2</sub> in both muscles showed a different time response. A significantly faster initial increase in local VO<sub>2</sub> was seen at lower work rates (from 100 W to 150 W) when compared to the increase in whole body VO<sub>2</sub> ( $p < 0.001$ ), while at higher work rates (200-300 W), the increase in local VO<sub>2</sub> leveled off and was significantly lower than that of whole body VO<sub>2</sub> (200-250W:  $p < 0.01$ , 250-300W:  $p < 0.001$ ). Discussion/Conclusion The main finding of the present study was a significantly different effect of work rate on local VO<sub>2</sub> as compared to that of whole body VO<sub>2</sub>. The steep initial increase in local VO<sub>2</sub> of both vastus medialis and vastus lateralis muscles indicate that they are probably two of the primary contributors to the total work rate at low intensity. During the increase to high intensity, no additional increase in local VO<sub>2</sub> is seen, which might indicate that although the vastii are remaining active, they probably reached their maximum VO<sub>2</sub> and the increased work rate may have been met by increased contribution from other muscles (e.g. hamstrings and gluteals) and anaerobic metabolism. However, measurements of additional muscles are necessary for a more definitive conclusion. The results of the present study indicate that caution should be taken when interpreting whole body VO<sub>2</sub> as an indication of what happens in the local muscles. References 1.Bojsen-Møller J, Losnegard T, Kemppainen J, Viljanen T, Kalliokoski KK, Hallen J (2010) *J Appl Physiol* 109: 1895-1903 2.Endo MY, Kobayakava M, Kinugasa R, Kuno S, Akima H, Rossiter HB, Miura A, Fukuba Y (2007) *Am J Physiol Regul Integr Comp Physiol*. 293: 812-820

### THE INFLUENCE OF ROWING-RELATED POSTURES UPON RESPIRATORY MUSCLE PRESSURE AND FLOW GENERATING CAPACITY

Griffiths, L., McConnell, A.

*University of Worcester*

THE INFLUENCE OF ROWING-RELATED POSTURES UPON RESPIRATORY MUSCLE PRESSURE AND FLOW GENERATING CAPACITY Griffiths, L.I., McConnell, A.2. 1: UW (Worcester, UK), 2: BU (Uxbridge, UK) Introduction During the rowing stroke, the respiratory muscles are responsible for postural control, trunk stabilisation, generation/transmission of propulsive forces and ventilation (Biersteker et al., 1986; Mahler et al., 1991). The challenge of these potentially competing requirements is exacerbated in certain parts of the rowing stroke due to flexed (stroke 'catch') and extended postures (stroke 'finish'). The purpose of this study was to assess the influence of the postural role of the trunk muscles upon pressure and flow generating capacity, by measuring maximal respiratory pressures, flows, and volumes in various seated postures relevant to rowing. Methods Eleven male and five female participants took part in the study. Participants performed two separate testing sessions using two different testing protocols. Participants performed either maximal inspiratory or expiratory mouth pressure manoeuvres (Protocol 1), or maximal flow volume loops (MFVLs) (Protocol 2), whilst maintaining a variety of specified supported or unsupported static rowing-related postures. Starting lung volume was controlled by initiating the test breath in the upright position. Results Respiratory mouth pressures tended to be lower with unsupported recumbency with a significant decrease in expiratory mouth pressures in all unsupported postures (3-9% compared to upright seated;  $p < 0.05$ ) There was a significant decrease in function during dynamic manoeuvres, including PIF (5-9%), FVC (4-7%) and FEV1 (4-6%), in unsupported recumbent postures ( $p < 0.0125$ ). Discussion Thus, respiratory pressure and flow generating capacity tended to decrease with recumbency; since lung volumes were standardised these differences are attributed to the influence of postural co-contraction of the trunk muscles. The findings demonstrate a potential decrease in respiratory function when rowing in extreme layback positions (>110°) thus supporting the use of a more upright finish position. References Biersteker M, Biersteker WA, Schreurs A (1986). *Int J Sports Med*, 7, 73-79. Mahler DA, Shuhart CR, Brew E, Stukel TA (1991). *Med Sci Sports Exerc*, 23, 186-193.

### THE EFFECTS OF ENDURANCE TRAINING ON LOCOMOTOR AND RESPIRATORY MUSCLE CHARACTERISTICS IN RATS

Vinogradova, O., Borzykh, A., Boleeva, G., Kuzmin, I., Tarasova, O.

*Institute for Biomedical Problems*

Introduction Respiratory muscles are rhythmically active during whole life of the organism and differ from locomotory muscles by their structure and metabolic characteristics. Therefore, mechanisms of adaptation to exercise training may be also different in these functionally different skeletal muscles. The aim of the present study was to compare the effects of endurance training on myosin composition, fiber cross-section area (CSA) and citrate synthase activity in medial head of gastrocnemius muscle (GM) and costal part of diaphragm (DIA). Methods Male Wistar rats were treadmill trained for 8 wks (6 days per week). The load was gradually increased; so that from the 5th week the rats were running 85.5 minutes per day at a speed 18.8 m/min and 5-degree incline of the belt. During the running sessions lactate concentration was measured electrochemically in blood microsamples taken from the tail tip. Expression of MHC isoforms and CSA were studied in individual muscle fibers by immunohistochemistry. Citrate synthase activity was measured in whole muscle homogenates spectrophotometrically. Results During the training sessions blood lactate did not exceed 4 mmol/L confirming mainly aerobic energy supply of working muscles. 8-week training resulted in a prominent rightward shift of the running speed – lactate concentration relationship, evidencing effectiveness of the employed training protocol. In sedentary rats citrate synthase activity in DIA was 1.8 times higher compared to GM; CSA of both fast and slow fibers in DIA was less than in GM. After training citrate synthase activity increased by 28% in GM but was not changed in DIA. The training had no effect on either myosin composition or fiber CSA in GM. However, in DIA of trained rats, the fractions of slow and hybrid fibers were increased by 14% and 92% respectively. Along with that cross-sectional areas of slow and fast muscle fibers were reduced by 16% and 18%. Discussion The strategy of adaptation to endurance training in DIA is different from GM. Chronically loaded DIA does not change its oxidative potential but demonstrates fast-to-slow shift of fiber composition and smaller fiber sizes. On the functional level these changes must reduce DIA fatigability and facilitate oxygen delivery because of shorter diffusion distance. Supported by the RFBR (grant 09-04-01701-a).

### THE IMPACT OF POSTURE DIFFERENCE ON OXYGEN UPTAKE IN HEALTHY SUBJECTS

Nogami, Y., Seo, Y., Ishizu, T., Yamamoto, M., Kawamura, R., Sakamaki, F., Yanaka, S., Nakajima, H., Iida, N., Aonuma, K.

*University of Tsukuba*

Introduction Exercise capacity reduces with aging. This age-related decreased exercise capacity is associated with reduced stroke volume (SV) during exercise. The previous study was reported that SV was greater in supine position than upright position (James et al.,

2007). Therefore, the purpose of this study was to evaluate whether exercise capacity was affected by difference posture or not. Methods Twenty-one healthy subjects (58±13 years; male/female n=7/14) underwent a symptom-limited incremental exercise on a cycle ergometer using a ramp protocol with continuous breath-by-breath analysis of respiratory gas exchange. All subjects underwent two trials, one was using with supine ergometer and the other was using with sitting ergometer. The index of exercise capacity was assessed by peak oxygen uptake (peakVO<sub>2</sub>) and VO<sub>2</sub> at anaerobic threshold (AT). Blood pressure (BP) and heart rate (HR) were measured every one minutes. Results PeakVO<sub>2</sub> with supine ergometer was significantly lower compared with sitting ergometer (25.7±4.4 vs. 26.6±4.7 ml/kg/min, P<0.05). However, O<sub>2</sub> pulse at peak exercise with supine ergometer was significantly higher than sitting ergometer (9.8±2.4 vs. 9.6±2.3, P<0.05). There was no difference between supine and sitting ergometer at peak work load (120±27 vs. 120±27 watt). On the other hand, VO<sub>2</sub>AT and AT work load with supine ergometer were higher than sitting ergometer (AT, 17.6±2.7 vs. 15.7±2.7ml/kg/min, P<0.01; work load, 74±17 vs. 62±15watt, P<0.01). Increased HR from rest to peak, systolic and diastolic BP at peak exercise were not significantly difference between supine and sitting ergometer. Discussion Parasympathetic nervous system is predominant in supine posture compared to sitting posture. In this study, using with supine ergometer, VO<sub>2</sub>AT and O<sub>2</sub> pulse were higher than using with sitting ergometer. Normally, AT level exercise is recommended for elderly and patients with exercise therapy. The present study was suggested that using with supine ergometer was more efficient than sitting ergometer in suitable exercise for therapy. References James C Baldi., Sophie Lalonde., Graeme Carrick-Ranson., Bruce D Johnson. (2007). *Eur J Appl Physiol*, 99, 651-657.

### **AEROBIC TRAINING IS MORE EFFECTIVE THAN AEROBIC PLUS RESISTANCE TRAINING IN IMPROVING ANOREXIGENIC FACTORS OF ENERGY BALANCE IN OBESE ADOLESCENTS.**

Ackel-D'Elia, C.1, Carnier, J.1, Campos, R.M.S.1, Martins, A.C.1, Caranti, D.A.4,5, Ganen, A.P.1, Sanches, P.L.1, Tock, L.1, Tufik, S.2,3, Mello, M.T.1,2,3, Damaso, A.R.1,4,5

*Universidade Federal de São Paulo*

1Post Graduate Program of Nutrition, São Paulo – Brazil 2Psychobiology Department, São Paulo – Brazil 3Association found of Incentive to Research, São Paulo – Brazil 4Biosciences Department, São Paulo – Brazil 5Post Graduate Program of Interdisciplinary Health Sciences, São Paulo – Brazil 6Diagnostic Imaging Department, São Paulo – Brazil 7Pediatric Department, São Paulo – Brazil \*Universidade Federal de São Paulo – Escola Paulista de Medicina – UNIFESP-EPM Abstract Aim: The aim of this study was to compare the effects of Aerobic Training (AT) and Aerobic plus Resistance Training (AT+RT) as part of an interdisciplinary therapy in anorexigenic and orexigenic factors in obese adolescents. Methods: A total of 26 obese adolescents were enrolled in the program. They aged 15-19 y, with BMI ≥ P95 and were submitted to 1 year of interdisciplinary intervention (clinical support, nutrition, psychology and physical exercise), randomized in two groups, aerobic training (AT) (n=13) and aerobic plus resistance training (AT+RT) (n=13). The Patients of AT group were matched according to gender and body mass. Blood samples were collected to analyze AGRP (ng/ml), NPY (ng/ml), MCH (ng/ml) and alfa-MSH (ng/ml). Results: No differences were found between groups in the baseline condition for body mass (kg), height (cm), BMI (kg/m<sup>2</sup>), body fat mass (kg and %) and body lean mass (kg and %). AGRP (ng/ml), which is an orexigenic factor, increased only in AT+RT group after 6 months of interdisciplinary intervention (0.25 + 0.08; 0.25 + 0.08; 0.28 + 0.05 and 0.74 + 0.34; 1.09 + 0.67; 0.80 + 0.28 in baseline condition, 6 months and 1 year of intervention for AT and AT+RT groups, respectively). For the other hand, alfa-MSH (ng/ml), which is an anorexigenic factor, increased only in AT group after 1 year of interdisciplinary intervention (4.05 + 2.51; 4.90 + 2.46; 8.56 + 2.61 and 1.28 + 0.32; 1.18 + 0.43; 1.62 + 1.08 in baseline condition, 6 months and 1 year of intervention for AT and AT+RT groups, respectively) Conclusion: Aerobic Training (AT) as part of an interdisciplinary therapy is more effective than Aerobic plus Resistance Training (AT+RT) in improving energy balance in obese adolescents after an interdisciplinary intervention. Financial support: AFIP, CAPES, CNPq, CEPE, CEMSA, UNIFESP-EPM, FAPESP (CEPID/Sono n° 1998/14302-3; 2006/00684-3; 2008/53069-0; 2011/50356-0; 2011/50414-0).

**14:45 - 15:45**

## **Poster presentations**

### **PP-PM51 Physiology 13**

#### **RELATIONSHIP BETWEEN FOOT GRIP STRENGTH AND JUMP PERFORMANCE**

Yamauchi, J.

*1: Tokyo Metropolitan University, 2: Future Institute for Sport Sciences*

[Introduction] Muscular power capability in lower limb is associated with muscle functions of dynamic movement. It has been demonstrated that the muscle function of lower limb multi-joint movement measured with the servo-controlled dynamometer (Yamauchi et al. 2007) is profoundly correlated with the vertical jump performance (Yamauchi & Ishii 2007). Many physical activities are performed with a standing position on the foot and foot bears body weight as it carry the body through daily or sports activities. There are numerous studies on muscle functions of lower limbs in dynamic movements; however, only few studies have demonstrated foot muscle functions underling the dynamic characteristics of lower limb multi-joint movement such as vertical jump performance. Therefore, the present study was to investigate how isometric foot grip force generation influenced the vertical jump performance. [Methods] Thirty-nine healthy young individuals were measured their foot length, foot width, foot arch height and calf circumference. Foot arch height was measured the distance between tuberosity of scaphoid and floor, and it relative to foot length stated to the relative foot arch height. For MVC measurement of foot grip force, subjects exerted maximum force for ~3 seconds on a foot grip dynamometer with either sitting or standing position. Subjects also performed two different types of vertical jump: i) a countermovement jump without arm swing (CMJ) and ii) a squat jump without arm swing starting from a semi-squatting position (SJ). Measurements were repeated three times with at least one-minute rest period between bouts, and the highest value among the measurements was used. [Results and Discussion] During standing as compared with sitting position, foot arch height was lower while foot length and width was increased by body weight so that foot configuration changed. Foot grip forces at the sitting and standing position were positively correlated with SJ ( $r=0.34$ ,  $p<0.05$ ;  $r=0.5$ ,  $p<0.01$ , respectively). Also, foot grip force at the standing position was positively correlated with CMJ ( $r=0.49$ ,  $p<0.01$ ); however, foot grip force at the sitting position was not correlated with CMJ ( $r=0.27$ ,  $p>0.05$ ). The present results indicate that the ability to generate higher foot grip force is an important factor for the jump performance. Practically, foot grip force at standing position is more useful for evaluating the



performance of vertical jump performance. [References] Yamauchi J & Ishii N. J Strength Cond Res. 21: 703-709, 2007. Yamauchi J et al. J Biomech. 40: 1433-1442, 2007.

### EFFECT OF CREATINE SUPPLEMENTATION ON SERUM MDA OF STRENGTH TRAINED MEN

Uba ChupeL, M., Letieri, R.V., Borba-Pinheiro, C.J.

*Faculty of Sports Science - University of Coimbra*

EFFECT OF CREATINE SUPPLEMENTATION ON SERUM MDA OF STRENGTH TRAINED MEN UBA CHUPEL, M.1, LETIERI, R.V.1, BORBA-PINHEIRO, C.J.2 1:FCDEF-UC (Coimbra-Portugal) 2:UNIRIO (Rio de Janeiro-Brazil) Introduction It is well established that endurance athletes produce large quantities of reactive oxygen species, which leads to oxidative stress. This oxidation of biomolecules is directly related with several diseases, including cardiovascular disease, cancer and neurodegenerative diseases. Some studies show that this type of training has increased plasma MDA levels (Souza Jr. et al, 2005). Thus, the main objective of this study was to examine the effect of resistance training and supplementation with Creatine (Cr) on serum MDA of trained men. Methods Our study was consisted of 36 trained men separated by two groups that trained at 75% 1RM of resistance training. Group 1 (n = 18) with Cr supplementation of 3g.kg.day during 7 days, and 0,05g.kg.day in the three weeks remaining (Saremi et al, 2010). Group 2 (n = 18) used placebo. After 4 weeks, blood sample was collected before and after a training session for analysis of plasma MDA. Results The results show that after training there was a statistically significant difference (p <0.05) between groups. The Group 1 exhibited increase of % = 0,873% and Group 2 increase of % = 1,057%. Discussion The resistance training promoted the increase of serum MDA in both groups. In our study, the level of MDA in subjects who had not supplemented was significantly higher than the group supplemented with Cr. This is probably because the Cr intake with strength training keeps longer the ATP values without encouraging greater activation on intramuscular cycle degradation of purines, main catabolic process independent of O2 responsible for intramuscular ROS production (Casey & Greenhaff, 2000). It's established that there is decrease in both ammonia and in hypoxanthine during intense exercise preceded the consumption of Cr (Bellinger et al. 2000). Thus, it's speculate that the lower production of hypoxanthine resulting from this procedure can reduce its catabolism to xanthine and urate lowering the production of hydrogen peroxide, superoxide and hidroxil. References Bellinger, B.M. Bold, A. Wilson, G.R. Noakes, T.D. Myburgh, K.H. (2000). Oral creatine supplementation decreases plasma markers of adenine nucleotide degradation during a 1-h cycle test. *Acta Physiol Scand*; 170:217-224 Casey, A. Greenhaff, P.L. (2000). Does dietary creatine supplementation play a role in skeletal muscle metabolism and performance? *Am J Clin Nutr*; 72 (suppl):607S-17S Saremi, A. Gharakhanloo, R. Sharghi, S. Gharati, M.R. Larijani, B. Omidfar, K. 2010. Effects of oral creatine and resistance training on serum myostatin and GASP-1. *Molecular and Cellular Endocrinology*; 317(2010):25-30 Souza Jr, T.P. Oliveira, P.R. Pereira, B. (2005). Exercício Físico e Estresse Oxidativo – Efeitos do exercício físico intenso sobre a quimiluminescência urinária e malondialdeído plasmático. *Rev Bras Med Esporte*. Vol 11 (1):91-96

### ANALYSIS OF CHANGE OF 1RM ACCORDING TO INTENSITY OF EXERCISE IN 12-WEEKS MUSCULAR RESISTANCE TRAINING PROGRAM FOR ELDERLY WOMEN WITH OBESITY

Kyung Ryul, C.1, Sa Yup, K.1, Seong bin, P.1, Gi Duck, P.2

*1:Korea Institut of industrial Technology, 2:Namseoul University*

Introduction The purpose of this research was to provide important basic information for muscular resistance training program by investigating effect of 12-weeks muscular resistance training program for elderly women with obesity on 1RM which is recognized as a standard of measuring muscular strength. In this research, an analysis was made on change of 1RM according to intensity of exercise in 12-weeks muscular resistance training program for elderly women with obesity. Methode For that purpose, 39 elderly women with obesity were put into 3 groups for 3 different types of muscular resistance training high(60-70%/max), middle(40-50%/max), low(20-30%/max) strength and 1RM were checked after 6 weeks and 12 weeks respectively. 1RM test were leg extension, leg curl, hip abduction, leg press, arm curl, shoulder press, chest press, lat pull down, abdominal machine, total 9 factor measured. Result The was as follows. As for change of 1RM, there was meaningful difference between groups according to period of exercise, and especially in 12th week, higher increase of 1RM occurred in the high strength and middle strength groups than in the low strength group. Reference Scott, T., David, W., & Michael, G. (2002). Maintenance of whole muscle strength and size following resistance training in older men. *Biological science and medical science*, 57, 138-143. Toth, M. J., Mathews, D. E., Tracy, R. P., & Previs, M. J. (2004). Age-related differences in skeletal muscle protein synthesis: relation to markers of immune activation. *American journal of physiology endocrinology metabolism*, 10, 1152.

### DOES C AND E VITAMIN SUPPLEMENTATION AFFECT PHYSIOLOGICAL ADAPTATIONS TO STRENGTH TRAINING IN HEALTHY RECREATIONAL TRAINED SUBJECTS?

Paulsen, G., Johansen, R., Hamarsland, H., Cumming, K.T., Sørstrøm, A., Garthe, I., Raastad, T.

*Norwegian School of Sport Science*

Introduction: Antioxidants, such as vitamin C and E, are popular nutritional supplementations and are used by both the general population and athletes. Antioxidants protect against oxidative cell damage; however, oxidative stress seems important for stimulating some of the cellular pathways that drive the adaptations to training. Thus, high doses of antioxidants may inhibit the effects of exercise due to diminution of the normal exercise-induced oxidative stress. Therefore, the aim of the study was to investigate whether intake of high doses of vitamin C and E could hamper some of the physiological adaptations to strength training. Methods: Twenty-nine recreational strength trained subjects (10 females and 19 males; 25±5 years) were randomised to supplementation of either 1000 mg vitamin C and 235 mg vitamin E per day (n=16) or placebo pills (n=13) (double-blinded design). The subjects exercised 4 times per week for 10 weeks. All major muscle groups were exercised twice a week; 2-3 x 7-10RM. Changes in muscle mass were evaluated by Dual-emission X-ray absorptiometry (DXA) and 1RM tests were used to assess changes in muscle strength. Biopsies were collected before and after the training period, and the samples are currently being analysed for myofibre cross-sectional area, fibre type distribution and satellite cells. Results: Both groups increased knee-extension 1RM (C+E-vitamin: 12±7 % and placebo: 13±8 %, both p < 0.01) and biceps curl 1RM (C+E-vitamin: 8±5 % and placebo: 17±17 %, both p < 0.01). The increase in biceps curl 1RM was larger in the placebo group than in the C+E-vitamin group (p < 0.01). Fat free mass (DXA) increased by 1.1±1.1 and 1.1±1.1 kg in the C+E-vitamin and placebo group, respectively (both p < 0.05). Discussion: High dosage C and E vitamin supplementation did not affect whole body muscle growth during 10 weeks of strength training. Although both groups increased muscle strength, the placebo group demonstrated a larger increase in elbow flexor strength. Therefore, it appears that high dosages of antioxidants may inhibit some of the adaptations to strength training.

## BLOOD LACTATE CONCENTRATION AS A POTENTIAL MEDIATOR OF RATINGS OF PERCEIVED EXERTIONS DURING RESISTANCE EXERCISE

Sousa, N.1,2, Silva Junior, A.3, Bertucci, D.3, Souza, M.4, Ferraresi, C.4, Rodrigues, M.4, Arakelian, V.1, Togashi, G.1, Martins, R.5, Baldissera, V.1

1:EEESC/FMRP/IQSC, USP (São Carlos, Brazil), 2:FCT (Portugal), 3:UNESP (Rio Claro, Brazil) 4:UFSCar (São Carlos, Brazil), 5:FCDEF (Coimbra, Portugal)

Introduction Interest in using ratings of perceived exertion (RPE) to regulate the intensity of resistance exercise has increased in recent years. Blood lactate concentration (BLC) is also investigated as a possible physiological mechanism that may mediate the intensity of resistance exercise. The aim was to determine whether BLC is a potential mediator of RPEs during four consecutive sets of bench press (BP) exercise. Methods Ten healthy men ( $20.3 \pm 4.2$  yr; IMC  $23.6 \pm 2.9$  kg/m<sup>2</sup>) performed four sets of ten repetitions in BP exercise at 70% of their 1RM. Participants rested three minutes between sets. Two separated RPEs were estimated immediately after the last repetition at each set of exercise using the Borg (6-20) Perceived Exertion Scale and the OMNI Resistance Exercise Scale. During the interval between stages, 25  $\mu$ l of capillary blood were collected for blood lactate analysis (YSI 1500S). BLC and RPEs were evaluated using repeated measures ANOVA and Pearson correlations. The alpha level was  $p < 0.05$ . Results The means ( $\pm$  SD) of RPEs were  $9.7 \pm 2.3$  in set 1 (S1),  $12.3 \pm 1.6$  in S2,  $13.8 \pm 1.0$  in S3 and  $15.1 \pm 1.9$  in S4 for Borg scale and  $3.0 \pm 1.4$  in S1,  $4.6 \pm 1.3$  in S2,  $6.4 \pm 1.2$  in S3 and  $7.5 \pm 1.5$  in S4 for OMNI scale. The BLC was  $2.43 \pm 0.90$  mmol/L in S1,  $4.20 \pm 1.10$  mmol/L in S2,  $5.27 \pm 1.31$  mmol/L in S3 and  $6.20 \pm 1.38$  mmol/L. The ANOVA results indicate a significant increase over the sets for both RPEs scales and BLC. There is high and significant correlation between Borg and OMNI scales ( $r = 0.78$ ,  $p < 0.05$ ), high and significant correlation between OMNI scale and BLC ( $r = 0.73$ ,  $p < 0.05$ ) and moderate and significant correlation between Borg and BLC. Discussion There were corresponding increases in both RPEs and BLC as sets of resistance exercise increased, even working with the same intensity of exercise. There is a positive relation between BLC and RPEs, especially between the OMNI scale. Previous studies have demonstrated similar associations (Suminski et al. 1997; Lagally et al. 2002). However, previous investigations have also demonstrated strong relationships between RPEs and resistance exercise intensity (Lagally and Robertson 2006). In this study, the RPEs increase during four sets of exercise at the same intensity. It is possible that parallel increases in both RPEs and BLC are really a covariate of the greater muscle activity even during the same exercise intensity. Meanwhile, this study suggests that BLC is a better mediator of the intensity on OMNI scale than on Borg scale during four consecutive sets of BP exercise. References Lagally, K. M. and R. J. Robertson (2006). 'Construct validity of the OMNI resistance exercise scale.' *J Strength Cond Res* 20(2): 252-6. Lagally, K. M., R. J. Robertson, et al. (2002). 'Perceived exertion, electromyography, and blood lactate during acute bouts of resistance exercise.' *Med Sci Sports Exerc* 34(3): 552-9; discussion 560. Suminski, R. R., R. J. Robertson, et al. (1997). 'Perception of Effort During Resistance Exercise.' *The Journal of Strength & Conditioning Research* 11(4): 261-265.

## POSTEXERCISE HYPOTENSION IN STRENGTH-TRAINED ATHLETES

Saito, Y., Nakamura, M., Eguchi, K., Arai, K., Takemata, T., Otsuki, T., Ajsaka, R., Takahashi, H.

*Japan Institute of Sports Sciences*

【Background】 Postexercise hypotension (PEH), considered as an explanation to antihypertensive nonpharmacological effect of exercise, occurs in young, middle-aged and older men and women (1). It can be seen in trained subjects, especially endurance-trained athletes, after long submaximal (2) or short maximal exercise (3). In such population the occurrence of PEH is reported to be more frequent in trained subjects with lower cardiopulmonary fitness level or higher resting blood pressure (BP) (3). Whereas, PEH response in strength-trained subjects, who have increased arterial stiffness (4), was unclear. The purpose of this study was to investigate the occurrence and mechanisms of PEH in strength-trained subjects after short maximal exercise. 【Method】 Nine male weight lifters ( $19.2 \pm 0.2$  years) and eight sedentary controls ( $19.6 \pm 0.4$  years) were studied. BP, cardiac output (CO), and total peripheral resistance (TPR) were determined before and after 30, 60, and 90 minutes after a graded cycling to exhaustion. 【Result】 Strength-trained men demonstrated higher baseline BP than the controls ( $p < 0.05$ ). BP was reduced after exercise from baseline ( $p < 0.05$ ), although the degree of change was not different between the groups. There were no group differences in TPR reduction with slight CO increase after exercise. Moreover, no correlation was found between the decrease in BP and baseline BP or maximal oxygen uptake. 【Conclusion】 We conclude the magnitude of PEH is similar in the strength-trained and sedentary men. The occurrence of hypotension did not seem to depend on cardiopulmonary fitness level or resting BP in the present subjects. 【Reference】 1)Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA. American College of Sports Medicine position stand. Exercise and hypertension.; American College of Sports Medicine. *Med Sci Sports Exerc* 36(3):533-53, 2004. 2)Senitko AN, Charkoudian N, Halliwill JR. Influence of endurance exercise training status and gender on postexercise hypotension. *J Appl Physiol*. 92(6):2368-74. 2002 3)Dujic Z, Ivancev V, Valic Z, Bakovic D, Marinović-Terzić I, Eterović D, Wisløff U. Postexercise hypotension in moderately trained athletes after maximal exercise. *Med Sci Sports Exerc*. 38(2):318-22, 2006 4)Otsuki T, Maeda S, Iemitsu M, Saito Y, Tanimura Y, Ajsaka R, Miyauchi T. Relationship between arterial stiffness and athletic training programs in young adult men. *Am J Hypertens* 20(9):967-73, 2007.

## ACUTE RESISTANCE EXERCISE AND CYTOKINES LEVELS IN METABOLIC SYNDROME

PEREZ, S.1, TIBANA, R.2, NAVALTA, J.3, SOUZA, N.1, CÔRDOVA, C.2, SOUZA, V.4, NÔBREGA, O.4,5, PRESTES, J.2, PEREIRA, G.1

1-Physiological Sciences Department, Federal University of Sao Carlos, Brazil. 2-Graduate Program in Physical Education and Health Catholic University of Brasília, Brazil. 3-Western Kentucky University

Introduction Chronic inflammation has been identified as an important component of the metabolic syndrome (MetS). The inhibition of the inflammatory mediator signals is a promising strategy against insulin resistance, atherosclerosis, and other problems associated with MetS. Regular exercise decreases the risk factor of MetS, including some inflammatory cytokines. However, the relationship between an acute resistance training (RT) session, cytokine levels, and MetS is unclear. Therefore the aim of the present study was to evaluate the effects of a single bout of acute RT on tumor necrosis factor (TNF- $\alpha$ ), interleukins (IL) IL-1 $\alpha$ , IL-1 $\beta$ , IL-12, IL-6, IL-10 and osteoprotegerin (OPG) in women with MetS. Methods Twenty-four women were divided into 2 groups: metabolic syndrome (MetS) and non-metabolic syndrome (Non-MetS). After the familiarization and testing for 1 repetition maximum (1RM), participants completed 3 sets of 10 repetitions in the following exercises: machine leg press, leg extension, leg curl, chest press, lat front pull-down and machine shoulder press with 60% of 1RM followed by 15 repetitions of abdominal crunches. A rest interval of one minute was allowed between sets and exercises. Plasma TNF- $\alpha$ , IL-1 $\alpha$ , IL-1 $\beta$ , IL-12, IL-6, IL-10 and OPG were measured before, immediately and 60 minutes after the RT. Results and Discussion

MetS group showed significant higher concentrations of IL-1 $\beta$  (P=0.024), IL-6 (P=0.049) and a trend for higher TNF- $\alpha$  values (P=0.092) compared with Non-MetS. There was no group x time interactions after the RT session on the measured cytokines and osteoprotegerin. Conclusion These data indicate that an acute RT session induced no additional increase of pro- nor a decrease of anti-inflammatory cytokines in women with MetS.

### EFFECTS OF MENSTRUAL CYCLE PHASE-BASED STRENGTH TRAINING IN FEMALES WITHOUT VERSUS WITH ORAL CONTRACEPTION

Sung, E., Han, A., Hinrichs, T., Vorgerd, M., Platen, P.

*Ruhr-University Bochum*

Purpose: The follicular (FP) and the luteal phase (LP) of the menstrual cycle are characterized by a certain profile of different hormones, including variations in anabolic and catabolic hormones. Oral contraception (OC) alters the profile of these hormones. We could recently demonstrate that adaptation to strength training is significantly higher in females who mainly conduct their training in FP compared to LP. This study compares the effects of menstrual cycle-based strength training in OC-users with the effects in non-OC users. Methods: 37 healthy females (n=20 non-OC users (25.9 $\pm$ 4.5 yrs, 164.2 $\pm$ 5.5 cm, 60.6 $\pm$ 7.8 kg) and 17 OC users (22.5 $\pm$ 2.4 yrs, 167.1 $\pm$ 6.6 cm, 62.9 $\pm$ 9.4 kg) completed a one-leg strength training on a leg press machine for each leg for 3 months. Both groups trained one leg mainly in the 1st half of the menstrual cycle (follicular and quasi-follicular phase-based training (FT and qFT) and the other leg mainly in the 2nd half of the cycle (luteal and quasi-luteal phase-based training (LT and qLT). Concentrations of estradiol (E2), progesterone (P4), total testosterone (T) and free testosterone (free T) were analyzed in FP and LP. Maximum isometric force (Fmax), muscle diameter (Mdm), muscle fiber diameter (Fdm) and cell nuclei to fiber ratio (N/F, biopsies of m. vastus lateralis, n=15) were analyzed prior to and after training. Results: Concentrations of E2, T and free T were significantly higher in non-OC users compared to OC users, while P4 was highest in LP compared to all other phases. Absolute increase of Fmax did not differ between FT and qFT but was lower (p<0.05) in LT compared to qLT (FT: +269 $\pm$ 101, qFT: +266 $\pm$ 115, LT: +188 $\pm$ 98, qLT: +282 $\pm$ 114 (values in N)). Increase in Mdm was not different between groups. Fdm increased after FT (+6.7 $\pm$ 7.1 $\mu$ m, p<0.05), but did not change after the other interventions (LT: +5.1 $\pm$ 8.1, qFT: +1.8 $\pm$ 11.4, qLT: +6.4 $\pm$ 7.0, values in  $\mu$ m, p>0.05). N/F increased after FT (+0.9 $\pm$ 1.0, p<0.05) and remained unchanged after the other interventions (LT: +0.0 $\pm$ 0.7, qFT: +0.5 $\pm$ 0.6, qLT: -0.2 $\pm$ 1.2, p>0.05). Conclusions: Although non-OC users had higher anabolic hormone concentrations compared to OC users, increase in Fmax was higher after qLT compared to LT. Alterations in muscle cell parameters, however, were only observed after FT under the predominant influence of anabolic hormones. Effects of anabolic and catabolic hormones might be different concerning training-induced changes in muscle strength and muscle cell parameters.

### EFFECT OF STRENGTH TRAINING PROGRAM ON SHOULDER ROTATOR MUSCLES IMBALANCE.

Mascarin, N.

*Universidade Federal de São Paulo*

Mascarin, N.C., Silva A.C., Andrade, M. Department of Physiology – UNIFESP (São Paulo, Brazil) Introduction Shoulder rotator muscles imbalance has been found to increase athletes risk for shoulder injuries, then preventive strength training programs (STP) aiming the reduction of this imbalance are warranted. Previous studies were not conclusive concerning efficient preventive strength training programs. Therefore, the aim of this study was to verify the effectiveness of a strength training program to improve shoulder muscular balance. Methods Twenty-eight female handball players were assigned to either experimental group [EG, (n=16)] or control group [CG, (n=12)]. EG athletes included in their usual training schedule 6 wk of individual progressive elastic resistance STP, 3 times a wk. CG athletes performed only the usual training sessions. All athletes performed concentric and eccentric strength tests of both dominant and non-dominant upper limbs on an isokinetic dynamometer. Internal (IR) and external rotator (ER) muscles peak torque (PT) was evaluated at angular velocities of 60 $^{\circ}$ /s and 240 $^{\circ}$ /s in the concentric (conc) mode and at 240 $^{\circ}$ /s in eccentric (ecc) mode. Based on ERcon/IRcon and ERexc /IRcon peak torque ratios a preventive STP was developed. Isokinetic strength tests were performed by all athletes before and after the intervention. Results STP improved IR PT values for dominant and non-dominant limbs (60 $^{\circ}$ /s) in EG (p=0.026 and p= 0.003, respectively), but not in CG. Significant differences were also found for dominant ER PT values pre X pos STP in EG (p= 0.021). Neither PT values assessed at 240 $^{\circ}$ /s nor PT strength ratios for both groups were significantly different before and after STP. Discussion Results showed that individual progressive elastic resistance STP effectively improves PT values for shoulder rotator muscles. In the same way, Niederbracht et al (2008) also found positive strength gain in rotator shoulder muscles following strength training program with dumbbells. Although PT improvement observed in our study was not enough to change muscular imbalance ratio, as it also has been demonstrated by Niederbracht et al (2008), a longer or more intense STP potentially decreases shoulder rotator muscle imbalance and the risk of shoulder injuries in overhead activity athletes. References Niederbracht Y, Shim AL, Sloniger MA, Paternostro-Boyles M, Short TH. J Strength Cond Res. 2008 Jan;22(1):140-5.

### COMPARISON BETWEEN ELBOW FLEXORS AND KNEE EXTENSORS FOR CHANGES IN MUSCLE STRENGTH FOLLOWING MAXIMAL ECCENTRIC CONTRACTIONS IN OLD SUBJECTS

Nogueira, F.1, Libardi, C.1,2, Nosaka, K.3, Vechin, F.1,2, Berton, R.1, Souza, T.1, Lixandrao, M.1, Cavaglieri, C.1, Chacon-Mikahil, M.P.1

1: UNICAMP (Brazil), 2: USP (Brazil), 3: ECU (Australia)

Introduction Unaccustomed eccentric exercise (ECC) results in prolonged decreases in muscle strength. The magnitude of decrease in muscle strength following ECC is smaller for knee extensors (KE) than elbow flexors (EF) in young individuals, probably due to a protective effect in the lower limb muscles conferred by submaximal ECC performed in daily activities (1,2). However, it is not known whether this is also the case for old individuals. It is possible that the difference between KE and EF is small for old individuals, because of less eccentric contractions of lower limb muscles performed in daily activities. This study compared changes in muscle strength following maximal ECC between KE and EF in the elderly. Methods Healthy old men (n=5) and women (n=3) with low daily activity level (61.6  $\pm$  1.8 y, 75.6  $\pm$  3.5 kg, 1.66  $\pm$  0.04 m) volunteered for the study. They performed 5 sets of 6 maximal isokinetic (90 $^{\circ}$ /s) eccentric contractions of the EF (range of motion: 80-20 $^{\circ}$ ) and KE (30-90 $^{\circ}$ ) of the non-dominant limb in a randomized, counterbalanced order with 2 weeks between bouts. Maximal voluntary contraction isometric (MVC-ISO) and concentric strength (MVC-CON) were measured before, immediately after, and 24, 48, 72 and 96 h following ECC, and changes over time were compared between KE and EF by a two-way repeated measures ANOVA. Results Following ECC, KE and EF showed significant (P<0.001) decreases in MVC-ISO and MVC-CON, but returned to the baseline by 96h

post-exercise. The magnitude of decrease in MVC from baseline was similar between KE (e.g. MVC-CON at 24h:  $15.1 \pm 4.4\%$ , 48h:  $9.8 \pm 5.3\%$ ) and EF ( $17.7 \pm 3.0\%$ ,  $10.0 \pm 4.0\%$ ). Discussion No significant difference was found between KE and EF for muscle strength changes following ECC. This is in contrast to young individuals showing greater strength loss for EF than KE (1,2). It appears that the decreases on muscle strength following EF were smaller in the present study compared with the previous studies (1,2). This seems to be a reason why no significant difference between KE and EF was found. We also compared KE and EF for young subjects in the same way as that of the present study, and found that the decreases in MVC-ISO and MVC-CON following EF were greater ( $P < 0.01$ ) compared with KE. Thus, it seems that the difference in muscle damage between KE and EF is smaller for old than young individuals. It is concluded that the susceptibility to ECC induced muscle damage is similar between KE and EF for healthy but sedentary old individuals. References 1) Jamurtas et al. (2005). *Eur J Appl Physiol*, 95(2-3), 179-85. 2) Chen et al. (2011). *Eur J Appl Physiol*, 111(2), 211-23.

### EFFECTS OF A SHOULDER INJURY PREVENTION STRENGTH TRAINING PROGRAM ON THROWING EFFECTIVENESS

Andrade, M.S., Mascarin, N.C., Silva, A.C.

*Federal University of Sao Paulo*

**Introduction** As a result of repetitive throwing motion, the concentrically activated internal rotator (IR) muscles significantly increase in strength, which may not be accompanied by a proportionally increase in external rotator (ER) muscles strength. These disproportional strength gains cause shoulder rotator muscles imbalance, which has been found to be a primary risk factor for glenohumeral joint injuries (Forthomme et al 2005). This adaptive imbalance may be beneficial for throwing performance. Therefore, the aim of this study was to verify if a strengthening program directed to correct adaptive strength imbalance may influence throwing effectiveness. **Methods** Twenty-eight female handball players were assigned to either an experimental group [EG, (n=16)] or a control group [CG, (n=12)]. EG athletes included in their usual training schedule 6 wk of individual progressive strength training program (STP), 3 times a wk. CG athletes performed only the usual training sessions. Athletes performed strength tests on an isokinetic dynamometer. IR and ER muscles peak torque (PT) values were evaluated at angular velocities of  $60^\circ/\text{s}$  and  $240^\circ/\text{s}$  in the concentric (con) mode and at  $240^\circ/\text{s}$  in eccentric (ecc) mode. Based on ERcon/IRcon and ERecc /IRcon peak torque ratios a preventive STP was developed. Athletes performed 2 tests to assess ball velocity and accuracy throwing. Tests consisted of 5 jumping or 5 standing shots on the spot towards a target from 7 m distance. The mean of 5 throws was calculated. Both tests were performed before and after the intervention. Results STP improved ER and IR PT ( $60^\circ/\text{s}$ ) values in EG ( $p < 0.05$ ) but not in CG. There were no significant differences for shoulder rotator muscle imbalance before and after STP for both groups, even though mean values for muscular imbalance were closer to those values suggested by previous studies. After STP throwing ball velocity was significantly higher in EG than in CG ( $p = 0.006$ ). There were no significant changes on aiming accuracy. **Discussion** Although Zapartidis et al (2007) have demonstrated that ER and IR PT values were not related to ball velocity the present study showed significantly higher ball velocities after STP in EG. Therefore, data suggest that STP is effective to increase muscular rotator strength, to correct shoulder muscle imbalance and to increase throwing ball velocity, without producing harmful effects on aiming accuracy. References Zapartidis I, Gouvali M, Bayios I, Boudolos K. *J Sports Med Phys Fitness*. 2007 Jun;47(2):169-78.. Forthomme B, Croisier JL, Ciccarone G, Crielaard JM, Cloes M. *Am J Sports Med*. 2005 Oct;33(10):1513-9. Epub 2005 Jul 11.

**14:45 - 15:45**

### Poster presentations

#### PP-BN10 Sport Biomechanics 6

### THE INFLUENCE OF SPRINTING SPEED TEST AND KINEMATIC PARAMETERS TEST ON RESULTS OF 100M DASH RACE PARTICULAR SEGMENTS SPRINTING

Babic, V., Blazevic, I.

*University of Zagreb; University of Pula*

**Introduction** Sprinting speed has certain dynamics which is constantly changing throughout the sprint race phases, whereas the sprint time is the consequence of the optimal coherence of all of these phases. Different qualities attribute differently to sprint race result; reaction time with 1%, the speed of start blocks push-off with 5%, start acceleration with 64%, maximal speed maintainance with 18%, and the ability to resist speed decline in deceleration phase with 12%. The aim of the present research was to investigate the relations of two variables of specific motor tests and eight variables of kinematic parameters with four variables of sprinting dynamics in 100m sprint race. **Methods** Participants in this study were 133 male students (aged  $21.7 \pm 1.08$ ; BH  $180.8 \pm 6.98$  cm; BW  $76.6 \pm 7.62$  kg). For all variables the basic descriptive parameters were computed. Relations of variable 20m sprinting from crouch start (sprinting speed in acceleration phase) and variable 20m sprinting from flying start (sprinting speed in maximum speed phase), as well as their kinematic parameters: average stride frequency, average stride length, foot-ground contact average duration, flight average duration in different phases of 100m sprint (0-30m; 30-60m; 60-80m; 80-100m) were determined using regression analysis. **Results & Discussion** Tests of specific motor abilities and kinematic parameters at different segments of 100 race explained 50%–63% of overall 100m sprint results. The multiple correlation coefficients were from 0,71 to 0,79 with p value of 0,01. The results showed the dominance of maximal sprinting speed influence in all 100m sprint race segments. 20m sprint from flying start is an indicator of quality and efficiency of sprinting motorics. 20m sprint from crouch start, the test used to assess quality of start acceleration, showed to be statistically significant only in start acceleration segment of a race. Sprinting technique kinematic parameters were statistically significant for prediction of all criterion variables of different segments of sprint race (0-30, 30-60, 60-80, 80-100m). In start acceleration segment (0-30m), statistically significant values were obtained for: stride length (for both 20m sprinting tests), whereas in all other sprint race segments (30-60m, 60-80m, 80-100m), statistically significant values were obtained for stride length and stride frequency from 20m sprint flying start test. No other variables showed to be statistically significant although it was expected that foot-ground contact average duration, as an integral indicator of maximal sprinting speed, would have better predictive values. However, this variable was not statistically significant for this population sample. References Babić, V., Harasin, D., Dizdar, D. (2007). *Kinesiology*, 39 (1), 28-39. Delalija, A., Babić, V. (2008). *International Journal of Performance Analysis in Sport*, 8 (2), 67-75. Babić, V., Delalija, A. (2009). *New Studies in Athletics*, 24 (1), 49-57. Babić, V., Delalija, A. (2009). *New Studies in Athletics*, 24 (1), 59-68.

## BIOMECHANICAL VARIABLES AND RUNNING ECONOMY DURING AN INCREMENTAL RUNNING TEST IN ELITE AND WELL-TRAINED RUNNERS

Tam, N., Santos-Concejero, J.

*University of Cape Town and University of the Basque Country*

**Introduction** The importance of running economy (RE) as a marker for running performance has been noted since the 1970s. However, our understanding of RE is relatively low compared to other markers of running performance. Contact time (CT) has been found to be a predictor of greater RE. Our aim of this study was to characterize changes in various biomechanical variables between well-trained and elite long distance runners at different running speeds and their influence on RE. **Methods** Twelve recreational and 14 elite Caucasian long distance runners participated in this study. Recreational inclusion criteria were 10km race time between 35-45 minutes. Inclusion criteria in the elite group included current participation in competitions and a 10km race time < 33.5 minutes. All subjects completed an incremental running test at 1% slope on a treadmill starting at 9 km/h. Speed increased by 1.5 km/h every 4 minutes until exhaustion, with 1 minute recovery between stages. Oxygen uptake (VO<sub>2</sub>) was continuously measured, with this data the last 30 seconds of each workload was considered steady state. Respiratory exchange ratio (RER) was determined and RE was calculated as steady-state VO<sub>2</sub> (ml/kg/km). Stride and step length, stride angle (SA), stride frequency (SF), CT, flight time (FT) and three sub-phases of CT (contact, foot-flat and propulsion) were measured during the test using the Optojump-next system (Bolzano, Italy). **Results** Differences were found in SA, SF, RER, RE, CT, FT, stride and step length as speed increased. Group differences were found in RER, RE, SF, SA and CT sub-phases (foot flat and propulsion phase). A greater RE was correlated with increased SA, SF, step and stride length and in the elite group a decreased CT but no relation with RER. **Discussion** To perform at increased running speeds, runners are required to increase SA, FT, SF, step and stride length, with a decrease in CT. These results are similar (except FT) to data previously reported elsewhere which clearly depict the adaptations needed to perform. Notably, RE decreased as the speed increased which shows an increased reliance on the anaerobic metabolism (increased RER) and changes in gait essential to generate the required effort to perform at high speeds. Greater SA (indicating a fore/midfoot striking pattern), FT and stride and decreased SF in the elite group may explain why there was only a significant correlation between a better RE and lower CT. It appears the elite athletes are able to best manipulate their gait to improve force output efficiently. This is further emphasized with the increased propulsive phase and decreased foot flat sub-phase of CT when compared to the recreational group. These data support the hypothesis that differences in RE between these two groups may be due to differences in CT (including sub-phases), other biomechanical variables.

## DIFFERENCES BETWEEN OCCASIONAL AND REGULAR TENNIS PLAYERS SHOES DIMENSIONS PREFERENCES

Herbaut, A., Guéguen, N., Foissac, M.

*Oxylane*

**Introduction** Fit is a major factor in footwear purchasing act and is necessary to practice sports safely. However, its measure is uneasy because it relies on subjective feeling. Thus, comparison of last and foot dimensions combined with questionnaire have been used to assess fit quality in both dress (Witana et al., 2004) and running shoes (Cheng & Hong, 2010). Nonetheless, level of expectation of fit and comfort are different among shoe type (Nacher et al., 2005) and feeling of tennis players has never been investigated. Therefore, the aim of this study was to determine the effect of foot dimensions and level of expertise on shoe dimensions preferences in tennis players. **Methods** Thirty-five tennis players (Eur 43) were divided in 2 groups of expertise (OP: Occasional Players / RP: Regular Players) and 2 groups of forefoot width (TF: Thin Feet [94; 101 mm] / WF: Wide Feet [103; 109 mm]). Subject's feet were measured with a tape. Four different pairs of tennis shoes with a shoe-hide were evaluated randomly. A 17 items questionnaire with 7-point Likert scales was filled for each shoe. It contained 2 types of questions of perception on each area: fit and comfort. A two-way repeated measures ANOVA was applied ( $P < 0.05$ ). **Results** RP felt a better overall comfort of shoes than OP ( $F(1, 33) = 6.72$ ;  $P < 0.05$ ). RP with WF felt a worse comfort of shoes at the forepart width than those with TF ( $P < 0.05$ ). RP WF judged them in average too tight while RP TF judged them rather suitable. No significant difference of perceived comfort and fit were found between TF and WF in OP ( $P > 0.05$ ). TF and WF OP judged the shoes in average too narrow. Similar results were found for waist girth. No significant difference between OP and RP was found for length, seat width and long heel girth shoes preference. However, players with a foot length of [260; 268 mm] felt the shoes length more suitable and comfortable than those with foot length of [269; 276 mm]. **Discussion** The comfort perceived of shoes by RP compared to OP could be due to their habit to wear tennis shoes and thus to appreciate the fit for this shoe type (Kouchi et al., 2005). Comfort of forefoot width was low for both TF and WF in OP. Either OP prefer wider shoes or they have a less accurate feeling and a lower understanding of their expectations than RP. These findings imply that the shoes should be different in width among player's expertise. Offer two shoe widths to RP should satisfy TF and WF while one shoe width should be sufficient to satisfy all OP. **References** Cheng YL & Hong Y (2010). *Footwear Science*, 2, 149-158. Kouchi M, Mochimaru M, Nogawa H, Ujihashi S (2005). 7th Symposium on Footwear Biomechanics, 38-39. Nacher B, Alemany S, Gonzalez JC, Alcantara E (2006). *SAE International*. Witana CP, Feng J, Goonetilleke RS (2004). *Ergonomics*, 47, 1301-1317.

## THE INFLUENCE OF THE DIRECTION OF THE DRAG-FLICK ON THE PLAYERS' PERFORMANCE

Gomez, M., Lopez de Subijana, C., Antonio, R.

*Sport Science Faculty - Technical University of Madrid - Spain*

**Introduction** The penalty corner is one of the most important scoring plays in field hockey (Laird & Sutherland, 2003). Previous researches have studied the biomechanical pattern of drag-flick, trying to find the cues for an optimal performance (López de Subijana, Juárez, Mallo & Navarro, 2010; McLaughlin, 1997; Yusoff et al., 2008). To date, none of them have analysed the different drag-flick patterns depending on the direction of the shot. The aim of this study was to analyse the individual differences in the drag-flick pattern between right and left shots. **Methods** One female skilled drag-flicker participated in the study. A VICON optoelectronic system was used to capture the drag-flicks with six cameras, sampling at 250 Hertz. A total of 50 retro-reflective markers were attached to anatomical landmarks. Fifteen trials from each side were randomly captured from the subject. **Results** The results showed significant differences between right and left shots ( $p < 0.05$ ) in the stick angles, stick minimum angular velocity and front foot-ball distance before the dragging action. During the front heel contact with the floor, the stick position of the right drag-flicks ( $-90.62 \pm 22.96^\circ$ ) was significantly behind the stick position of the left ones ( $-77.28 \pm 31.80^\circ$ ). At the same time, the distance between the front foot and the ball was significantly longer in the right hand side ( $-1.58 \pm 0.05$ m) than in the left drag-flicks ( $-1.51 \pm 0.07$ m). The minimum angular velocity of the stick before the release of the ball was significantly higher in the right drag-flicks ( $-185.04 \pm 31.06^\circ/s$ ) than in the left ones ( $-114.75 \pm 69.52^\circ/s$ ). **Discussion** The findings of this study showed that the main differences between right and left drag-flicks are the position of the stick and the ball when the front foot heel

contacts the floor and at the minimum velocity of the stick, before the dragging action. It is remarkable that both side shots are equally efficient because there were found no differences in ball velocities neither at the kinematic sequences of both goal areas. References Laird, P. & Sutherland, P. (2003). Penalty corners in field hockey: A guide to success. *International Journal of Performance Analysis in Sport*, 3(1), 19-26. López de Subijana, C., Juárez, D., Mallo, D. & Navarro, E. (2010). Biomechanical analysis of the penalty-corner drag-flick of elite male and female hockey players. *Sports Biomechanics*, 9(2), 72-78. McLaughlin, P. (1997). Three-dimensional biomechanical analysis of the hockey drag-flick: full report. Belconnen, A.C.T., Australia: Australian Sports Commission. Yusoff, S., Hasan, N., & Wilson, B. (2008). Three-dimensional biomechanical analysis of the hockey drag flick performed in competition. *ISN Bulletin*, National Sport Institute of Malaysia, 1(1), 35-43.

#### **DETERMINING THE CUSHIONING PROPERTIES OF ATHLETIC SOCKS USING AN IMPACT TESTING METHOD.**

Blackmore, T., Scurr, J., Jessop, D., Bruce-Low, S.

*Southampton Solent University*

**Introduction** Socks may have the potential for injury protection through the absorption and redistribution of impact forces (Howarth and Rome, 1996). Previous research has been participant-based which may increase variability whereas an impact testing methodology would reduce this variability and be more representative of the cushioning properties of the socks alone. This study used an impact testing method and aimed to determine the effect of athletic socks on peak impact force, time to peak impact force and loading rate. **Methods** The impact testing system utilised a vertical impact striker (8.5 kg) released from 0.05 m to impact the specimen on the vertical axis (impact velocity = 1.02 m/s). A Kistler load cell (5000 Hz) was integrated into the system. Five samples of 13 sock conditions, a no sock and shoe only control condition were used. Each specimen was subjected to 25 pre-impacts as part of a conditioning process followed by 10 recorded impacts. Results Repeated measures ANOVA and Friedman tests revealed significant differences between sock and sock/shoe conditions for peak impact force time to peak impact force and loading rate respectively. Contrast analysis and Wilcoxon Signed Ranks Test revealed that when compared to a control condition, athletic socks significantly reduced peak impact force by up to 20%, loading rate by up to 47%, whilst significantly increasing the time to peak impact force by up to 33%. When tested in conjunction with a shoe sole, the athletic socks significantly reduced peak impact force by up to 6%, loading rate by up to 9% whilst significantly increasing the time to peak impact force by up to 15%. Significantly strong correlations were observed between thickness and the three dependant variables in the sock only condition. **Discussion** Whilst all socks demonstrated an ability to attenuate impact force, superior cushioning properties were observed in socks composed predominantly of wool which is one of the most resilient natural fibres (Howarth and Rome, 1996) and may provide resilience to compression forces (Blackmore et al., 2011). However, these effects were diminished when tested in conjunction with a shoe sole, suggesting that the superior cushioning properties of the shoe may mask the cushioning properties of the socks. Correlation coefficients revealed that there was a significantly strong linear relationship between thickness and the three dependant variables in the sock only condition suggesting that attenuation of impact force is a function of sock thickness. References Blackmore T, Ball N, Scurr J. (2011). *The Foot*, 21, 1-5. Howarth SJ, Rome K. (1996). *The Foot*, 6, 5-9.

#### **THE USE OF A MINIMAL MARKER SET FOR PELVIC MOTION ANALYSIS DURING RUNNING**

Hébert-Losier, K.1, Almstrom, P.2, Holmberg, H.C.1

*Mid Sweden University*

**Background** A decade ago, the use of a 3D motion capture system to analyze running technique was reserved to professional runners, Olympic-medal contenders, or researchers. Nowadays, numerous clinical and training based facilities access these technologies and provide biomechanical analysis services to runners of all skill level. In these circumstances, it is important for testing protocols to be user-friendly; and for results to be relevant to individuals and clinicians. Considering the apparent role of core stability in injury prevention and sports performance, and gender differences in running, the aim of this study was to use a minimal marker set in a clinical-base setting to analyze pelvic motion in male and female recreational runners. **Methods** Twenty-eight recreational runners (18M: 10F, age 28±8yrs) ran on a treadmill at incremental velocities of 10, 12, 14, 16, and 18km•h<sup>-1</sup>. Whole-body kinematics were recorded using an 8 infrared cameras 3D motion analysis system (Qualisys AB, Gothenburg, Sweden) capturing at 200Hz. Markers for capturing and reconstructing pelvis motion were positioned on the right and left anterior superior iliac spines, and on the sacrum between the two posterior iliac spines. Pelvis vertical displacement (cm), and pelvis obliquity and tilt at foot strike were computed. Measures were fitted into a generalized estimation equation to provide estimates on kinematic parameters of pelvis motion at various speeds during running and between genders. **Results** The vertical displacement of the pelvis during running was on average 8.2±1.8cm. The vertical motion decreased as velocity increased (P<0.001), with no influence from gender (P=0.102). On the contrary, gender had a significant effect on the obliquity of the pelvis at foot strike (P=0.047), with no influence from velocity (P=0.693). The amount of side bending was 1.1° (%CI: 0.02-2.2°) greater in males than females. The anterior-posterior tilt at foot strike was not influenced by running velocity (P=0.072) or gender (P=0.120). On average, it was 14.6±7.4°. **Discussion** This study applied a simple set of movement markers to describe pelvic motion in a group of recreational runners. The range of vertical pelvic motion decreased as running velocity increased, consistent with biomechanical efficiency of running. The results suggest that there are biomechanical differences between male and female runners in pelvic motion, particularly in the frontal plane. This user-friendly clinical approach to 3D motion capture has the potential to develop into a usual screening tool, particularly if a good database is available for use as normative comparative values.

#### **EFFECT OF ANKLE BRACING ON ANKLE STABILIZER MUSCLES STRENGTH AFTER EXERCISE AT THE INTENSITY OF BASKETBALL MATCH-PLAY**

Gonçalves, M., Castro, A., Spinoso, D.H., Almeida Neto, A.F., Milanezi, F.C., Cardozo, A.C.

*São Paulo State University*

**EFFECT OF ANKLE BRACING ON ANKLE STABILIZER MUSCLES STRENGTH AFTER EXERCISE AT THE INTENSITY OF BASKETBALL MATCH-PLAY** Gonçalves M1, Castro A1, Spinoso DH1, Almeida Neto AF1, Milanezi FC1, Cardozo AC1. 1: UNESP (Rio Claro, Brazil) **Introduction** The lateral ankle sprain is the most common injury in basketball. The use of braces and the identification of strength deficits of the ankle muscles are suggested to minimize the gravity and the occurrence of the injuries. Due to the high complexity in analyzing the muscular demands in the actual match situation this study aimed to analyze the effect of the use of ankle bracing on isokinetic peak of torque (PT) and functional ratio of the ankle stabilizer muscles after an exercise at the intensity of a basketball match-play. **Methods** Ten health college basketball players performed an exercise at the intensity of basketball match-play under two conditions: with and without ankle bracing. The test

was composed of a succession of intermittent physical effort equally distributed in four periods of 10 min each, considering the mechanical and physiological demands of a basketball match-play. Prior to the start of the trial (Evaluation 1) and after 2° (Evaluation 2) and 4° (Evaluation 3) period, the subjects performed five maximal isokinetic concentric and eccentric contractions of ankle invertors and evertors muscles, separated by two minutes rest, at 60°/s and 120°/s. The functional ratio were determined by eccentric eversion PT divided inversion concentric PT for the ankle inversion movement. Repeated Measures two factors was used for comparison of variables between the assessments and conditions ( $p < 0.05$ ). Results There were no differences for the PT and functional ratio between the assessments and conditions at 60°/s and 120°/s ( $p > 0.05$ ). It was observed the decreasing of EVEEXC and EVECON PT, when was compared the Evaluation 1 with the 2 and 3 in both conditions and velocities tested ( $p < 0.01$ ). The INVEXC and INVCON PT values decreased only between the Evaluation 1 and 3, in both conditions and velocities ( $p < 0.01$ ). The INVEXC PT at 120°/s also decreased from the Evaluation 2 to 3 ( $p < 0.05$ ). Discussion The decline of the ankle stabilizer muscles strength, in fatigue situations, may harm the joint position sense. Thus, the mechanisms of evertor muscles activation, which have shown higher strength deficits than the invertor muscles during the proposed protocol, particularly the peroneal muscles that act eccentrically during inversion, could not respond fast enough and predispose the individual to an ankle sprain during the basketball match. Conclusion The use of ankle braces does not influence the torque production and the functional ratio of the ankle stabilizer muscles during simulation basketball match intensity. However, the strength of the ankle stabilizer muscles, predominantly, in high isokinetic velocities and the evertor muscles was harmed, which suggests the increasing of ankle injury risk in this activity.

### **EFFECT OF ACCOMMODATIVE CUSHION FOOT ORTHOSES IN PLANTAR PRESSURES ON PROFESSIONAL CYCLISTS: PRELIMINARY STUDY. ANOTHER RELEVANT PARAMENTRES.**

Navarro, D.

*Catholic University of Valencia*

EFFECT OF ACCOMMODATIVE CUSHION FOOT ORTHOSES IN PLANTAR PRESSURES ON PROFESSIONAL CYCLISTS: PRELIMINARY STUDY. ANOTHER RELEVANT PARAMENTRES. Navarro, D.1, Huertas, F.1, Vera, P.2, Zahonero, J.1, Barrios, C.2 1: Sports Sciences and Physical Activity Department, Catholic University of Valencia, 2: Collaborator of Sports Sciences and Physical Activity Department, Catholic University of Valencia. Introduction. The purpose of this preliminary study is to obtain previous information on the differences in plantar pressures when cyclists use accommodative cushion foot orthoses and the effects of position and different power on plantar pressures. Previous studies (Hennig, Sanderson, 1995; Sanderson, Henning & Black, 2000), claim that there is a pattern of pressure on the insoles for cyclists, where most pressure is exerted on the first metatarsian and hallux (first finger). Methods. 4 cyclists with mean age of 25 years ( $\pm 2$  years) belonging to UCI professional teams, have been made accommodative cushion foot orthoses. Recordings were made with the Biofoot/IBV, grouping the 64 sensors in 9 zones, recording 6 seconds of constant and stable pedaling at 250 Hz. Cyclists ride on a hill between 6 and 8% slope in sitting position, standing on the pedals, two different powers (2W/kg and 4w/kg), with placebo and study insoles. The power has been controlled by commercial validated powermeter. The statistical treatment used was a repeated measures ANOVA on the values of average and maximum pressure. Results. Significant differences were found in plantar pressure in different positions of sitting and standing ( $p = 0,04$ ) and different powers depending on the area ( $p = 0,00$ ). We also found specific differences ( $p = 0,5$ ) in the distribution of pressure between the study and placebo insoles. Discussion. The effect of position is justified by the distribution of support points, there are 3 points when the subject is seated and 2 when is in standing position, so the weight of the subject that supports the seat rests on the pedals. Results supports Hennig and Sanderson (1995) conclusions, increase of power involve plantar pressures increase. Differences between cushion foot orthoses and placebo insoles, could be that ones are standard manufactured insoles and the others are custom. References. Hennig, E. M., & Sanderson, D. J. (1995). In-shoe pressure distributions for cycling With Two Different types of footwear at mechanical loads. *Journal of Applied Biomechanics*, 11 (1), 68-80. Sanderson, D. J., Hennig, E. M., & Black, A. H. (2000). The Influence of cadence and power output on force application and in-shoe pressure distribution during competitive and recreational cycling by cyclists. *Journal of Sports Sciences*, 18 (3), 173 - 181.

**14:45 - 15:45**

## **Poster presentations**

### **PP-BN11 Motor Learning 1**

#### **CONTROL OF SHOULDER EXTERNAL ROTATION WITH A LONG SLEEVE COMPRESSION GARMENT DURING ISOTONIC CONTRACTIONS**

Tsuruike, M.1, Ellenbecker, T.S.2

1: *Osaka University of Health and Sport Sciences, Osaka, JAPAN*, 2: *Physiotherapy Associates Scottsdale Sports Clinic, Scottsdale, Arizona USA*

Introduction The shoulder external rotation (ER) has been considered an important role in the follow-through phase for overhead athletes. One reason for this is that a decrease in strength of ER can be associated with the overuse injury. Consequently, the athletes may seek performance enhancing aid in their overhead skill training, such as a compression garment (CG). The purpose of this study was therefore to determine the effect of both CG and ongoing visual feedback information (OVFI) on muscular performance during the isotonic contraction. Methods Twelve male college tennis players and 12 male college soccer players were tested in this study. The subjects stood upright, and performed 5 consecutive repetitions of both concentric and eccentric ER of the shoulder joint at 20 to 30% and 40 to 50% of MVIC. Conversely, the lever arm was not moved below or above the limited range of loads set for each performance. Each subject was also asked to wear a long sleeve compression garment (YONEX Inc. Tokyo Japan, Muscle Power STB). Additionally, each subject was given ongoing visual feedback information (OVFI) of the torque generated on the monitor of the personal computer in front of the subject during the performance of the isotonic contractions. The orders of CG-wearing and the presence of OVFI were both randomly assigned across the subjects for both 20-30% of MVIC and 40-50. A mixed ANOVA design was used to examine differences for each dependent variable of 5 consecutive repetitions. Results The analysis of the results indicated a significant three-way interaction between CG-wearing and OVFI across loads ( $p < 0.05$ ). Specifically, the mean value of the completion times with OVFI was significantly faster than without OVFI

when the subjects performed without CG-wearing at 40-50% of MVIC, (33.4 and 28.6 sec respectively), whereas no difference was identified with and without OVFI when the subjects wore the CG, (25.5 and 26.8 sec respectively). Discussion An increase in maximal rotator cuff activation occurred when the scapula was stabilized (Kibler et al, 2006). CG-wearing exhibited an increase in the postural balance mediated by the complicated motor task during the standing position. This study focused the complicated task on ER of the shoulder which was of importance to overhead athletes. Taken together, a long sleeve upper CG may help the rotator cuff and scapular muscles adequately work together during complicatedly demanded tasks without visuomotor control imposed on force outputs as compared without CG wearing References Kibler, WB, Press, J, Sciascia, A. (2006) The role of core stability in athletic function. Sports Medicine 36, 189-198.

### FATIGUE INDUCED IN LEG MUSCLES BY CYCLING INFLUENCES THE EXCITABILITY OF CONNECTIONS BETWEEN DORSAL PREMOTOR AND THE HAND AREA OF PRIMARY MOTOR CORTEX

Maruyama, A.1,2, Yoshida, T.1,2, Kojima, S.1, Yamashiro, K.1,2, Sato, D.1,2, Onishi, H.1, Rothwell, J.C.3

1,2: NUHW (Niigata, Japan), 3:UCL (London, UK)

**Introduction** We have previously reported that fatigue of leg muscles reduces intracortical inhibition in non-exercised hand and arm muscles during recovery period despite the fact that there is no overlap or known anatomical connection within primary motor cortex (M1) that might link activity in the leg with that of the arm. However, there are shared connections between dorsal premotor cortex (PMd) and arm and leg areas of M1 which are thought to be involved in facilitating isodirectional movements of hand and foot (Byblow et al. 2007). We therefore tested in the present experiments if exhaustive exercise of leg muscles changed the excitability of connections between PMd and M1 projections to non-exercised hand muscles. **Method** Seven (five male and two female) active subjects (age: 21-24yrs) participated this experiment. Maximal work rate (WRmax) was previously determined using a progressive incremental load method to exhaustion. All subjects exercised on the cycle ergometer at 100% of WRmax for 7 min or until exhaustion. PMd-M1 connectivity was tested with a paired pulse TMS design before, immediately after exercise and then 5, 10, 15, 20 and 30 min later. MEPs recorded in the left (non-exercised) relaxed FDI muscle were evoked by a TMS stimulus over right M1 hand area. Intensity was adjusted to produce an MEP of 1.2mV peak to peak amplitude. These were conditioned in random trials by a TMS pulse given 8ms earlier over left PMd at an intensity of 90% resting motor threshold (PMd-M18ms) (Mochizuki et al. (2004)). Results As reported previously MEPs evoked by the M1 stimulus alone were facilitated immediately after exhaustive leg exercise compared to baseline values. They were slightly suppressed at 5min, and then increased at 10 and 15min until returning to baseline levels after 30 min. At baseline, stimulation of PMd suppressed the MEP to 78% of its control value. This effect was abolished immediately after exercise, and at 5min, stimulation of PMd facilitated the MEP rather than suppressing it; inhibition returned gradually and was at baseline levels by 30min after exercise. **Discussion** Cycling fatigue of leg muscles increased the excitability of M1 projections to a non-exercised left hand muscle. Connections from PMd-M1 also changed after exercise from inhibition at baseline to frank facilitation 5min after exercise before slowly returning back to normal. It is possible that the effect of leg muscle fatigue on M1 excitability is mediated in part by an indirect effect on connectivity from PMd-M1. References Byblow et al. J Neurophysiol 98: 414-422, (2007) Takahashi et al. Brain stimulation (2011) Mochizuki et al. J physiology 561.1 pp331-338 (2004)

### WHAT PRODUCES THE CONSTRAINT IN TWO-LIMB COORDINATED MOVEMENT IN THE SAGITTAL PLANE?

Kento, N., Muraoka, T., Kanosue, K.

Waseda University

What produces the constraint in two-limb coordinated movement in the sagittal plane? Nakagawa K.1,2, Muraoka T.3, Kanosue K.4 1Graduate School of Sport Sciences, Waseda University (Saitama, Japan) 2Research Fellow of the Japan Society for the Promotion of Science 3College of Economics, Nihon University (Tokyo, Japan) 4Faculty of Sport Sciences, Waseda University (Saitama, Japan) **Introduction** In various situations in daily life as well as in sports, humans perform complex actions that require the coordination of multi-limbs. Previous studies have shown that difficulty appears when two limbs are moved simultaneously in the opposite direction in the sagittal plane, whereas the difficulty almost never appears when movements are in the same direction (Swinnen, 2002). Additionally, the difficulty depends on the combination of two limbs (Kelso & Jeka, 1992). To investigate the factors involved in the constraint that simultaneous movements in the opposite directions are difficult, we examined the effects of 1) the number of motor commands sent from the brain, 2) interference of the kinesthetic afferent signals, 3) necessity of monitoring feedback information, and 4) combination of two limbs. **Methods** In the first experiment, we compared movement behaviors of ipsilateral hand and foot in two conditions. First, both limbs were actively moved by the subject. Second, one limb was actively moved by the subject, while another limb was passively moved by an experimenter. In both conditions, movements in the same and opposite directions were executed. The subjects performed with their eyes closed. The movement frequency was set at 2.5 Hz. We evaluated the performance by calculating the relative phase between movements of two limbs. The second experiment was done using both hands with the similar protocol. **Results & Discussion** Regardless of whether one limb was moved actively or passively, the opposite directional movements were difficult than the same directional movements. However, when ignoring the movement of the passively-moved foot, even moving hand in the opposite direction could be easily performed. These results suggest that monitoring the feedback information from moving two limbs rather than number of motor commands or interference of afferent signals would be the critical factor for the constraint. Additionally, while difficulty of two-limb movements in the opposite direction changed depending on the combination of limbs when they were performed actively, the movements became equally difficult in any combination of two limbs, either ipsilateral hand and foot or bilateral hands when one limb was moved passively. This suggests that the motor control algorithms of voluntary coordinated movement differ substantially depending on the combination of two limbs. Reference Swinnen SP. (2002). Nat Rev Neurosci, 3: 348-359. Kelso JAS. & Jeka JJ. (1992). J Exp Psychol Hum Percept Perform, 18: 645-668

### THE RELATIONSHIP BETWEEN EYE DOMINANCE AND DYNAMIC PROPERTIES OF BINOCULAR EYE MOVEMENTS IN COLLEGE BASKETBALL PLAYERS

Kokubu, M.1,2, Higashi, A.1, Araki, M.1

1: Osaka University of Health and Sport Sciences, 2: Japan Society for the Promotion of Science

**Introduction** In ball sports which require the athletes to execute target-aiming movements, it is important to make use of eye movements and visual information. For instance, expert basketball players have a longer fixation on the target before taking the actual shot (e.g., Vickers, 1996). However, earlier studies regarding ball game players have taken only one eye movement into account. Thus it is still unclear whether there are differences in their dynamic response properties between two eyes, which might be concerned with eye



dominance. The purpose of the present study was to investigate whether ocular dominance is related to the characteristics of binocular eye movements in basketball players. Methods Eye dominance and binocular eye movements (saccade and vergence) were examined for 86 participants in college basketball teams. The two standard tests (i.e., Miles and Porta tests) were used for the determination of their eye dominance. In the binocular eye movement tasks, they were seated with their head position stabilized by a head rest. For saccade, visual stimuli were presented 20 deg. to the left and right from the central one. For vergence, they were located 20 and 150 cm from the center of the two eyes in the mid-sagittal plane. The participants were asked to make eye movements to the appearance of the visual stimulus as quickly as possible. Horizontal movements of the left and right eyes were recorded respectively with the electrooculogram. Results On the basis of the eye dominance test, 63 participants were right eye dominance, 19 were left eye dominance, and 4 did not show clear dominance. For vergence, latency of the left eye was significantly longer than that of the right eye in the right eye dominant group ( $p < .01$ ), but there was no statistical difference between the two eyes in the left eye dominant group. Divergence showed less symmetrical movements for the two eyes than convergence and contained versional components (i.e., both eyes moved in the same direction) in the early response phase. For saccade, there were no significant differences in the response property between the eyes for both eye dominant groups. Discussion The present study revealed that the response of the non-dominant eye was slower than that of dominant eye in the right eye dominant players when shifting binocular fixation in the depth direction, possibly reflecting differences in sensorimotor processing between the two eyes. These findings suggest that eye dominance becomes an important factor when quickly aiming at a farther target. References Vickers, JN. (1996) *J Exp Psychol Hum Percept Perform*, 22, 342-354.

### EFFECT OF DIRECTION AND CONSISTENCY OF HANDEDNESS ON MANUAL PROFICIENCY OF CHILDREN WITH AND WITHOUT DOWN SYNDROME

Reyes, A.C.1, Corredeira, R.2, Rodrigues, P.3, Vasconcelos, O.1

1:Motor Control and Learning Laboratory, CI/F2D, Faculty of Sports, University of Porto, Portugal; 2:Adapted Physical Activity Department, CIAFEL, Faculty of Sports, University of Porto, Portugal; 3:Inst. Piaget

Introduction: It has been proposed that left-handedness is linked to pathology. However, recent studies on developmental disorders tend to show that lack of asymmetry, rather than left-handedness, is associated with pathology (Carlier et al., 2011). Hand preference (HP) and its relation with manual proficiency were studied in Down Syndrome (DS) and typically developing (TD) children. Methods: The participants were pre-schoolers (age range: 3-5 years) divided in groups according to the HP direction (DS: 16 right-handers and 8 left-handers; TD: 32 right-handers and 4 left-handers) and consistency (DS: 13 consistent and 11 inconsistent; TD: 29 consistent and 7 inconsistent). Laterality was assessed using a preference test (Gabbard & Rabb, 2000; Harris & Carlson, 1993) and a manual dexterity test adapted to children. Results: Although the two groups did not differ for the frequency of left-handers ( $\chi^2(1) = 1.333$ ,  $p = 0.248$ ), the occurrence of left-handedness was higher in children with DS ( $n=8$ ) than in TD ( $n=4$ ) children. Moreover, inconsistent left-handers were higher in the group of DS ( $n=7$ ) compared to TD ( $n=2$ ), although differences did not reach statistical significance ( $\chi^2(1) = 1.000$ ,  $p = 0.317$ ). Concerning performance, the interaction between group and consistency ( $F(1,56) = 5.632$ ;  $p = 0.021$ ) revealed that in the TD group the more strongly consistent lateralized individuals exhibited better performance while the opposite was found for the DS children. Discussion: These results somewhat support other studies indicating that less rightward asymmetry and inconsistency are associated with intellectual deficiency in children and hence with atypical patterns of lateralization. References: Carlier, M., Desplanches, A. G., Philip, N., Stefanini, S., Vicari, S., Volterra, V., Deruelle, C., Fisch, G., Doyen, A. L., & Swillen, A. (2011). Laterality preference and cognition: cross-syndrome comparison of patients with trisomy 21 (Down), del7q11.23 (Williams-Beuren) and del22q11.2 (DiGeorge or Velo-Cardio-Facial) syndromes. *Behavior Genetics*, 41(3), 413-422. Gabbard, C., & Rabb, C. (2000). What determines choice of limb for unimanual reaching movements? *J Gen Psychol*, 127(2), 178-184. Harris, L. J., & Carlson, D. F. (1993). Hand preference for visually-guided reaching in human infants and adults. In J. P. Ward & W. D. Hopkins (Eds.), *Primate laterality: Current behavioural evidence of primate asymmetries* (pp. 285-305). New York: Springer-Verlag.

### MUSCLE RELAXATION OF THE FOOT REDUCES THE CORTICOSPINAL EXCITABILITY OF THE HAND MUSCLES

Kato, K., Mizuguchi, N., Nakata, H., Muraoka, T., Kanosue, K.

Waseda University

Muscle relaxation of the foot reduces the corticospinal excitability of the hand muscles Kato, K.1, Mizuguchi, N.1, Nakata, H.2, Muraoka, T.3, Kanosue, K.2, 1: Graduate school of Sport Sciences, Waseda University (Saitama, Japan) 2: Faculty of Sport Sciences, Waseda University (Saitama, Japan) 3: College of Economics, Nihon University (Tokyo, Japan) Introduction Muscle relaxation is an important factor to make good performances in sports, but the mechanism has not been well understood. It has been suggested that muscle relaxation is accomplished by an active process in the brain, and not the mere end of contraction. Transcranial magnetic stimulation (TMS) study suggested that corticospinal excitability was reduced just prior to the voluntary muscle relaxation (Begum et al., 2005). On the other hand, previous studies that focus on motor control of multi limb movements have shown that simple contraction induces increase of corticospinal excitability in other ipsilateral muscles (Baldissera et al., 2002). Moreover, we have observed that EMG level of contraction in one hand decreased during the relaxation of the ipsilateral foot. The purpose of the present study was to clarify the effects of relaxation of foot muscles on the corticospinal excitability of hand. Methods Nine subjects performed relaxation of the right foot dorsiflexor immediately in response to an audio cue. The completion of relaxation (offset-time) was defined by the offset of the EMG. TMS stimulation was delivered to the hand area of the left motor cortex at -100, -50, 0, 50, and 100 ms (TMS stimuli-time) from the offset-time predetermined from 10 pre-trials without stimulation. Motor evoked potentials (MEPs) were recorded from the wrist extensor (ECR) and flexor muscles (FCR). Actual TMS timing was determined from the period between the offset-time of each trial to TMS stimuli-time. Corticospinal excitability was assessed by peak-to-peak amplitude of MEPs. Results The MEP amplitudes of ECR and FCR were higher in the periods of “~ -101 ms” than that in the resting condition. The MEP amplitude of ECR was smaller in the period of “100 ms~” than that in the resting condition. The MEP amplitude of FCR was smaller in the periods of “50~99 ms” and “100 ms~” than that in the resting condition. Discussion Corticospinal excitabilities of both ECR and FCR increased before ankle relaxation compared to resting condition. After ankle relaxation, on the other hand, corticospinal excitability decreased compared to resting condition. It is suggested that inhibitory commands were conveyed not only to the relaxing muscle (TA) but also to other resting muscles (ECR and FCR) during muscle relaxation. In conclusion, relaxation of foot dorsiflexor decreased in the excitabilities of hand muscle, both flexor and extensor. References Begum T et al., *Neurosci Res.* 53:428-435. 2005 Baldissera F et al., *J Physiol.* 539: 903-911. 2002

## THE EVALUATION OF JOINT POSITION SENSE IN FOLK DANCERS

Akdogan, E.I, Ertan, H.I

*Anadolu University*

**Introduction** Proprioception has been defined as an awareness of joint position in space as sensed by the central nervous system. In this study it is aimed that in the positions of weight bearing (WB), partial weight bearing (PWB) and non weight bearing (NWB) proprioception is examined among the participants of the study -the regular folk dancers and sedantaries. **Methods** Totaly 30 men - 15 folk dancers ( Average age: 21.33 ± 0.89, Average exercise age: 3 ± 0.76 year)-and 15 sedantaries ( Average age: 21. 2 ± 0.75) have participated in this study as volunteers. The subjects did not report any knee, hip and ankle injuries. For the propriceptive measurements, 15°, 30°, 45° and 60° has been chosen. The subjects has been asked first to bring their joints to given angles by open eyes using three passive repetitions, than after to find the correct angle eyes-closed with three active repetitions in of weight bearing (WB), partial weight bearing (PWB) and non weight bearing (NWB) positions. **Results** According to the results, when the proprioception was examined on dominant leg in three different measurement positions, with 15°,30°,45° and 60° degrees, meaningful differences were identified in favour of folk dancers in the position of lie back down non weight bearing (NWB) 45° and 60° degrees ( $p \leq 0,05$ ) . However, no meaningful diffrences were found in the position of non weight bearing (NWB) lie back and face down 15° and 30° degrees , partial weight bearing (PWB) and in the position of weight bearing (WB), 15°, 30°, 45° and 60° degrees. **Discussion** Folk dancers perform repetitive movements by carrying the whole body weight. However, The sedanter group has been composed of the subjects not participating regular physical activity except for their daily routines. So, the type of physical activity being heavy or medium weight-bearing exercise may have an effect on the proprioceptive sense on the knee joint. **References** Barrack R.L., Skinner H.B., Buckley S.L., Proprioception in the Anterior Cruciate Deficient Knee, *Am J Sports Med*, 17(1): 1-6 (1989) Bellew JW, Fenter PC, Chelette B, Moore R, Loreno D., Effects of a Short-Term Dynamic Balance Training Program in Healthy Older Women, *J Geriatr Phys Ther*; 4-8, 27 (2005) Beynnon BD (Eds), Validation of Techniques to Measure Knee Proprioception, In: Lephart SM, Fu FH, Proprioception and Neuromuscular Control in Joint Stability, Human Kinetics USA, 127-138 (2000) Biedert R.M., Contribution of the Three Levels of Nervous System Motor Control: Spinal Cord, Lower Brain, Cerebral Cortex Proprioception and Neuromuscular Control in Joint Stability, *Human Kinetics USA*, 23 (2000)

## EFFECTIVES OF DIFFERENT VERBAL FEEDBACK DURING LEARNING COMPLEX MOTOR TASK

Niznikowski, T., Sadowski, J., Mastalerz, A.

*University of Physical Education in Warsaw*

**Introduction** From theoretical and applied perspective, one of the major issues of interest in motor skill acquisition is how information feedback influences learning. Many researchers (Salmoni, Schmidt, Walter, 1984, Wulf & Shea, 2004, Sadowski et. al., 2011) attempted to find the most appropriate methods of providing information through feedback to refine and develop motor skills. However, less is know about of effectiveness of verbal feedback in the learning motor complex task. Therefore, the aim of this study was to investigate how different types of corrective verbal feedback improve learning one double leg tuck jump with the knees bringing up to chest and hands grip on shin in the flight phase and then squat landing with the arms straight on the side. **Methods** Nineteen students were randomly divided into three experimental groups. The first group (P) received verbal feedback on the correctness in the task performance (mean stature 177 cm ± 5.0 cm, body mass 81.2 kg ± 3.8 kg, age 20.3 ± 1.3 yrs). The second group (E) received verbal feedback about errors in the task performance (mean stature 178 cm ± 4.0 cm, body mass 79.4 kg ± 3.6 kg, 20.4 ± 1.2 yrs). The third group (E&P) received verbal feedback about errors and correctness in the task performance (mean stature 181 cm ± 3.9 cm, body mass 83.4 kg ± 3.8 kg, age 20.2 ± 1.1 yrs). The progressive-part method was employed in this study. Each component and the whole task were learned separately. All participants completed three practice sessions per sixteen weeks. Prior to practicing, all of the participants received a demonstration of the task along with verbal guidance. Three qualified judges viewed each trial and provided a performance score. Results It was established the increase of judge assessments for all groups. The ANOVA with repeated measures analysis revealed a significant effect of test time ( $F(2,32) = 8.30$ ;  $p < .001$ ). Post hoc comparison indicated that significant improvement of performance was observed only in group P (4.4 %,  $p < .007$ ) and E (14.5%,  $p < .001$ ). All judges ratings in the group E&P improved insignificantly. **Discussion** It was shown that the amount of verbal information is not cornerstone for learning complex motor task whit many degree of freedom. The group E outperformed groups P and E&P. Probably the amount and precision of Knowledge Performers are often too overwhelming, which exceeds the ability to correct the response. **References** Salmoni AW, Schmidt RA, Walter CB. (1984). *Psychol Bull*, 95, 355-386. Wulf G, Shea CH. (2004). In A.M. Williams, & N.J. Hodges (Eds.), *Skill acquisition in sport* (pp. 121-144). Oxford, England: Routledge. Sadowski J, Mastalerz A, Niznikowski T, Wisniowski W, Kulik M, Biegajlo M. (2011). *Pol J Sport and Tourism*, 18, 308-310.

## THE ABILITY OF MAINTENANCE OF STATIC AND DYNAMIC BALANCE IN RHYTHMIC GYMNASTICS. COMPARISON OF FORMER ELITE GYMNASTS AND NO GYMNASTS

Skoura, D.I, Tsopani, D.I, Papouliakos, S.2, Korres, S.2

*National and Kapodistrian University*

**Introduction** Balance is vital to many aspects of our daily lives and in rhythmic gymnastics the ability to maintain a stable position is indispensable for the implementation of every element of the sport ( Karpenko, 2003). The purpose of this research is to study the degree of balance capacity among former athletes skilled Rhythmic Gymnastics and non-athletes to determine whether and to what extent the special training in rhythmic gymnastics at high level develops the ability to balance. **Methods** Participants were 35 female volunteers aged 19 to 25 years, divided into two groups. Experimental group: 15 were former elite gymnasts of rhythmic gymnastics and the control group: consisted of 20 participants who have not worked systematically in a sport. The measurements were made at an otolaryngology workshop of Medical School in Athens using a platform of computerised posturography for assessing the ability to balance (NeuroCom). A key test, Sensory Organization Test, reflects the overall coordination of the visual, somatosensory and vestibular systems that contribute to postural control ( Hans Chaundry, 2004). Other tests evaluated: motor adaptation to different vibrations of the platform, reaction time, movement velocity, directional control, on-axis velocity. **Results** According to statistical data analysis it is shown that elite athlets excel in reaction time after auditory stimulus ( 0,5/1,1 sec), in movement velocity ( 2,4/6,8 deg/ sec) and in balance with swaying the environment and the surface ( 58,3%/51%) **Discussion** The statistical results confirmed the initial hypothesis that elite athletes have better ability of balance probably due to the content of training in rhythmic gymnasts that includes quick reflexes and abilities to keep the balance under adverse conditions. **References** Hans Chaundry, Thomas Findley, and al, Measures of postural stability, *Journal of Rehabilitation Re-*

search & Development, September/October 2004, Volume 41, Number 5, Pages 713–720 Karpenko L.A., Rhythmic Gymnastics, 2003, State Academy of Physical Education St. Petersburg, OAO « ГАЗПИРОМ»

### EFFECT OF DEGREE OF HANDEDNESS ON INTERMANUAL TRANSFER OF LEARNING

Batista, S.I, Freitas, C.I, Botelho, M.I, Rodrigues, P.2, Vasconcelos, O.I

1: *Motor Control and Learning Laboratory, CIFI2D, Faculty of Sports, University of Porto, Portugal*; 2: *Instituto Piaget, CIIERT/Edutec, Portugal*

**Introduction** The majority of studies of intermanual transfer use right-handers as participants. To our knowledge, only a few studies took into account direction (Kumar & Mandal, 2005; van Mier & Petersen, 2006) and degree of handedness (Chase & Seidler, 2008). The aim of this study was to evaluate whether the magnitude of learning and intermanual transfer were influenced by either direction and/or degree of handedness. **Methods** Forty nine male and female children from 6 to 10 years of age were analysed performing the Purdue Pegboard task. Following learning with either the dominant or non-dominant hand, 32 right-handers (17 consistent and 15 non-consistent) and 17 left-handers (5 consistent and 12 non-consistent) transferred to task performance with the other hand. Transfer direction was tested from the dominant to non-dominant hand and vice versa. **Results** No significant differences were found between right- and left-handed participants, males and females, and transfer directions. **Discussion** Like other previous studies, our results seem to indicate that in some tasks motor control takes place at a higher level independent of the effector system. **References** Chase, C., & Seidler, R. (2008). Degree of handedness affects intermanual transfer of skill learning. *Experimental brain research*, 190(3), 317-328. Kumar, S., & Mandal, M. K. (2005). Bilateral transfer of skill in left- and right-handers. *Laterality*, 10(4), 337-344. van Mier, H. I., & Petersen, S. E. (2006). Intermanual transfer effects in sequential tactuomotor learning: evidence for effector independent coding. *Neuropsychologia*, 44(6), 939-949.

### EFFECT OF SUPRAPOSTURAL TASKS ON POSTURAL PERFORMANCE: A META-ANALYSIS

Bund, A., Lippens, V.

*University of Oldenburg*

**Introduction** In opposite to the classical "quite stance"-paradigm of research on postural control, it is sup-posed from an ecological point of view that postural control is functionally integrated into a specific context, which is determined by superordinate tasks or goals ("suprapostural tasks", e.g., Stoffregen et al., 2007). Thus, postural performance should be superior if a suprapostural task is given compared to a non-suprapostural task setting. The purpose of this meta-analysis was to examine the effect of suprapostural tasks on postural performance and the impact of relevant moderator variables (e.g., age of subjects, visual condition). **Methods** A total of 47 studies with N = 917 participants fulfilled the following criteria: (a) measure of postural sway with and without suprapostural task in a crossover design, and (b) published in english or german language after 1990. The studies were coded independently by two raters with Cohen's Kappa ranging from 0.80 to 1.00. Mean effect sizes (Hedges' g) were computed using the random effect model and analyzed in terms of significance (Z), heterogeneity (Q), and publication bias (Funnel plot, Orwin's fail-safe N). As effects of crossover studies are commonly overestimated, the calculation of effect sizes was performed conservatively. **Results** In fact, suprapostural tasks significantly reduce postural sway both in anterior-posterior ( $g = 0.49$ ,  $p < .001$ ) and medio-lateral direction ( $g = 0.46$ ,  $p < .001$ ), that is, suprapostural tasks generally improve postural performance. However, the study effect sizes are not homogeneous ( $Q = 139.39$ ,  $p < .001$ , and  $Q = 149.83$ ,  $p < .001$ ). The suprapostural task effect is significantly greater for perceptual tasks ( $g = 0.84$ ) than for motor tasks ( $g = 0.31$ ); cognitive tasks have no sway-reducing effect ( $g = 0.01$ ). Furthermore, the mean effect size for young adults ( $g = 0.43$ ) is significantly greater than the mean effect size for old adults ( $g = -0.08$ ) and the mean effect size for eyes closed condition ( $g = 0.49$ ) is insignificantly greater than that for eyes open condition ( $g = 0.34$ ). **Discussion** Results of the meta-analysis clearly support the ecological approach to human postural control. According to this approach, postural control can be understood as an adaptable set of well learned strategies, which is an inherent part of the broader action-perception system to facilitate the execution of suprapostural tasks (Stoffregen et al., 2007; van Emmering & van Wegen, 2002). However, the effect of suprapostural tasks is not homogenous but depends from personal and contextual variables (i.e., age, physical health, visual condition, relationship between postural and suprapostural task). Further research on this variables is needed to clarify the functioning of postural control and to develop effective postural trainings. **References** Stoffregen, T.A., Hove, P., Bardy, B.G., Riley, M., Bonnet, C.T. (2007). *J Mot Behav*, 39, 126-138. Van Emmerink, R.E.A., van Wegen, E.E.H. (2002). *Exerc Sport Sc Rev*, 30, 177-184.

### A COMPARISON OF RUNNING GAIT IN CHILDREN WITH AND WITHOUT DEVELOPMENTAL COORDINATION DISORDER

Chia, E., Licari, M.K., Guelfi, K.J., Reid, S.

*The University of Western Australia*

**Introduction** Children with developmental coordination disorder (DCD) demonstrate low levels of motor proficiency which affects their ability to perform many activities, including running. Running is an important fundamental movement skill, as it is the most basic skill to participate in a variety of common sports. Given the qualitative nature of previous research investigating running proficiency in this population, further research is needed to quantify potential differences to clearly understand the movement constraints within this population. Therefore, the aim of this study was to quantify running gait patterns of children with DCD to identify differences in technique. **Methods** Twenty seven boys participated in this study, 13 with DCD (9y 3mo, SD 1y) and 14 typically developing controls (9y 6mo, SD 1y 1mo). Motor proficiency was assessed by the Movement Assessment Battery for Children-2, with all children in the DCD group falling below the 15th percentile (3.5, SD 3.01), while the typically developing group scored above the 25th percentile (71.43, SD 16.9). Kinematic and kinetic data was obtained using a 12-camera Vicon MX system and AMTI force plate. The children ran at a velocity of  $2.44 \pm 0.25$  m/s across a 15 m track, with data for 3 cycles of each limb collected. Three-dimensional kinematics and kinetics of the trunk and lower limbs were produced. **Results** Spatio-temporal analysis of running gait showed a trend for children with DCD to have a longer stance period than their typically developing peers ( $p = 0.061$ ). The features of the kinematic and kinetic trajectories were similar between both groups. However, the DCD group displayed increased variability in the sagittal plane kinematics of the hip and ankle during toe off as compared to their typically developing peers. Kinetic analysis revealed that typically developing children had significantly greater knee extensor moment ( $p=0.001$ ) and ankle plantarflexor moment ( $p=0.03$ ) during the stance phase of the running cycle. Consequently, peak knee power absorption and peak ankle power generation was significantly greater in the typically developing children ( $p=0.014$ ;  $p=0.018$ ). **Discussion** The reduced power absorption at the knee and power generation at the ankle in children with DCD suggests that they are less efficient in producing power and transferring energy in the stance phase of the running gait cycle. These power production inefficiencies may have

implications for the energy cost of running in children with DCD. In addition, the greater variation in the running kinematics of children with DCD may reflect the need for individualised training to improve running gait technique.

**14:45 - 15:45**

## Poster presentations

### PP-SH11 Psychology 3

#### PATIENTS WITH SCHIZOPHRENIA SUBMITTED TO 20 WKS OF RESISTANCE EXERCISE: A BLIND STUDY

Cassilhas, R.C., Andrade, B., Attux, C., Gadelha, A.L., Telles, B.A.S., Bressan, R.A., Tufik, S., de Mello, M.T.

*Federal University of Sao Paulo*

**Introduction** Schizophrenia is a serious mental disease characterized by a combination of positive and negative symptoms. Recently, it has been hypothesized that alterations in neuroplasticity and IGF-1 may be an important factor for the development of schizophrenia. In addition to antipsychotic medications, resistance exercise not only may be another way to increase IGF-1, but also decrease disease symptoms and improve quality of life. Therefore, the aim of this study was to evaluate the effects of 20 weeks of resistance training on psychotic and depressive symptoms, quality of life and serum IGF-1 concentration. **Methods** Nine paranoid schizophrenic patients participated in a blind, randomized clinical trial for 20 weeks. The patients were divided into two groups: CTRL (n=5) and RESEX (n=4). The exercise program consisted of resistance exercise with increasing intensity (40 – 85% of 1RM, 2 – 3 sets of 6 – 15 repetitions) twice per week. The blindly evaluation (scales for psychotic symptoms, depression and quality of life, serum IGF-1) were conducted at three time points (beginning, 10 weeks and 20 weeks). **Results** After intervention, the RESEX group had a decrease in psychotic and depressive symptoms and an improved quality of life. Serum IGF-1 levels were higher in the RESEX group at the end of treatment. **Discussion** These findings corroborate previous studies used aerobic (Pajonk et al., 2010) and concurrent training in this population (Marzolini et al., 2009) which improvements in mental health were observed after the exercise. Moreover, the patients who trained increased serum IGF-1 levels. We suggest that resistance exercise could improve the symptoms of schizophrenia/ depression by stimulating the IGF-1 pathway in the brain. Therefore, we propose that resistance training be incorporated as a non-medicinal treatment for the management of schizophrenia to support antipsychotic drug treatment and psychotherapy; to possibly increase IGF-1 in the body; to improve disease symptoms and quality of life; and to alleviate potential motor, cognitive and metabolic side-effects. **In summary**, 20 weeks of progressive resistance training improved the quality of life and symptoms of schizophrenia and depression and decrease both negative and positive symptoms, while also increasing serum IGF-1 levels. These findings support the existence of a neurobiological mechanism for exercise. **References** Marzolini, S., Jensen, B. & Melville, P. (2009) Feasibility and effects of a group-based resistance and aerobic exercise program for individuals with severe schizophrenia: A multidisciplinary approach. *Mental Health and Physical Activity*, 2, 29-36. Pajonk, F.G., Wobrock, T., Gruber, O., Scherk, H., Berner, D., Kaizl, I., Kierer, A., Muller, S., Oest, M., Meyer, T., Backens, M., Schneider-Axmann, T., Thornton, A.E., Honer, W.G. & Falkai, P. (2010) Hippocampal plasticity in response to exercise in schizophrenia. *Arch. Gen. Psychiatry*, 67, 133-143.

#### THE EFFECT OF SYNCHRONOUS MUSIC ON MOOD AND CYCLING ECONOMY DURING AEROBIC EXERCISE.

Kiyota, N.1, Morita, Y.2,3, Uchida, S.4,5

*1)School of Sport Sciences, Waseda University, 2)Graduate school of Sport Sciences, 3)Research Fellow of Japan Society for the Promotion of Science, 4)Faculty of Sport Sciences, Waseda University,*

**The effect of synchronous music on mood and cycling economy during aerobic exercise.** Natsuki Kiyota<sup>1)</sup>, Yuko Morita<sup>2)3)</sup>, Sunao Uchida<sup>4)5)</sup> *1)School of Sport Sciences, Waseda University, 2)Graduate school of Sport Sciences, Waseda University, 3)Research Fellow of Japan Society for the Promotion of Science, 4)Faculty of Sport Sciences, Waseda University, 5) Institute for Sport Sciences* **Introduction** Previous studies indicated listening to music during aerobic exercise reduced rates of perceived exertion (RPE). However, most past studies studied the effect on psychological parameters during exercise. There have been only few studies that evaluated the effect of music during on physiological parameters during exercise. Further question is that the exercise performance itself is influenced by listening to music. The purpose of this study was to investigate the effect of listening to music during aerobic exercise on physiological and psychological parameters, and exercise performance. **Method** Subjects were 9 healthy female (age: 21.9±0.9, height: 160.7±4.4cm, weight: 51.7±5.8kg). All of them did not have a menstrual irregularity and did not exercise more than three times a week. They took cycling exercise with music at 60%VO<sub>2</sub>max and 65rpm for 30 minutes (music condition), and they also did the same exercise with the metronome (control). These two conditions were separated by three days. Both conditions were measured in low temperature phase of menstrual cycle. In both conditions, RPE, pedaling rhythm and VO<sub>2</sub>/min were measured during exercise. Pedaling rhythm measured by electromyography (EMG) at vastus medialis muscle at three sections (0-5min, 10-15min, 25-30min). RPE was measured by Borg scale at every five minutes. Two-way ANOVA (time × condition) was used to analyze. **Result** Data from RPE, there were significant main effects of time and condition (for each p < 0.05), although time × condition interaction did not reach significant difference. RPE score in music condition showed significantly low compared to the control (p < 0.05), although time × condition interaction did not reach significant difference. Pedaling rhythms had a significant main effect of time (p < 0.05) and interaction trend between time and conditions (p = 0.065). There was no significant difference time × condition interaction in VO<sub>2</sub>/min. VO<sub>2</sub>/min showed a significant main effect of time (p < 0.05). In both conditions, VO<sub>2</sub>/min increased with time. **Discussion** These results indicated listening to music reduced subjective fatigue during exercise. Further, it suggested listening to music during exercise could improve cycling economy.

#### RELATIONSHIP BETWEEN HEART RATE VARIABILITY AND COGNITIVE FUNCTION. INFLUENCE OF PHYSICAL FITNESS.

Luque, A., Sanabria, D., Morales, E., Mateo-March, M., Zabala, M.

*University of Granada and University Miguel Hernandez of Elche, Alicante*

**Introduction** The quotation of our ancestors “mens sana in corpora sano” is supported by recent studies suggesting that physical activity has an important role as a protective factor at the physical and mental health (Albinet, Boucard, Bouquet, & Audiffren, 2010). The aim of

the present study was to investigate the relationship between exercise, heart rate variability (HRV) and cognitive performance. Methods Two groups of participants (athletes and sedentary) participated in this study. Both groups completed three cognitive tasks at rest: Psychomotor Vigilance Task (PVT), temporal orienting (TO) and time perception (TP). To record the HRV we used a FirstBeat Bodyguard (Firstbeat Technologies Oy-Jyväskylä) and obtained time-domain indicators (mean R-R, SDNN and rMSSD), frequency domain indicators (HF and LF bands) and non linear results (SD1 and DFA-1). Results The results showed a clear main effect of cognitive task in all measured indicators of HRV that did not interact with the variable Group. The PVT was associated with greater involvement of the parasympathetic (mean R-R, SDNN, rMSSD, SD1 and DFA-1). TO and TP tasks showed the least variability, respectively. There were apparently contradictory results with the frequency indicators that showed less vagal involvement in the PVT. We also found a group effect in time domain indicators and SD1. A significant benefit in the PVT's reaction times was found in the group of athletes compared to sedentary. Discussion In the present study we showed that the benefits of training on cognitive performance are produced selectively (Thayer, Hansen, Saus-Rose, & Johnsen, 2009). Crucially, the type of task and cognitive load also influence directly and differentially the HRV. There were some contradictory results in the frequency domain indicators. Additionally, our results provide information also from non-linear indicators that support those obtained in time domain and give the possibility of new interpretations in the disagreement present in the literature. References Albinet, C. T., Boucard, G., Bouquet, C. A., & Audiffren, M. (2010). Increased heart rate variability and executive performance after aerobic training in the elderly. *European Journal of Applied Physiology*, 109(4), 617-624 Thayer, J. F., Hansen, A. L., Saus-Rose, E., & Johnsen, B. H. (2009). Heart rate variability, prefrontal neural function, and cognitive performance: The neurovisceral integration perspective on self-regulation, adaptation, and health. *Annals of Behavioral Medicine*, 37(2), 141-153

## EFFECTS OF CAFFEINE INTAKE ON TEMPORAL ESTIMATION AT REST VS. DURING A MODERATE AEROBIC EXERCISE

Blasco, E., Monleón, C., Llorens, F., Moratal, C., Correa, A., Huertas, F.

*Universidad Católica de Valencia San Vicente Mártir*

INTRODUCTION The effect of caffeine intake on physical and cognitive performance are well documented. This fact together with its removal from the list of prohibited substances by World Anti-Doping Agency, have raised the prevalence of caffeine use by the athletes of different sports disciplines. There are many studies about the effects of caffeine on physical performance, looking for increased energy, improved efficiency, and reduced fatigue (Ganio et al., 2009) and also interested in the effects on cognitive performance (Brunyé et al., 2010). However, there are a few references related to the study of the interaction between caffeine and temporal attention (Gruber & Block, 2005). Aim of this work was to determine whether caffeine intake (4 mg / kg) modulates the temporal estimation of activity in different conditions (rest vs. effort). METHODS Sixteen subjects participated in four experimental counterbalanced conditions (exercise/caffeine, exercise/placebo, rest/caffeine, rest/placebo). Previously, participants performed an incremental cycle ergometer test to determine the intensities of effort would develop attentional task in the exercise condition. Repeated measures ANOVAs were used to estimate the main effects and interactions of different variables. RESULTS Our results show that only the variable activity modulated the temporal estimation. Higher temporal underestimation were observed in the effort condition compared to the rest condition. The caffeine does not appear to influence temporal estimation. DISCUSSION According to the findings from Botella et al. (2001) this result could be related to the increased level of Arousal induced by the effort, which will accelerate the operation of our 'cognitive clock' due to increased secretion of dopamine. Moreover, under 'dual-task' contexts, in which it develops our exercise condition, the available cognitive resources are directed towards the realization of the cognitive task and less to the temporal estimation of it. REFERENCES Brunyé, T.T., Mahoney, C.R., Lieberman, H.R., & Taylor, H.A (2010). Caffeine modulates attention network function. *Brain and Cognition*, 72: 181-188. Ganio, M.S., Klau, J.F., Casa, D. J, Armstrong, L.E.; Maresh, C.M. (2009). Effect of Caffeine on Sport-Specific Endurance Performance: A Systematic Review. *Journal of Strength & Conditioning Research*, 23 (1): 315-324. Gruber, R.P., & Block, R.A. (2003). Effects of caffeine on prospective duration judgements of various intervals depend on task difficulty. *Hum Psychopharmacol Clin Exp*, 20: 275-285

## THE ANALYSIS OF MOOD STATE AND INSOMNIA SEVERITY DURING SIX MONTHS OF WTK EXERCISE

Cheng, C.M.1, Chao, K.L.2, TING, W.C.3, CHANG, K.M.4

1 : KUAS (KAOHSIUNG, TAIWAN), 2 : YITC(PINGTUNG, TAIWAN), 3 : CSU (KAOHSIUNG, TAIWAN), 4 : TJUI(PINGTUNG, TAIWAN)

Introduction:Regimen exercise is traditionally viewed as a health care exercise used to improve health and to expand of life. The uniqueness of the traditional Taiwanese body-mind Wai Tan Kung (WTK) exercise is due to its usage of whole-body trembling and coordinated movements. It combines Han Calisthenics 9 forms, and consists of a sequence of 12 postures that are smooth, harmonic, and relaxing. During WTK exercise, the body is constantly trembling from feet to fingers and head, while deep and slow breathing and mental concentration are required to achieve harmony between the body and the mind (Chang CT, 1986).Therefore, practicing WTK might improve variety of health benefits in human being. Methods:Participants and study design. Both WTK practitioners (N=49, M=25, F=24) were recruited from a WTK association in Taiwan, and the control group's participants (N=51, M=51, F=50) without WTK experience were recruited from the communities. All subjects had normal lifestyles and were capable of daily activities without limitations. The Institute Review Board of Kaohsiung Medical University Chung-Ho Memorial Hospital had approved this study (KMUH-IRB-980568). The procedure was fully explained to the subjects, and obtained written consent from them before study. After baseline recording, the WTK practitioners had practiced WTK calisthenics at least 1 hour each time, 3 times per week and the normal controls did not treat. All the participants had filled in survey per 3-month and lasted for half a year.Data analysis. The test-retest was executed to compare the baseline characteristics and the SHPS, ISI, POMS and PANAS survey measures between WTK practitioners and normal controls. A P< 0.05 was considered statistically significant. All data are presented as mean ± SD. Results: There were no significant differences in the age, gender, body weight, body height and body mass index. There were no significant differences between WTK and controls with SHPS and PANAS survey, but with practice-time differences, there were significant differences in the SHPS domains scores of ARB, SST, EDB and SE. The other dimensions showed significant difference in confusion, vitality, fatigue, and Self-respect of POMS. There were significant differences in ISI, except the baseline score.Discussion:The basic principle of WTK exercise is performed in sequence with varying degrees of trembling and relaxation of various groups of muscles and it can get rid of distracting ideas and allow one's inner energy to rise up automatically from inside and make the whole body tremble by itself.Owing to the WTK regular practice, the domains scores decreasing in SHPS and ISI, and reducing score of fatigue, nervousness, confusion, anger and depression in POMS. The conclusions of this study are that WTK can decrease insomnia severity, confusion, fatigue, and increase vitality, self-respect and ultimately enable one to become healthy and happy as showed above. References Chang C.T. (1986). Chinese Wai Tan Kung Illustrated: A Taoist Kung Fu for Your Health. Taipei, Ministry of Education.

## A STUDY OF THE DEPRESSIVE TENDENCY FOR JAPANESE COLLEGE ATHLETES: INFLUENCES OF SOC AND NEUROTICISM

Kase, T., Endo, S., Yano, M., Oishi, K.

*Rikkyo University*

**Introduction** Recently, maladjusted youths who possess depressive tendencies have been increased in Japan, and then the importance of prevention and improvement of the depressive tendency have been paid attention. It is known that the depressive tendency relates various factors individually, such as personality traits (especially, neuroticism), life orientation (e.g., Sense of Coherence; SOC), and sports activities, etc. However, the relationships among these factors were not fully known. Therefore, investigating the relationships among these factors, it is expected to find the effective interventions which prevent and/or reduce the depressive tendency. This study investigated the differences of the relationships between athlete and the other groups, to clarify the effects of sporting activities on those relationships. **Methods** Subjects were 249 college students (137 males, 112 females, mean age: 20.0±1.0 years). The depressive tendency and SOC were measured by using Self-rating Depression Scale (SDS), and Japanese version of SOC-29 individually. Neuroticism, one of the Big Five personality factors, was measured by using the Big Five Scales (Wada, 1996). Additionally, sports activities were surveyed in terms of the purpose in their activities and frequencies, etc. Based on these sports activity data, subjects were categorized into three groups, i.e., athlete, hobby, and non-exercise groups. **Results** For SOC scores, one-way analysis of variance revealed the significant differences in three groups  $F(2, 246) = 3.73, p < .05$ , and multiple comparisons showed significant differences between athlete and hobby groups ( $p < .05$ ). A multiple regression analysis showed that neuroticism was not associated with SDS, and SOC was negatively associated with SDS ( $\beta = -.687, p < .01$ ) in athlete group ( $R^2 = .472, p < .001$ ). On the other hand, neuroticism was positively associated with SDS ( $\beta = .224, .370, p > .05$  or  $.01$ ), and SOC was negatively associated with SDS ( $\beta = -.563, -.528, \text{both } p < .01$ ) in hobby and non-exercise groups respectively ( $R^2 = .511, .472, \text{both } p < .001$ ). **Discussion** These results showed that neuroticism was more effective on the depressive tendency in hobby and non-exercise groups. In contrast, SOC was the most effective factor to improve the depressive tendency in athlete group. It was suggested that competitive sports strengthened SOC, and then SOC reduced the expression of neuroticism and enabled us to cope with the depressive tendency more appropriately. **References** Wada S. (1996). Construction of the Big Five Scales of personality trait terms and concurrent validity with NPI. *Japanese Journal of Psychology*, Vol.67(1): 61-67.

## ATHLETE BURNOUT: RELATIONSHIPS BETWEEN BEHAVIORAL REGULATION, PERFECTIONISM AND SATISFACTION AND THWARTING OF PSYCHOLOGICAL NEEDS

Guillet-Descas, E., Moiret, S., Isoard-Gauthier, S.

*Université Claude Bernard Lyon 1*

**ATHLETE BURNOUT: RELATIONSHIPS BETWEEN BEHAVIORAL REGULATION, PERFECTIONISM AND SATISFACTION AND THWARTING OF PSYCHOLOGICAL NEEDS** Guillet-Descas, E.1, Moiret, S.1, & Isoard-Gauthier, S.1 1: CRIS (Lyon, France) **Introduction** Athlete burnout is defined as a syndrome with three dimensions: reduced sense of accomplishment, sport devaluation, and emotional and physical exhaustion (Raedeke & Smith, 2009). Gustafsson, et al. (2011) proposed an integrated model of athlete burnout (IMAB). This model include major antecedents, early signs, entrapment, vulnerability factors, and maladaptive consequences. The present study focused on the relationships between two early signs: motivation and psychological needs; and one vulnerability factor: perfectionism. The frustration over lack of accomplishment and perceived competence is one of the first signs of burnout. Research guided by basic psychological need theory has established that negative outcomes are hypothesised to occur when individuals perceive their psychological needs to be actively undermined (i.e., thwarted) in their immediate social environment. We examined the satisfaction and thwarting of psychological need simultaneously (Bartholomew, et al. 2011). The extent to which these needs are satisfied or thwarted determines the degree to which an athlete's behaviour is regulated by self-determined motivation. Research suggest that individuals whose needs are frustrated show greater amotivation and controlled motivation, and these have been associated with maladaptive outcomes. The alternative measure of self-determined motivation, by Lonsdale, et al. (2008) was used. The IMAB postulated that several personality factors appear to increase burnout risk. One personality characteristic that has been found is perfectionism. Hewitt & Flett (1991) identified three distinct forms of perfectionism: self-oriented, other oriented, and socially prescribed perfectionisms. The purpose was to examine whether perfectionism forms would moderate any association between satisfaction or thwarting of psychological needs with self-determined motivation and dimensions athlete burnout. **Method** Adolescents involved in elite sport have participated. Regression analyses will be used to examine the multivariate association between athletes' perfectionism scores, psychological needs, behavioural regulations and burnout. **Expected Results** We expect that the thwarting of psychological needs would be positively associated with less self-determined motives, would show positive associations with burnout. This interaction would be moderate by some perfectionism forms, such as other oriented or socially prescribed. **References** Bartholomew K, Ntoumanis N, Ryan R, Thøgersen-Ntoumani C. (2011). *J Sport Exercise Psych*, 33, 75–102. Gustafsson H, Kenttä G, Hassmén P. (2011). *Int Rev Sport Exercise Psychol*, 4: 1, 3 -24 Hewitt P, Flett, G. (1991). *J Personality Social Psychol*, 60, 456-470. Lonsdale C, Hodge K, Rose, E. (2008). *J Sport Exercise Psychol*, 30, 323–335. Raedeke T, Smith A. (2009). *The athlete burnout questionnaire manual*.

## NEW DIRECTIONS IN THE CONCEPTUALISATION OF ATHLETE BURNOUT

Isoard-Gauthier, S., Guillet-Descas, E.

*Université Claude Bernard Lyon 1*

**Introduction** Athlete burnout (AB) has been a growing subject of interest during the past decade. Raedeke and Smith (2009) developed a multidimensional definition based on the workplace definition, and characterized AB as a syndrome with three key dimensions: (a) reduced sense of accomplishment, which correspond to a sense of ineffectiveness and a tendency of an individual to evaluate himself negatively in terms of performance and athletic achievements, (b) sport devaluation, which corresponds to a negative and detached attitude towards sport, resulting in a lack of interest about sport and performance, and (c) emotional and physical exhaustion, which refers to a feeling of emotional and physical fatigue stemming from the high demands associated with trainings and competitions. AB is considered as a syndrome with three dimensions that means that in order to consider that an athlete is burned out, he might report moderate to high scores on all the three dimensions (Eklund & Cresswell, 2007). Recent qualitative studies using retrospective interviews have proposed that the three dimensions of AB develop among time and that sport devaluation might be the last step of a sequence involving emotional/physical exhaustion and reduced sense of accomplishment (Cresswell & Eklund, 2007; Gustafsson, Hassmén, Kenttä & Johansson, 2008). Otherwise, Lonsdale, Hodge and Jackson (2007) have suggested to reconsider the emotional and physical exhaust-

tion dimension of AB. In line with the items in the Athlete Burnout Questionnaire (ABQ; Raedeke & Smith, 2009) it can be supposed that the two aspects of exhaustion can be two separate dimensions of AB. The first aim of the present study was to examine the prevalence of AB and its developmental sequence. The second aim was to develop a revised version of the ABQ (ABQ-R) by splitting exhaustion in two dimensions. Methods Adolescents involved in elite training centres have participated in two studies aimed to test the hypothesis. Growth curve and cluster analyses were used to examine the prevalence and the developmental sequence of AB. Expected Results and Discussion A developmental sequence involving the three dimensions of AB should be found. Specifically, we assume that sport devaluation should be the last step of the developmental sequence. Moreover, we expect that the ABQ-R offer good properties and could be used to reveal different profiles of AB among adolescents in elite training centres. References Cresswell S, Eklund R. (2007). *Sport Psychol*, 21, 1-20. Eklund R, Cresswell S. (2007). *Handbook of sport psychology* (3rd ed., pp. 621-641). Gustafsson H, Hassmèn P, Kenttä G, Johansson M. (2008). *Psychol Sport Exercise*, 9, 800-816. Lonsdale C, Hodge K, Jackson S. (2007). *Int J Sport Psychol*, 38, 471-492. Raedeke T, Smith A. (2009). *The athlete burnout questionnaire manual*.

## DOES PERSONALITY AFFECT NEUROFEEDBACK PERFORMANCE? AN EXPLORATORY STUDY WITH ELITE YOUTH ATHLETES

Rowley, C., Earle, K.

*University of Hull*

**Introduction** The current study aims to expand upon the limited amount of research utilising neurofeedback devices within the sporting domain. A number of researchers have recently made calls for personality to be considered as a potential mediating factor in regulating the efficacy of psychological interventions (Hardy et al., 2010, Woodman et al., 2010). On this justification, the present study aims to analyse the potential moderating effect that personality traits have on a neurofeedback performance task. Method 31 male academy level rugby league players completed the 16PF-5 personality measure (Cattell et al., 1995) as well as completing a one-off neurofeedback task using the Mindball Trainer® device. The task involved participants optimising their levels of relaxation and focus in order to move a ball from one end of the device's scale to the other. The electrode headband which they wore during the completion of the task measured their corresponding brain activity which in turn produced forwards or backwards movements in the ball. Their overall aim was to complete the first level of the training program within the allotted time period of 2 minutes. A scoring scale of 1-10 was employed in which 1 represented the lowest score possible, and 10 represented the highest. A 1 was awarded if a participant failed to reach any of the 4 quadrants on the scale in the allotted time, whereas a 10 was awarded for full completion of the task within 0-24 seconds. Results Regression analyses revealed Rule Consciousness as being the only significant personality trait in terms of predicting actual neurofeedback performance ( $r = 0.41$ ,  $p < .05$ ). Discussion The relationship between personality and performance has been well established (e.g. Fisher et al. 1977). However, in this study the only aspect of personality that related to performance was rule-consciousness. An explanation for this finding may be that this trait has particular relevance when performing a novel or 'unusual' task. It would appear that the more dutiful and conforming individuals are able to produce higher levels of performance on the neurofeedback task, indicating a greater ability to focus and concentrate when faced with such tasks. This provides further support for a recent paper by Cupples and O'Connor (2011) who found that personality (encompassing coachability) was one of the top five performance indicators required to reach the elite level in rugby league. References Cattell et al. (1995) *Educ Psychol Meas*, 55, 926-937 Fisher et al. (1977) *Int J Sport Psychol*, 8, 92-102. Hardy et al. (2010) *Psychol Sport Exer*, 11, 27-35 Lawton et al. (1998) *J Sport Exer Psych*, 20, 35-53 Woodman et al. (2010) *J App Sport Psych*, 22, 183-197

## EFFECT OF A 5' BOUT OF ANAEROBIC EXERCISE ON COGNITION

Llorens, F.1,2, Huertas, F.1, Sanabria, D.2

*Universidad Católica de Valencia*

Llorens, F.1,2, Sanabria, D.2, & Huertas, F.1. Departamento de Gestión y Ciencias Aplicadas a la Actividad Física, Universidad Católica de Valencia, Spain. 2. Departamento de Psicología Experimental, Universidad de Granada, Spain **Introduction** There is growing evidence regarding the effect of acute bouts of aerobic exercise in the functioning of attention (McMorris, Tomporowski & Audiffren, 2009). Executive control is responsible for selecting the correct response and the inhibition of automatic unwanted responses (Posner & Digirolamo, 1998) (e.g., basketball players have to decide within a few seconds whether to shoot, bounce or to dribble). Spatial visual attention select potential relevant stimuli in the visual field, enhancing its processing while ignoring stimuli that are irrelevant for the task at hand (Reynolds & Chelazzi, 2004) (e.g., the movement of a member of the audience can capture the attention of a basketball player throwing a free shot). In the present study, we measured the deployment of the exogenous spatial attention and executive control in three different conditions. **Methods** We used a Cardgirus Medical Pro cycle ergometer, RS800CX Polar monitor to record the heart rate (HR) and a Lactate Pro lactate test meter and Lactate Pro strips to determinate the anaerobic threshold and for experimental conditions. Participants performed a spatial attention task at rest, immediately after an acute bout of anaerobic exercise, and after recovering the basal HR following an acute bout of anaerobic exercise. **Results** The results showed that the magnitude of the Stimulus-response compatibility was larger in the Post-effort session than in R and Pe+r session. In contrast, we did not observed any modulation of exogenous spatial attention by the 5' bout of anaerobic exercise. **Discussion** Regarding executive control, the current findings replicate other studies (e.g., Del Giorgio et al., 2010), which observed a worse functioning of executive control while performing an acute bout of anaerobic exercise. Our results lend support to the Transient Hypofrontality Theory. References Del Giorgio, J. M., Hall, E. E., O'Leary, K. C., Bixby, W. R., & Miller, P. C. (2010). Cognitive function during acute exercise: a test of the transient hypofrontality theory. *Journal of Sport & Exercise Psychology*, 32(3), 312-323. McMorris, T., Tomporowski, P. & Audiffren, M. (2009). *Exercise and cognitive function*. Michigan: Wiley-Blackwell. Posner M. I., & Digirolamo, G. J. (1998). Executive attention: Conflict, target detection and cognitive control. En R. Parasuraman (Ed.), *The attentive brain* (pp. 401-423). Cambridge: MIT Press. Reynolds, J. H., & Chelazzi, L. (2004). Attentional modulation of visual processing. *Annual Review of Neuroscience*, 27, 611-647.

## MEASURING ATTENTION AFTER AN ACUTE BOUT OF AEROBIC AND ANEROBIC EXERCISE

Llorens, F.1,2, Huertas, F.1, Sanabria, D.2

*Universidad Católica de Valencia*

Llorens, F.1,2; Huertas, F.1; Sanabria, D.2. 1. Departamento de Gestión y Ciencias Aplicadas a la Actividad Física, Universidad Católica de Valencia, Spain. 2. Departamento de Psicología Experimental, Universidad de Granada, Spain **Introduction** There is growing evidence regarding the effect of acute bouts of aerobic exercise in the functioning of attention (Tomporowski, 2003). This study explored the effects

of aerobic and anaerobic bouts of physical activity on the deployment of exogenous spatial attention and stimulus-response conflict. Executive control and spatial orienting processes play an important role in sport competition. Methods We used a VIA sprint 150 P cycle ergometer, RS800CX Polar monitor to record the heart rate (HR) and analysis of expired gases occurred using the MasterScreen CPX Metabolic Cart to obtain anaerobic threshold. Participants performed a spatial attention task at rest, during an acute bout of 100% anaerobic threshold, 80% of anaerobic threshold and after recovering the basal heart rate (HR) following an acute bout of anaerobic and aerobic exercise. These sessions were counterbalanced across participants. Results Anaerobic exercise induced an increase in the stimulus-response compatibility effect magnitude (i.e., RT incompatibles – RT compatibles) compared to a situation in which the cognitive task was performed at rest. This effect disappeared when participants recovered their basal HR. Exogenous attention was not modulated by anaerobic exercise. On the contrary aerobic exercise modulated exogenous spatial attention but did not affect executive control. Discussion Regarding executive control, the current findings replicate other studies (e.g., Del Giorno et al., 2010), which observed a worse functioning of the executive control network while performing anaerobic exercise. This effect disappeared after recovering the basal HR. This result lends support to the Transient Hypofrontality Theory. On the contrary, aerobic exercise only modulated the deployment of exogenous spatial attention. We argue that aerobic exercise enhanced participants' attentional reactivity to peripheral stimuli, replicating Sanabria et al.'s (2011) study. References Del Giorno, J. M., Hall, E. E., O'Leary, K. C., Bixby, W. R. & Miller, P. C. (2010). Cognitive function during acute exercise: a test of the transient hypofrontality theory. *Journal of Sport & Exercise Psychology*, 32(3), 312-323. Tomporowski, P. D. (2003). Effects of acute bouts of exercise on cognition. *Acta Psychologica*, 112, 297-324. Sanabria, D., Morales, E., Luque, A., Galvez, G., Huertas, F. y Lupianez, J. (2011). Effects of aerobic exercise on exogenous spatial attention. *Psychology of Sport and Exercise*, 12(5), 570-574.

## GROUP AND INDIVIDUAL DIFFERENCES DURING THE STUDY OF PERCEPTUAL CUES FOR TENNIS SERVES

Zawadzki, P., Roca, J.

*Barcelona University*

Introduction During a tennis match, the ability to anticipate an opponent stroke is composed in part from what one can perceive from his technique. Over matches players normally formulate knowledge based on a group or a single player. With the aim of explore this argument an analysis over a study of perceptual cues of tennis serves were made. Methods Kinematics analysis was used to describe 19 professional tennis players during competition through four groups of perceptual cues: position of serve (pos), ball toss (bal), knee bend (kne) and racket arm location at appearance to returner (rac). Canonical Correlation Analyses were performed between groups on all professionals, and on three participants random assigned. Results Canonical correlation coefficient (Rc) showed for the group value of 0.2402 ( $p=0.01$ ), with canonical variates of pos=0.0031, bal=0.299, kne=0.0746, and rac=-0.1598. Player 1 showed results Rc=0.8909 ( $p=0.05$ ) for the first coefficient, with canonical variates of pos=0.0517, bal=-0.0969, kne=0.0909, and rac=0.0019. Player 2 showed Rc=0.9109 ( $p=0.004$ ), with canonical variates values of pos=0.493, bal=-0.0261, kne=0.1363, and rac=0.0122. Player 3 showed Rc=0.8805 ( $p=0.0013$ ), with canonical variates values of - pos=0.199, bal=0.0499, kne=0.0007, and rac=-0.047. The greater canonical weight on the result group was ball speed for all results. Discussion Despite all correlations resulted significant ( $p<0.05$ ), power of correlations comes from 0.2 on the group to 0.9 on one player. Canonical variates also are different for each case. This evidence suggests that knowledge should be elaborated starting on the single player to be more efficient. Baker, Farrow, Elliott, and Anderson (2009) and Farrow, Abernethy, and Jackson (2005) showed evidences that support the kinematic content of a server as responsible for the anticipatory skill of their participants, justifying the need of a perceptual cue description at individual level. Zawadzki and Roca (2010) relates the Opponent Technique Study as a field plenty of opportunities to help players to fit their responses faster and more accurate. References Baker, J., Farrow, D., Elliott, B., and Anderson, J. (2009). The influence of processing time on expert anticipation. *International Journal of Sport Psychology*, 40(4), 476-488. Farrow, D., Abernethy, B., and Jackson, R. C. (2005). Probing expert anticipation with the temporal occlusion paradigm: Experimental investigations of some methodological issues. *Motor Control*, 9(3), 332-351. Zawadzki, P., and Roca, J. (2010). Un estudio sobre indicios perceptivos para el resto en el servicio de tenis. *Revista de Psicología del Deporte*, 19(1), 59-71.

**14:45 - 15:45**

## Poster presentations

### PP-SH12 Sport Statistics and Analysis 2

#### ALL FOR ONE AND ONE FOR ALL! DISPARITY BETWEEN OVERALL CREW AND INDIVIDUAL ROWERS PACING STRATEGIES DURING ROWING

Renfree, A., Martin, L., St Clair Gibson, A.

*University of Worcester*

ALL FOR ONE AND ONE FOR ALL! DISPARITY BETWEEN OVERALL CREW AND INDIVIDUAL ROWERS PACING STRATEGIES DURING ROWING Renfree, A.1, Martin, L.1, St Clair Gibson A.2 1: University of Worcester UK, 2: Northumbria University UK Introduction During on-water 2000m rowing a common parabolic race profile has been reported (Muehlbauer et al 2011). Previous studies have reported total boat speed when analysing pacing strategies during rowing, and no published study has reported individual rower or overall boat power profiles. The aim of this case study was therefore to describe overall and individual rower power profiles of a coxless four boat during 2 km and 5 km trials. Methods A crew of four male rowers with at least three years competitive experience at varsity level participated in this study. Following familiarisation trials, the crew performed maximal trials over 2 km and 5 km in a Janousek 4- boat (Janousek Racing, Surrey, UK). The oarlocks were replaced with power-line gates (Peach Power-Line systems, Peach Innovations Ltd. Cambridge UK). The Power-line system was interfaced to a PC equipped with Power-Line V3-3 software which calculated power output (Watts) generated during each stroke. For both trials, mean overall boat and individual rower stroke power was calculated for each 25% epoch (25% of total strokes taken), and power for each individual epoch was calculated as a percentage of mean power maintained over the entire distance. The coefficient of variation was used to determine stroke to stroke and epoch to epoch variability for individual rowers and the overall boat. Results Power profiles indicate that in both trials the overall pacing strategy consisted of a high power output in the initial 25% that decreased in the middle 50% and increased again in the final 25%. Individual rower data indicates that each has a different power profile, and not all mimic the overall boat profile. In both trials, the stroke and bow seats produced their highest power during the final



epoch whereas rowers in the middle positions produced their highest power outputs in the opening epoch. Additionally, each individual also demonstrated a high degree of oscillation in stroke-to-stroke power output throughout the trials. Discussion This study demonstrates that overall boat power profiles during 2 km and 5 km rowing trials are similar to velocity profiles previously reported for individual ergometry and on-water racing events. However, this overall profile is achieved despite considerable variation within individual rower profiles. Further research is warranted in order to determine the mechanisms through which individual contributions to overall pacing strategy are regulated, and the effectiveness or otherwise of seemingly disparate individual strategies on overall performance. Reference 1. Muehlbauer T, Schindler T, Widmer A. (2010) Pacing pattern and performance during the 2008 Olympic rowing regatta. *Eur J Sport Sci*, 5, 291-296

### CHARACTERISTICS OF MATCH ACTIVITY IN JAPANESE SOCCER REFEREES.

Ishihara, Y., Naito, H., Katamoto, S.

*Juntendo university*

INTRODUCTION: Previous studies demonstrated that the match intensities of referees in premier league were positively correlated with the levels of competition (Weston et al. 2006). However, the effect of competition standard on match activities of referees in highschool and university football matches has yet to be thoroughly examined. Therefore, this study aimed to quantify the characteristics of the match activity with respect to referee's running distance and speed, and heart rate during Japanese amateur U-18 and U-22 football matches, and to investigate the influence of match technical-tactical data of field players on these measures. METHODS: Twenty male football referees (25 ± 3 year-old) holding a 1st or 2nd class licence accredited by Japan Football Association participated in this study. Match activity data were collected using a GPS (15 Hz, Gpsports, Australia) from 20 referees: 10 refereed for Takamado trophy U-18 football league (U-18), and the rest for the Kanto university league (U-22) during the 2011 season. The recorded movement speeds of the referees were classified into the following categories (1) Walking: ≤ 6 km/h, (2) Jogging: 6-8 km/h, (3) Low speed: 8-12 km/h, (4) Moderate speed: 12-15 km/h, (5) High speed: 15-18 km/h, and (6) Sprinting: ≥ 18 km/h. The high-intensity running (HIR) was defined as the speed greater than 15 km/h. Heart rate (HR) was recorded using short-range radio telemetry. All matches were video filmed to record the distance of the referees from infringements, and players' match technical-tactical data using a broad video camera. Technical-tactical data were the numbers of (1) passes, (2) shots, (3) infringements, (4) penetrations into attacking zone, and (5) offence-defence turnovers. RESULTS: Of all the matches observed, the mean total distance covered by the referees was 11209 ± 665 m. 17 % of that (1872 ± 472 m) was covered by HIR. Mean running speed and HR were 7.1 ± 0.4 km/h and 167 ± 8 beats/min (86 ± 4 %HRmax), respectively. A significant negative correlation was observed between the total distance covered and the mean distance from infringements ( $r = -0.56$ ,  $p < 0.05$ ). These measured variables did not significantly differ between U-18 and U-22 matches, nor were they affected by the players' technical-tactical behaviors and appeared to be similar to previously reported values of FIFA referees. DISCUSSION: The age-related competition level and players' technical-tactical data had no effect on the referees' match activities. moreover, the match activity level observed in this study resembled that of FIFA top level referees. These results could suggest that the referees moved independently of players' moves or skills but predicted the flow of events with a broad view in cooperation with the assistant referees. REFERENCES: Weston M, et al. (2006) *J Sci Med Sport*, 9(3): 256-62.

### 100 M BACKSTROKE TIME ESTIMATION FROM AGE: A MODEL BASED ON REGRESSION ANALYSIS

MORALES, E., Dominguez-Castells, R., Femia, P., Arellano, R.

*Faculty of Sport Sciences*

Introduction The dynamic process of training needs as much information as possible from performance and training testing, which will help the coach monitor the training program. It must be designed according to swimming time and age. Performance in 100 m backstroke (B) improves with age during the growing period. Race components change with gradual development of many physical fitness factors. Regression equations were obtained through the race components analysis in different competitions (Absaliamov and Timakovoy, 1990; Arellano et al., 1996; Nomura, 2006). This investigation aimed to estimate the event times (ET) in 100m backstroke from age. Methods Data from different competitions (Age group Andalusia Championship 2004, European Youth Olympics 2001, Junior European Championship 2000 to 2004, and Senior European Championship 2000 to 2005) were used to develop the regression analysis. These times were published in a web: <http://www.swim.ee//competition>. 100 m backstroke semifinalists and finalists were analyzed. The Kolmogorov-Smirnov test, which confirmed the normal distribution, was used. Regression analysis was used to determine the tendency and model of the event time. Inverse function approximation of the event time by age (AGE) and gender (GEN) was carried out. The generic equation obtained was:  $ET = a + a' * GEN + b/AGE (1 - b' * GEN)$  The time estimation formula from age according to gender was as follows: ET men =  $a_1 + b_1/AGE$ ; ET woman =  $a_2 + b_2/AGE$  Furthermore, regression analysis and inverse function for the event time were calculated. Results The type of equations obtained for event time according to gender were inverse functions: ET men =  $26.752 + 556.094 * AGE^{-1}$  ( $R^2 = 0.646$ ); ET woman =  $35.852 + 458.654 * AGE^{-1}$  ( $R^2 = 0.593$ ) Discussion 200m freestyle times for young swimmers during growth were estimated through regression analysis (Nomura, 2006). The model proposed for backstroke enhances this estimation, allowing to determine swimming times according to age and gender. Peak performance times were estimated until 35 years old (maximum swimmers' age found in these competitions). A progressive time increase until 70 years old was obtained in the analysis of different competitions in the US Masters Swimming, which was characterized by a steep quadratic term (Donato et al., 2003). In conclusion, bearing long-term planning in mind, with internal and external development factors, this regression model can be used as a reference guide for a correct swimmer development. References Absaliamov, Timakovoy (1990). Aseguramiento Científico de la Competición. A.I. Zvonarev. Trans. 1 ed, vol.1. Moscú: Vneshtorgizdat. Arellano R, Brown P, Cappaert J, Nelson R (1996). XIV Int Symp on Biomech in Sports, 274-276. Donato AJ, Tench K, Glueck DH, Seals DR, Escurza I, Tanaka H (2003). *J Appl Physiol*, 94, 764-769. Nomura T (2006). *Revista portuguesa de ciências do desporto*, 6, Supl. 2, 239-241.

### VO2MAX ESTIMATION USING SUB-MAXIMAL METABOLIC RESPONSES IN MIDDLE-AGED WOMEN, AGES 40~60 YEARS

Jeon, Y.J.1, Yoon, J.H.2, Lee, B.K.3, Kim, C.H.4, Kim, B.W.5, Im, J.H.6

1,2,6 : KAIST(Daejeon, S.Korea), 3 : SangMyung U.(Seoul, S.Korea), 4,5 : Daejeon U.(Daejeon, S.korea)

Introduction The purpose of this study is to make regression equation which estimates maximal oxygen uptake of middle-aged women. Maximal oxygen uptake is known as a standard of person's cardio-respiratory capacity. Methods 153 women subjects, ages 40~60

years ( $48.6 \pm 5.5$  years old in average) were participated in this study. Maximal exercise test was carried out on a treadmill followed by Bruce protocol, and data of metabolic responses were recorded when test time was 3 and 6 minutes especially. We used these sub-maximal metabolic responses and physical property variables and made 2 models by applying multiple regression analysis with step-wise method. Results The equation of 3 minutes model is  $VO_{2max}(ml/kg/min) = 61.363 - 0.155Age - 0.414Weight - 0.128HR(3) + 0.028VO_2(3) - 0.015VCO_2(3)$  made by age, weight, HR at 3 minutes (HR(3)),  $VO_2$  at 3 minutes ( $VO_2(3)$ ) and  $VCO_2$  at 3 minutes ( $VCO_2(3)$ ). R (multiple correlation) of this model was 0.728, SEE was 2.72 ml/kg/min and CV was 9.16% ( $p < 0.05$ ). And the equation of 6 minutes model is  $VO_{2max}(ml/kg/min) = 33.705 - 0.433Weight + 0.026VO_2(6) - 0.011VCO_2(6)$  made by age,  $VO_2$  at 6 minutes ( $VO_2(6)$ ) and  $VCO_2$  at 6 minutes ( $VCO_2(6)$ ). R of this model was 0.823, SEE was 2.24ml/kg/min and CV was 7.50% ( $p < 0.05$ ). Discussion The result of cross-validation of these models with rest 45 subjects showed very little errors. And compared with other studies, statistical data between models were similar. Therefore both models are suitable for predicting maximal oxygen uptake. But maximal oxygen uptake of subjects who had good cardio-respiratory capacity was underestimated little.

### FREE KICKS IN FOOTBALL: COORDINATING TO SUCCESS

Vicente, A., Lopes, H., Fernando, C.

*University of Beira Interior, University of Madeira, CIDESD*

Introduction In the FIFA World Cup 2010 there was 2011 fouls on the 64 matches (an average of 31.42 fouls per game). From these fouls resulted a huge percentage of direct or indirect free kicks. However, from the 1018 total shots in the FIFA World Cup 2010 only 159 were free kick shoots, and even a lower percentage resulted in goal. The free kick is a very important opportunity to score. However, studies on this situation are essentially empirical and there is not enough knowledge to understand this situation functionally and by this how it can be improved so that its success can increase. The aim of this study was to analyse a set of free kicks from a major football competition in order to understand this situation functionally in the continuation of previous studies (e.g. Vicente et al., 2011). Methods Using a model of team sports (Almada et al., 2008) we've defined limits for  $t$  (being  $t$  - the time the ball takes to reach the goal area) and the intermediate times in that we can decompose this  $t$  and what actions can be made in those times by the attacking team. We compared all these times with the times that concomitantly were used by the defending team ( $t'$ ), and the parcel times that compose this  $t'$ . We've compared the reached conclusions with what we have analyzed in 10 free kicks from the FIFA World Cup 2010 Final (Netherlands vs. Spain), trying to understand if our definitions were coherent. We've calculated the time the ball took to reach the goal area using the ballistic trajectory formula and defined the different conditions that were possible in acceptable limits. We've measured the time the ball took until being touched by any player or enter the goal. Results The ball took a minimum of 320 up to a maximum of 3420 milliseconds to reach the goal or being touched/shot by a player. The attacking players mostly started their movement before the defending players and, in average, 240ms before the ball being kicked. No goal was scored from this situation in this match. Discussion The definition of possible strategies in a free kick situation for the attacking team with the knowledge of the variables limits is possible and can improve the performance of football teams if the right strategy is prepared. Ecological studies that we are still carrying out tend to corroborate that there are limits that can be reached and are useful, but depending on the objectives aimed there are others that are neither reachable nor useful. Their definitions are useful to orientate practice and improve player's and team's performances in these situations. References Almada F., Fernando C., Lopes H., Vicente A., Vitoria M. (2008). V.M.L., Torres Novas. Vicente A., Fernando C., Lopes H. (2010). 16th ECSS, Liverpool.

### EXECUTION TIME OF MAWASHI-GUERI IN KARATE COMPETITION AND TRAINING SITUATIONS

Fernando, C., Vicente, A., Lopes, H.

*University of Madeira, University of Beira Interior, CIDESD*

Introduction Training is a preparation for the competition; however, in order to actually accomplish this aim efficiently it is necessary that the conditions under which it is made suit the training goals (Almada et al., 2008). Understanding the inherent variables in the ecological situation of a mawashi-gueri is essential to build coherent training models but it is also important to test whether the starting conjectures are consistent with the data obtained. Methods In a sample of 5 senior level male individuals with experience in karate (karateka) we recorded and measure the execution time of mawashi-gueri in three different situations: 1) In a combat situation in competition; 2) In a training situation where from the usual displacement movement in combat the karateka performed the mawashi-gueri for a pre-defined area; 3) In a training situation starting from a static position the karateka performed the mawashi-gueri. The films from each situation were edited with Adobe Premiere Pro C4, with a breakdown of 25 frames/minute and quantified the time of 7 mawashi-gueri for every situation and every karateka. Results The average time for the execution of mawashi-gueri in situation 1) was 377ms, in situation 2) 398ms and in situation 3) 598ms. The standard deviation was respectively 0.45ms, 0.27ms and 0.44ms. In all the situations the values range was 400ms, being the maximum value of 680ms and the minimum of 280ms. Discussion The obtained data from the ecological situation of combat (228-248ms) are far below those known for the execution time of the mawashi-gueri, including the data presented by Villani et al. (2009) where the times were reported between 610-640ms. Also Mori et al. (2002) in punching and kicking techniques indicate values between 430-660ms. This difference is easily explained by the fact that the values presented by these studies were collected in laboratorial situations where the karateka starts moving from a static position. However, through the experimental situations made, we have verified that even in an isolated situation of mawashi-gueri training it is possible that the karatekas present time values closest to the ecological situation if the exercise is designed with this concern. Moreover, we believe that the difference in the execution times of mawashi-gueri in a static situation (situation 3) found when compared to data from other studies may have been caused by the fact that karatekas were influenced by the other held situation (situation 2) or even by their competition experiences. References Almada F., Fernando C., Lopes, H., Vicente A., Vitoria M. (2008). V.M.L., Torres Novas. Mori S., Ohtani Y., Imanaka, K. (2002). Human Movement Science, 21, 213-230. Villani R., Ceccacci A., Gasperini D., Distaso M., Giangrande M. (2009). 13th ECSS, Oslo.

### UNDERSTANDING THE CORNER KICK IN FOOTBALL – QUANTIFYING FOR TRAINING

Lopes, H., Fernando, C., Vicente, A.

*University of Madeira, University of Beira Interior, CIDESD*

Introduction The corner kick is an important opportunity to score in football. However although, on average, 10 corners occur per game the ones that achieve goal are very low. Knowing that the ball takes on average between 1500ms and 3000ms to reach the front of the goal (Vicente et al. 2011) and that even 21 players can be involved in this situation it is important to quantify some of the execution times involved so that training should decrease it's empirical dominance. Methods Using the model for functional analysis of the corner kicks in

football developed by Almada et al. (2010) a laboratorial situation was created where a forward had a defender on its back and tried to pass over him in the shortest possible time, placing himself ahead of the opponent (the defender). The defender could move in an area of 1.2meters by 0.6 meters and the forward moved from an area of 0.6m by 0.6m placed behind the defender zone (with three positions: in the middle, the entire left and all the right) and had to reach an identical area placed in front of the defender zone. The sample consisted of 20 football players who assumed the forward and defender functions. Each forward repeated the situation 30 times (10 starting from the center, 10 starting at left and 10 at right). Results The obtained times varied in a ranged between 690ms and 2420ms with an average of 1380ms (SD+400ms). There were no significant differences between the times from the three forward starting positions (center, left and right). Discussion Considering that in the corner kick in football the ball takes in average between 1500ms and 3000ms to reach the front of the goal, and the forward that seeks to gain advantage over the defender in order to be in a better position to be able to intercept the ball route and try to score takes between 690ms and 2420ms to do it, this may mean that the forward has enough time to gain position over the defender by choosing the best moment to do so even after the ball starts. But we must not forget that the forward can know in advance the ball route and the area where it begins to be possible to act over it, so that it is possible an articulation between the different forwards so that their movements can not only give the wrong information to the defenders about what will happen, but also blocking the defenders, preventing them, including the goalkeeper from intercepting the ball. References Almada F., Fernando C., Lopes H., Vicente A. (2010). V.M.L., Torres Novas. Vicente A., Fernando C., Lopes H. (2011). 7th WCSF, Nagoya.

### **INFLUENCE OF CODE OF POINTS IN BRAZILIAN MEN'S GYMNASTICS TRAINING**

Carrara, P.1, Mochizuki, L.1, Araujo, C.2, Botelho, M.2

1: USP (São Paulo, Brasil), 2: FADEUP (Porto, Portugal)

Introduction: The Gymnastics' Code of Points (CP) had great changes after 2006. With a new dimension for competitions evaluation criteria, the traditional ten point score was substituted by the top ten elements of difficulty and maximum ten points of presentation in an exercise (Carrara and Mochizuki, 2011). The aim of this study is to verify the influence of the CP new rules on the systematization of high level men's gymnastics training. Methods: To understand these alterations, fifteen senior coaches of Brazil, including those working with national team, were questioned about the changes in the CP rules and their respective influence on training. For the interviews, a comparative analysis between the rules of the 2001 and 2006 CP was performed, whose results were used to construct and validate the questionnaire. A questionnaire of 12 items were answered and commented upon. Content analysis was used for evaluation of the comments (Bardin, 2004), where the emerging themes were the training components. Results: The coaches expressed some tendencies toward training changes. In this respect, an increase in training volume to develop elements of higher difficulty in different groups; and intensity increase to execute routines with more elements of higher difficulty, including the dismount was introduced into Physical Preparation. In Technical Preparation a wider element variety and element difficulty of the different groups were necessary. In Tactical Preparation routines involving a larger number of more difficult elements, including dismount, were observed. Discussion: The coaches mentioned that the new rules imply changes in routines composition and noticed new tendencies in training systematization. The main results permit to conclude that the 2006 CP led to changes in routine composition, with the use of a more varied number of elements on the apparatuses. Specifically, floor exercise is the only with maximum presentation time, what requires greater number of elements and acrobatic sequences to earn bonus score. Rings routines require changes in strength training, to develop new elements and connections in static elements. Rings also need a wide range of group elements, and were considered the most complex apparatus to dismount at the routine's end. Comparing coaches' interviews with international results, Brazil's team improved from one gymnast classified to 2008 Olympic Games (OG) to three gymnasts in 2012 OG. In world championships hold two medals, 2007 and 2011, on floor exercises and reached on rings its first medal in 2011. It is important to consider that gymnast performances on the different apparatuses are not only conditioned by training characteristics, but also by the gymnast's individual potential (Arkaev, 2004). References: Arkaev L, Suchilin N (2004). *Gymnastics: how to create champions*. Oxford: Meyer & Meyer Sport. Bardin L (2004). *Análise de conteúdo*. Lisboa: Edições 70. Carrara P, Mochizuki L (2011). *Motriz*, 17 (4), 691-699.

### **CRITICAL ACCELERATION-DECELERATION ALLOWS ESTIMATES REAL METABOLIC DEMAND DURING A SOCCER GAME.**

Argemi, R., Ortega, G.P.

*Club Boca Juniors*

Since 1950 many different efforts have been made to estimate the metabolic demands of a soccer game, despite the different tools the only published information is about distance and speed during the game. We hypothesize that this approach underestimates the real metabolic demand of a soccer game compared to accelerations and decelerations measure. PURPOSE: To determine the physical demand of a soccer game comparing, running speed vs. acceleration-deceleration. METHODS: We evaluate 10 field players of the professional team of Boca Juniors, Argentina. First, they done endurance intermittent level 2 Yo-Yo Test, with GPS (gpsport®, Australian). We establish the critical velocity (CV) (average velocity of the last step) and critical acceleration-deceleration (CAD). ( acceleration and desacceleration of the last step in 0,5 1, 2 and 3 seconds) Using a commercially available semi-automatic video analysis system we compare the distance covered at different speeds and at different intensities of acceleration-deceleration during an official Argentine first division soccer game. RESULTS: the results for the distance covered in meters; the percentage of the total distance covered; the average distance covered; and the number of efforts are shown for >80%, >100% or >200% of critical velocity (CV) and critical acceleration desacceleration (CAD) Distance in meters (CV: 2271, 1279 and 0) (CAD: 3881\*, 2323\* and 534\*). % total Distance (CV: 22,52, 1274 and 0) (CAD: 38,44\*, 23,02\* and 5,3\*)Average distance per entry (CV: 5.24, 6.49 and 0) (CAD: 2.60\*, 3.12\*, and 5.3\*). \* p: < 0,05 . CONCLUSION: Running speed underestimates the real metabolic demands of a soccer game. The average distances of each effort are very short to develop high velocities, even when the players are accelerating at their maximal or near maximal capacity. Considering acceleration and deceleration, the efforts double the values of intense exercise from the traditional methodology which measure only velocity.

### **PLOTTING PAIRED DATA SAMPLED FROM DIFFERENT GROUPS USING THE DISTRIBUTION-FREE R PACKAGE 'PAIREDATA'**

Champely, S., Verdot, C., Monteil, K.M.

*University Lyon 1*

Introduction "The most common design in sports and exercise science involves one between-subject factor at two levels and one within-subject factor also at two levels" (Newell et al., 2010). Before analysing such data (by gain score analysis, repeated measures ANOVA or

ANCOVA), a data visualisation is important in order to detect the existence of outliers, clusters, heteroscedasticity, granularity, or still departures from normality. Such a visualisation stage could also suggest some data cleaning, a convenient data transformation or simply a more suitable data description. Several specific plots exist for the genuine paired data situation: the correlation plot, the Bland-Altman plot, the profile plot and the paired dotplot. Nevertheless, all these graphic methods are rarely available in usual statistical software and not often described in statistics handbooks. Furthermore, to differentiate paired data sampled from different groups, it is essential to use more complex visual strategies such as faceting (small multiples of the simple plot) or grouping ones (overlapping plots). Methods The layered grammar of graphics (Wickam, 2011) considers a statistical graphics as a mapping from data to aesthetic attributes (colour, shape...) of geometric objects (points, lines...) drawn on a given coordinate system, with faceting implemented in this framework. We indeed propose in the distribution-free R package 'PairedData' some innovative plotting tools based on this powerful grammar. Results The interest of these tools will be shown on two datasets: firstly through a comparison of the flexibility of left and right shoulders between swimmers and sedentary people; and secondly through an analysis of the evolution of prisoners' stress between a group physically trained during a five month period and a control group (comparison of stress rates at the beginning and at the end of the five month period). Discussion The display devices proposed in the 'PairedData' package can also be used with a between-subject factor at multiple levels or even with a combination of two between-subject factors. In addition, this package implements some statistical tools for studying the simple paired two-sample design. A robust location test, two robust scale tests and one robust procedure for computing an effect size, were especially written for paired data. A graphical user interface is currently under construction to provide an easy-to-use environment to these new functionalities. References Newell J, Aitchinson T, Grant S (2010). Statistics for Sports and Exercise Science. Pearson, Harlow, England. R Development Core Team (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org>. Wickam H (2011). ggplot2. Springer, New-York.

### TIME SPENT IN MODERATE INTENSE PHYSICAL ACTIVITIES VARIES DEPENDING ON TYPE OF ANALYSIS AND SELECTED METS CUT-OFFS.

Van Remoortel, H., Hornikx, M., Demeyer, H., Burtin, C., Langer, D., Janssens, W., Decramer, M., Gosselink, R., Troosters, T.  
*Katholieke Universiteit Leuven, Faculty of Kinesiology and Rehabilitation Sciences*

Time spent in moderate intense physical activity is a health-related outcome frequently used in clinical trials and physical activity guidelines. Different age-dependent cut-offs to define moderate intensity are existing. The aim of the present study is to investigate the adherence of an elderly population to different cut-offs of moderate intense physical activities. Hundred sixty-seven older adults (50 non-smokers, 63 (ex-)smokers and 54 mild COPD patients; age  $62 \pm 7$  y, 66% male and BMI  $26.4 \pm 4.0$ ) wore a multisensor activity monitor (SenseWear Pro Armband) for 7 consecutive days. Metabolic Equivalent of Tasks (METs) were recorded minute-by-minute during >22h wearing time on at least 3 days. Cut-offs to define moderate intense physical activities were based on 1) ACSM physical activity guidelines (ACSM:  $\leq 65$ y; 3 METs, >65y; individual METs level corresponding to 50% of VO<sub>2</sub> reserve), 2) Individual METs level (50% of VO<sub>2</sub> reserve) for each person (INDIVIDUAL) and 3) age-dependent cut-offs from Haskell and Pollock (HP: age  $\leq 65$ y; 4.5 METs, >65y; 3.6 METs). Time spent in at least moderate intense physical activities was analyzed with (BOUITS) and without (NO BOUITS) bouts of at least 10 minutes consecutive activity above the threshold. 'Physically active' was defined as  $\geq 30$  minutes (BOUITS) moderate intense physical activity per day. As expected, the median time spent in moderate intense physical activities was significantly less in BOUITS compared to NO BOUITS (38 [13 to 72] vs 106 [61 to 152] min/day with ACSM, 44 [15 to 79] vs 120 [68 to 173] min/day with INDIVIDUAL and 4 [0 to 18] vs 24 [9 to 60] min/day with HP, all  $p < 0.01$ ) and significantly lower values were observed for HP cut offs ( $p < 0.05$ ). Fifty-nine and 60% of the participants were classified as physically active corresponding to ACSM and INDIVIDUAL, respectively. HP cut-offs classified significantly less subjects (18%,  $n=31$ ) as physically active ( $p < 0.0001$ ). Underestimation of moderate intense physical activities with HP compared to ACSM was higher in adults of 60-65y (mean difference of  $-87 \pm 19\%$ ) compared to adults >65y (mean difference of  $-47 \pm 49\%$ ,  $p < 0.05$ ). The amount of moderate intense physical activity in bouts of at least 10 minutes is 2 to 3 fold lower compared to no bouts. Similar results in moderate intense physical activity are reported with individual cut-offs and ACSM whereas HP cut-offs are more stringent especially in older adults from 60 to 65 years. The present study showed that type of analysis and selected METs cut-off are important factors when using an activity monitor. Prospective validation of the cut offs related to adverse long term outcome seems needed.

14:45 - 15:45

## Poster presentations

### PP-PM52 Rehabilitation and Sports Medicine

#### SPATIAL AND TEMPORAL ANALYSIS EFFECTS OF HIGH FREQUENCY FOCUSED VIBRATION ON CERVICAL PAIN

Iodice, P., Bellomo, R.G., Di Pancrazio, L., Saggini, R.  
*University of Chieti*

Introduction. Several investigation have documented the ability of vibration to reduce or alleviate both experimental pain and pain of clinical origin. High frequency focused (120Hz) stimulus has been found to be more effective at activating the vibrotactile system and reducing musculoskeletal activity. Methods In the present study, we used rigorously controlled conditions to examine vibratory analgesia and muscle adaptation in participants (N = 15) with cervical pain. Results of 120 Hz vibration were compared with data from a no-vibration control condition. We measured its time course using continuous visual analog scale (VAS) recording, and its spatial aspects by asking subjects to indicate painful regions on standardized drawings. Moreover, before and after each treatment was carried out an electromyographic (EMG) investigation of trapezius muscle. Results VAS ratings and drawings both showed that pain is reduced by 120 Hz but not in control condition. EMGs results indicate that high frequency focused vibration treatment decrease trapezius muscle activity. Discussion Decrease of muscle activity and decrease of VAS were statistically correlated, suggesting that vibratory analgesia can be attributed to involving Pacinian corpuscles. Spatial analyses results suggest at least in part a involvement of central nervous system processes.

## EFFECTS OF BRIDGING EXERCISE METHODS ON THE MUSCULAR ACTIVITY OF THE NECK AND TRUNK

Dong-hyun, S., Gi Duck, P., Chul-ho, S., Han-Yong, L.

*Namseoul University*

**Introduction** Lumbar stabilization exercise trains patients to control force in unstable positions and consciously and unconsciously regulate motion so as to maintain the spinal neutral position in which the spine can be best adapted to external load. Recently, lumbar stabilization exercise has drawn attention as a therapeutic exercise as well as a method for preventive management. The purpose of this study was to investigate the effects of different bridging exercise methods varied by the position of the lower limbs on the muscular activity of the neck and trunk. **Methods** The subjects of this study were 14 males in their twenties. The muscular activity of the longissimus capitis and sternocleidomastoid in the neck, the erector spinae and rectus abdominis in the trunk was measured using a surface electromyography. **Results** The comparison of the muscular activity showed significant differences in the longissimus capitis, rectus abdominis, erector spinae muscle depending on bridging exercise method. **Conclusion** Using the theoretical mechanisms proposed in previous bridging exercise studies and the results in the study, it can be concluded that muscular activity can be changed by the variation of the position of the lower limbs when applying a bridging exercise. **Reference** Stevens, V. K, Coorevits, P. L., & Bouche, K. G. (2007) The influence of specific training on trunk muscle recruitment patterns in healthy subjects during stabilization exercises. *Manual Therapy*, 12: 271-279. Haynes, W. (2004). Core stability and the unstable platform device. *Journal of Bodywork and Movement Therapies*, 8: 88-103.

## NEW PERSPECTIVES IN RECOVERY AND CORRECTING SPECIFIC SPINE DEFORMITIES FROM SCHEUERMANN'S DISEASE

Marinescu, Gh.1, Tataru, T.1, Ene, D.1, Cioroboiu, A.1, Dumangiu, M.1, Paunescu, C.2, Moscaliuc, C.3, Zamfir, V.1, Ticala, L.1, Prisacaru, R.1

*National University of Physical Education and Sport*

**NEW PERSPECTIVES IN RECOVERY AND CORRECTING SPECIFIC SPINE DEFORMITIES FROM SCHEUERMANN'S DISEASE** Marinescu, Gh.1, Tataru, T.1, Ene, D.1, Cioroboiu, A.1, Dumangiu, M. 1, Paunescu, C.2, Moscaliuc, C.3, Zamfir, V.1, Ticala, L.1, Prisacaru, R.1 1:NUFES (Bucharest, Romania), 2:UMFCD (Bucharest, Romania), 3:USM (Suceava, Romania), **Introduction** Scheuermann's Disease (juvenile kyphosis) is a disease affecting children and young people. Results in an deformity in the thoracic or thoracolumbar spine in children and adolescents, characterized by accentuated curvature at an angle over 45 degree (typical form), wedging vertebrae and the presence of Schmorl nodes - characteristic of the disease. The two forms of manifestation determine specific disorders of spine alignment. Therefore, we consider necessary therapeutic approach and recovery of disease by treating the differentiation of the two forms and enrichment by means of recovery, hydrokinotherapy (complex mean of recovery) and adapted programs for those forms. **Methods** The study was carried out by repeated evaluations in comparison, in the four groups: - group (I) with the typical form, which made physical therapy program; - group (II) with the typical form, which in addition to physical therapy made a program of hydrokinotherapy; - group (III) with atypical form, which performed the physical therapy program; - group (IV) with atypical form, which performed in addition to physiotherapy a program of hydrokinotherapy; **Results** Research was made longitudinal and transverse, using several methods and statistical-mathematical tests that contributed to the processing and interpretation of data obtained after assessments carried out before and after application of individualized physical therapy programs and hydrokinotherapy, designed for each form of manifestation of Scheuermann's disease. Where used: simple ANOVA test, dependent t test, Cohen index of size effect, etc. Final evaluations have revealed significant rises in all four groups that carried out physical therapy programs. Comparing the results between the groups which carried out the hydrokinotherapy and those who have not, data have shown rises for groups with both forms of programs. **Discussion** Programs of individualized exercises for every form of disease is prerequisite to the recovery of Scheuermann's Disease, clinical manifestations are quite different between the two forms. Hydrokinotherapy by new methods and techniques (i.e. the program in six stages) is updating and innovation required. **References** Koury, J., M. (1996) Aquatic therapy programming-guideline for orthopedic rehabilitation, Human Kinetics; Lambrinudi, I., (2007) Adolescent and senile kyphosis, BMJ, London; Marinescu, Gh., (1998) Copiii si performanta in sport, Bucuresti; Marinescu, Gh., (2003) Efort si antrenament, Bucuresti; Wood, W., Lovell, Robert, B., Winter, Raymond, T., Morrissy, Stuart, L., Weinstein (2009) - Lovell and Winter's pediatric orthopaedics, vol. 1+2, Philadelphia;

## EFFECT OF AUGMENTED REALITY ON LOCAL DYNAMIC STABILITY OF PELVIS AND TRUNK MOVEMENTS IN HUMANS

Hamacher, D., Schega, L.

*Otto-von-Guericke-University Magdeburg*

**Effect of augmented reality on local dynamic stability of pelvis and trunk movements in humans** Hamacher, D.1, Schega, L.1 1: ISPW (Magdeburg, Germany) **Introduction** The application of Augmented Reality (AR) in gait retraining to improve trunk and pelvis movements in patients with total hip replacement (THR) has already been evaluated (Schega et al., 2011). However, the effect of AR-based gait training on the stability of pelvis and trunk trajectories remains unexplored. Hence, the purpose of the present study was to evaluate the effect of AR-based feedback 1) in healthy individuals and subjects with several gait disorders whilst using the AR-system and 2) in patients with THR in a retention test after having passed an AR-based training. **Methods** Kinematic parameters (MVN, Xsens) of 15 women without any motor and functional impairments (CG1, 65±4.2 years) and 11 women with several gait disorders (IG1, 65±5.5 years) have been captured in a clinical gait analysis (m1) and while using the AR-system (m2). Moreover a total of 21 patients (female, 58±4.3 years) with THR have been randomly assigned either to an intervention group (IG2, n = 11) or a control group (CG2, n = 10). Additional to the post-hospital curative treatment all patients passed a standardized gait training (3 weeks, 20 min/day). Corrections of gait patterns were given by either verbal therapeutic instructions (CG2) or with help of an AR-system (IG2). In order to identify differences between the intervention strategies, kinematic gait data was captured in a pre-test, a mid-test and post-test. The largest Lyapunov exponents of the 3 dimensional (3D) pelvis and trunk trajectories (3D angular velocity; 3D linear velocity) and for a detailed view in sagittal, transversal and frontal plane have been calculated. The Data have been tested for normal distribution (Kolmogorov-Smirnov test). Group differences were examined with t-test and ANOVA. **Results** The results show less stable pattern of the 3D pelvis movement in m2 vs. m1 for both, the IG1 (p=.011) and CG1 (p=.004). The interaction effect time times group (IG2 & CG2) indicated a significant different pattern of pelvis trajectories (angular velocity) in the frontal plane (F=4.577, p=.048). Furthermore the anterior-posterior movement of the trunk (linear velocity) is more stable in the IG2 vs. CG2 in post-test (p=.030). **Discussion** The AR-based intervention treatment causes a less stable movement of the pelvis whilst using the AR-system. Thus, there may be a larger risk of falling in healthy women. A more stable movement of trunk was observed in patients with THR after a period of training with AR-system compared to verbal information based intervention. Therefore, perturbations

occurring during walking to the trunk may be managed more appropriately after a training period with the AR-system. References Schega, L., Hamacher, D., Wagenaar, R. (2011). Archives of physical medicine and rehabilitation, 92 (10), 1734–1735.

### EFFECTS OF AN INDIVIDUALIZED REHABILITATION PROGRAM TO THE CROSSOVER POINT ON THE USE OF ENERGY SUBSTRATA AND PERCEIVED EXERTION IN WOMEN WITH METABOLIC SYNDROME

Garcin, M.

*University Lille Nord de France*

EFFECTS OF AN INDIVIDUALIZED REHABILITATION PROGRAM TO THE CROSSOVER POINT ON THE USE OF ENERGY SUBSTRATA AND PERCEIVED EXERTION IN WOMEN WITH METABOLIC SYNDROME Garcin, M.1 2, Borel, B.1 2, Coquart, J.3, Matran, R.1 4, Delsart, P.5, Mounier-Vehier, C.5 1: Univ Lille Nord de France (Lille, France), 2: UDSL, EA4488 (Ronchin, France), 3: Univ Rouen, EA 3832 (Rouen, France), 4: Service des Explorations Fonctionnelles et Respiratoires, Hôpital Calmette, CHRU Lille (France), 5: Service de Médecine Vasculaire et Hypertension Artérielle, CHRU Lille (France) Introduction The use of indirect calorimetry in effort is used in order to individualize the prescription of exercise intensity (Brun et al., 2007). Two exercise intensities may be used: one corresponding at most of oxidation of lipids (LIPOXmax) and another one corresponding to the crossover point of substrate utilization (COP) (Dumortier et al., 2003). The prescription of a rehabilitation program at this last intensity could be particularly relevant in patients with metabolic syndrome (MS). The study's aim was to show the effects of a rehabilitation program at an intensity related to the COP prescribed by means of the perceived exertion value associated to this point in women with MS on the use of energy substrata during exercise and perceived exertion. Methods Fifteen women with MS (age = 56.0 ± 8.2 yrs; mass = 87.7 ± 12.7 kg; height = 160 ± 6 cm) performed a test to exhaustion to measure the peak of oxygen uptake (VO2peak) and the power output peak (Ppeak), and a test of indirect calorimetry to determine COP and LIPOXmax. Then, these women followed a rehabilitation program (3 sessions of 45 min.wk-1 at the RPE related to their COP on cycle ergometer during 12 wks). After the rehabilitation program, the tests were performed again. Results VO2peak and Ppeak increased after the rehabilitation period (17.3 ± 3.9 vs 18.5 ± 4.3 ml.min-1.kg-1; 101 ± 25 vs 122 ± 29 W, respectively; p=0.01). RPE to COP and LIPOXmax (11.8 ± 3.0 vs 10.3 ± 3.2 and 12.1 ± 3.8 vs 10.2 ± 3.6, respectively), and the absolute power output values to COP (40 ± 18 vs 48 ± 16W) were significantly different after the rehabilitation program (p<0.05). However, no effect of the rehabilitation program on the relative power output values was noticed (p>0.05). Concerning RPE as well as the power outputs, both values related to COP were not significantly different from those to LIPOXmax (p>0.05). Discussion The prescription of an individualized rehabilitation program from the RPE related to COP allowed to improve the maximal work capacity and to decrease the RPE at COP and LIPOXmax in these women with MS, but the program did not seem to have any effect on the use of energy substrata during exercise. References Brun JF, Jean E, Ghanassia E, Flavier S, Mercier J. (2007) Ann Readapt Med Phys 50, 528-534. Dumortier M, Brandou F, Perez-Martin A, Fedou C, Mercier J, Brun JF. (2003) Diabetes Metab, 29, 509-518.

### THE ARCHITECTURAL AND MECHANICAL PROPERTIES OF PARALYZED TRICEPS SURAE MUSCLES IN PATIENTS WITH SPINAL CORD INJURY AND POST-STROKE.

Kato, E., Negishi, D., Niimi, M., Ogata, T., Kawashima, N.

*National Rehabilitation Center for Persons with Disabilities*

The architectural and mechanical properties of paralyzed triceps surae muscles in patients with spinal cord injury and post-stroke. Kato, E. 1, Negishi, D. 2, Niimi, M.3, Ogata, T. 1, Kawashima, N. 1 1: National Rehabilitation Center for Person with Disabilities (Saitama, Japan), 2: Shibaaura Institute of Technology (Saitama, Japan), 3: Ochanomizu University (Tokyo, Japan) Introduction It is well known that motor paralysis due to central nervous system disorder, i. e., spinal cord injury (SCI) and stroke, leads higher joint torque in response to passive joint motion. In order to establish an effective rehabilitation approach for the prevention of disuse syndrome, quantitative evaluation for the paralyzed muscle is quite important. The purpose of this study was to determine a better understanding with regard to muscle property due to motor paralysis. Methods Nine SCI, 13 stroke (paretic side or non-paretic side) and 13 neurologically normal subjects participated. We measured muscle thickness (MT) of the triceps surae muscles and stiffness of the gastrocnemius medialis (MG) as the architectural and the mechanical properties using ultrasound, respectively. The measurements of MG and gastrocnemius lateralis (LG) were taken at proximal level 30%, and the soleus muscle (SOL) was at 50% of the shank length from the popliteal crease to the lateral malleolus. To calculate stiffness, the ankle joint was passively dorsiflexed from 5 degrees of plantar flexion to 15 degrees of dorsiflexion (5deg/s) and passive torque was divided by the elongation of MG. In MT and stiffness, multi-group comparisons were performed by one-way analysis of variance followed by the Tukey-Kramer post-hoc test. Results In MT, there were statistically significant among four groups (F=13.3, 10.0 and 7.7 for MG, LG and SOL, respectively, p<0.001). Normal showed the highest value of all muscles and then non-paretic side and paretic side of stroke, and SCI showed the lowest. It showed significant interaction among four groups about stiffness (F=7.5, p<0.001). Paretic side of stroke showed the highest value in stiffness. SCI showed similar value as non-paretic side of stroke, and normal showed lowest. Discussion While muscle stiffness was not significantly different, the extent of the reduction of MT in SCI was greater than that in Normal and non-paretic side of stroke. Present result also indicated a larger inter-individual variability in SCI patient, suggesting that the inactivity-induced alteration of the paralyzed area largely affected by level of injury and extent of motor paralysis after SCI. The present result implies that the protocol of rehabilitation approach for reducing muscle stiffness should be carefully prescribed based on the characteristics of muscle property due to type of injury/disorder. References 1. Chung et al. (2004). Arch Phys Med Rehabil, 85, 1638-46. 2. Rymer et al. (1994). Phys Med Rehabil State Art Rev, 8, 441-54. 3. Kawakami et al. (1998). J Appl Physiol, 85, 398-404.

### EFFECTS OF FORTNIGHTLY AND WEEKLY THERAPEUTIC EXERCISE ON PHYSICAL FUNCTION AND HEALTH-RELATED QUALITY OF LIFE IN SUBJECTS WITH HIP OSTEOARTHRITIS

Jigami, H.1,2, Endo, N.2

*1:Tokyo University of Technology, 2:Niigata University Graduate School of Medical and Dental Sciences*

Background There are many studies of the effects of therapeutic exercise on the patients with osteoarthritis (OA) of the hip joint. However, in most of those studies, the subjects included are knee OA or postoperative patients. Moreover, therapeutic exercise on hip OA has been recommended in some systematic reviews, a consensus on the effective interventional frequency has not been reached. The purpose of this interventional prospective cohort study was to investigate the effects of therapeutic exercise performed at different interventional frequencies in subjects with hip OA. Methods The subjects who were diagnosed hip OA (36 women, aged 42–79 years; 19 in 2009 and 17 in 2010) were recruited from the cooperating medical institutions. The therapeutic exercise was implemented at two different interventional frequencies, according to which the subjects were divided: fortnightly in 2009 (fortnightly group) and once weekly in 2010

(weekly group). The subjects in the fortnightly and weekly groups performed the same therapeutic exercise program including land-based and aquatic exercises on the same day for a total of 10 sessions. Muscle strength of the lower extremity, timed "Up and Go" (TUG), time of one-leg standing with open eyes (TOLS), and health-related QOL by SF-36 were measured before and after the interventions. Results No significant differences were noted in physical functions and QOL between the fortnightly and weekly groups at before intervention. In lower muscle strength, the fortnightly group had no significant changes between before and after the intervention, but the strength of all the muscles in the weekly group improved significantly after the intervention ( $p < 0.05$ ). There were no significant differences in their SF-36 scores between before and after intervention in both two groups. TUG and the worse hip of TOLS showed significant improvement ( $p < 0.05$ ). Conclusions This result that once a week exercise at least effect to improve muscle strengthening is meaningful and may be useful for prescribing the effective frequency of therapeutic exercise for hip OA. In addition, the exercise program in this study consisted of both land- and water-based exercises which may markedly contribute to improved physical function regardless of the exercise frequency. References 1.Foley A, Halbert J, Hewitt T, Crotty M: Does hydrotherapy improve strength and physical function in patients with osteoarthritis—a randomised controlled trial comparing a gym based and a hydrotherapy based strengthening programme. *Ann Rheum Dis* 2003, 62:1162-1167. 2.Tak E, Staats P, Van Hespren A, Hopman-Rock M: The effects of an exercise program for older adults with osteoarthritis of the hip. *J Rheumatol* 2005, 32:1106-1113. 3.Fransen M, McConnell S, Hernandez-Molina G, Reichenbach S: Does land-based exercise reduce pain and disability associated with hip osteoarthritis? A meta-analysis of randomized controlled trials. *Osteoarthritis Cartilage* 2010, 18:613-620.

### DISSEMINATION OF A STANDARDIZED BACK SCHOOL: STRUCTURE AND NEEDS IN INPATIENT REHABILITATION FACILITIES PRIOR TO IMPLEMENTATION

Peters, S.

*University of Erlangen-Nuremberg*

Dissemination of a standardized back school: structure and needs in inpatient rehabilitation facilities prior to implementation Peters, S. (1), Pfeifer, K. (1), Schulze, A. (2), Faller, H. (2), Meng, K. (2) (1) Institute of Sport Science and Sport, University of Erlangen-Nuremberg (Germany), (2) Rehabilitation Sciences Unit, University of Würzburg (Germany) Introduction A back school is a mandatory part of the rehabilitation of chronic low back pain (clbp) in Germany. In recent years, the recommendations for the content of those programs have changed due to scientific evidence. Traditional back schools are often based on a biomedical approach and theory-based techniques to foster physical activity are rarely used. Currently, a biopsychosocial approach is recommended with the enhancement of physical activity as a major goal. Meeting those requirements, only one standardized and evaluated back school exists in Germany. The mere existence doesn't do the job of dissemination. Implementation of standardized programs into routine care in clinics is often performed incompletely. Evidence for the best strategy to implement a multidisciplinary rehabilitation program is lacking. In this study, two strategies (Train-the-Trainer seminar and written educational material) to implement the above-mentioned back school were developed and evaluated. Methods The purpose of this part of the study was to capture assets and barriers regarding the implementation of the standardized active back school and to detect the subjective need of the health professionals for advanced training. The sample consists of 10 rehabilitation facilities. Delivering the back school, 45 exercise therapists, 17 physicians, 13 psychologists and 2 persons from other professions were covered. A check-list was used to gather certain attributes of structure and processes. A questionnaire (110 items) was developed to survey other influencing factors based on 12 domains detected by Michie et al. (2009) (e.g. skills, motivation/goals) as well as the subjective need for advanced training. Results 90% of all health professionals favor the TTT over the written educational material. All in all, the interest on the seminar (max.=10) reaches a high level:  $M=8.3$  ( $SD=1.9$ ); Median=9. There is an ongoing evaluation of the rest of the data. So far, the descriptive analysis shows quite a variation in many factors between facilities and health professionals. Discussion Assets and barriers regarding an implementation of the above-mentioned standardized back school vary between rehabilitation facilities as well as between the health professionals. Regarding this implementation, exercise therapists, physicians and psychologists have different needs for advanced training. References Michie, S. et al. on behalf of the "Psychological Theory" Group (2005). Making psychological theory useful for implementing evidence based practice: a consensus approach. *Quality and Safety in Health Care*, 14, 26-33.

### WAVELET-BASED ENTROPY ANALYSIS OF ELECTROMIOGRAPHY DURING 100 JUMP

Daniuseviciute, L., Pukenas, K., Brazaitis, M., Skurvydas, A., Linonis, V.

*Lithuanian Academy of Physical Education, Kaunas University of Technology*

WAVELET-BASED ENTROPY ANALYSIS OF ELECTROMIOGRAPHY DURING 100 JUMP Daniuseviciute, L.1,2, Pukenas, K.1, Brazaitis, M.1, Skurvydas, A.1, Linonis, V.2. 1:Lithuanian Academy of Physical Education, 2:Kaunas University of Technology. Introduction For a measure of EMG system complexity that is applicable to noisy and short datasets, we chose Shannon entropy, where the complexity decreases in muscle fatigue condition. The nonlinear dynamic measure as Shannon wavelet entropy appears as a measure of the degree of order or disorder of the signal. Methods Healthy female ( $n=9$ ) have participated in the study. Bipolar Ag-AgCl surface electrodes were used for EMG recordings (silver bar electrodes, diameter 10 mm, centre-to-centre distance 20 mm) of the long head of the vastus lateralis and biceps femoris (DataLog type no. P3X8 USB, Biometrics Ltd, Gwent, UK). After 10 min of not-intensive warming-up 100 jumps on vertical jump force plate (New Test, Finland) from a 75 cm stage were made, when the participant got to amortization phase while the knee joints were flexed at 90°. EMG values were analysed by Shannon wavelet entropy and median frequency using software written in Matlab (The MathWorks, Natick, MA). The Symlet (sym5) wavelet was used for analysis and the decomposition of EMG was performed at 6 levels. Results There was reverse significant relationship between changes in jumping height and Shannon wavelet entropy of EMG vastus lateralis ( $r=-0.5$ ,  $P < 0.05$ ) and Shannon wavelet entropy of EMG biceps femoris ( $r=-0.7$ ,  $P < 0.05$ ). There was no significant relationship between changes in jumping height and median frequency of EMG vastus lateralis ( $r=-0.3$ ,  $P > 0.05$ ), but there was reverse significant relationship between changes in jumping height and median frequency of EMG biceps femoris ( $r=-0.7$ ,  $P < 0.05$ ). Discussion The findings of the present study indicate that during an eccentric exercise the complexity of EMG signals was higher using wavelet-based Shannon entropy than median frequency method. Pearson correlation coefficient was significantly stronger compare jumping height values with EMG Shannon wavelet entropy values. Muscles that contain a relatively greater proportion of type I fibers may not demonstrate increases in median frequency with greater forces, despite the additional recruitment of these fibers (Pincivero et al., 2001). Moreover, it has been suggested that increases in both synchronization and spike duration and slowing of conduction velocity would tend to increase the amplitude of the surface EMG (Hatzikotoulas et al., 2004). References Pincivero, DM, Campy, RM, Salfetnikov, Y, Bright, A, Coelho, AJ. (2001). Influence of contraction intensity, muscle, and gender on median frequency of the quadriceps femoris. *Journal of Applied Physiology*. Vol. 90, 804-810. Hatzikotoulas, K, Theophanis, S, Spyropoulos, E, Paraschos, I, Patikas, D. (2004). Muscle fatigue and

electromyographic changes are not different in women and men matched for strength. *European Journal of Applied Physiology*. Vol. 92, 298–304.

**14:45 - 15:45**

## Poster presentations

### PP-PM53 Sports Medicine 5

#### PULSE PRESSURE CENTILES FOR ITALIAN ATHLETES FROM 6 TO 80 YEARS OLD

Attisani, G., Castagna, A.

*Studio Medico Attisani*

**Objective:** Pulse pressure (the difference between systolic and diastolic blood pressures) is recognized as a leading predictor of cardiovascular disease. Independently of mean blood pressure, pulse pressure is a strong determinant of cardiovascular events, including coronary heart disease and stroke. The present study describes a representative cross section pulse pressure reference centiles for Italian athletes. **Design:** Analysis of blood pressure data from a people of athletes examined in a Sport Medicine Clinics from 2006 to 2010. Was excluded all athletes with cardiovascular disease. **Methods:** The blood pressure was always measured with the same protocol: athlete at rest and at the beginning of the medical examination. Pulse pressure (P systolic – P diastolic) was calculated. Data from 2000 male (aged 6-80 years) and 1000 female (aged 6-75 years) were included in the analysis, after excluding 0.3% missing or outlying data. Centiles were derived using the latent moderated structural (LMS) equations method of Cole. **Results:** We found that pulse pressure reaches a first peak at age 22 in males (Tab. 1) and at 18 age in females (Tab. 2) and a subsequent rise after 38.5 years old for males and after 35.5 years old in females. Knowledge of the variations from hormonal changes should help to explain these variations **Conclusion:** These centiles increase our knowledge of normal pulse pressure in athletes. The values between 5% and 95% centiles are probably representative of a reduced risk of cardiovascular disease. The pulse pressure may be a simple predictor of cardiovascular risk.

#### IS ADIPOSE TISSUE MICRO INFLAMMATION INFLUENCED BY 14 DAYS PROLONGED EXERCISE IN LEAN OLDER MEN?

Andersen, P.R., Christensen, K.K., Prats, C., Poulsen, S.S., Munch-Andersen, T., Morville, T., Mattson, N., Dela, F., Rasmussen, H., Helge, J.W.

*University of Copenhagen*

Is adipose tissue micro inflammation influenced by 14 days prolonged exercise in lean older men? Andersen PR1, Christensen KK1, Prats C1, Poulsen,SS1, Munch-Andersen T1, Morville T1, Mattson N2, Dela F1, Rasmussen, H, & Helge JW 1. 1Center of Healthy Aging, Department of Biomedical Sciences, University of Copenhagen. 2Department of Cardiology, H:S Bispebjerg Abstract. **Introduction.** Major changes have been observed in obese individuals as a response to lifestyle-interventions such as diet or exercise modifications. Among these changes is a shift in the inflammatory state of adipose tissue quantified by means of adipose tissue macrophage (ATM) count. However, the influence of regular exercise on micro inflammation in human subcutaneous adipose tissue is not well known. Therefore we investigated the effect of 14 days of very prolonged exercise on micro inflammation in adipose tissue in lean trained older individuals. **Methods.** Six lean (BMI;  $24 \pm 1$  kg/m<sup>2</sup>), moderately well trained (VO<sub>2</sub>max:  $48 \pm 2$  mlO<sub>2</sub>/kg/min) men (age  $61 \pm 4$  yrs) participated in the study. During 14 days the subjects cycled a total of 2770 km averaging a duration of  $580 \pm 30$  min cycling per day. Before and after the 14 days a basal blood sample and a biopsy from the abdominal subcutaneous fat depot were obtained. Adipose tissue macrophages (ATM) were immunohistochemically stained in cross sectional sections using a CD163 binding antibody. The ATM stain and adipocyte sizes were analysed blindly. **Results.** Subjects maintained their body weight across the 14 days ( $77 \pm 5$ ,  $78 \pm 5$  kg, pre and post). The plasma glucose ( $5.9 \pm 0.2$  mmol/l), C-reactive protein ( $0.19 \pm 0.08$  mg/dl), TNFalpha ( $0.19 \pm 0.08$  pg/ml) and IL-18 ( $310 \pm 44$  pg/ml) concentration at baseline were not changed after 14 days (data not shown). Plasma insulin ( $16 \pm 2$ ,  $33 \pm 2$  pmol/L), IL-6 ( $0.7 \pm 0.1$ ,  $1.1 \pm 0.1$  pg/ml), and insulin sensitivity (HOMA) ( $0.62 \pm 0.08$ ,  $1.3 \pm 0.1$  a.u.) all tended ( $P < 0.07$ ) to increase after 14 days; pre and post, respectively. The average CD-163 identified macrophage area ( $1251 \pm 693$ ,  $996 \pm 295$   $\mu$ m<sup>2</sup>) and the adipocyte average area ( $7609 \pm 640$ ,  $7489 \pm 493$   $\mu$ m<sup>2</sup>) were not significantly influenced after the 14 days. **Conclusion.** In the present study no effect of prolonged repeated exercise was detectable on adipose tissue macrophage content or adipocyte average size in abdominal adipose tissue. Prior studies in rodents have demonstrated decreased adipose tissue macrophage inflammation after longer exercise interventions. It is possible that the present exercise regimen is not of sufficient duration to induce a decreased macrophage inflammation, but probably more likely that the amount of exercise in this study was simply too high. The latter notion is supported by the trend towards an increased insulin resistance observed after the 14 days.

#### ANTHROPOMETRIC CHARACTERISTICS, BODY COMPOSITION AND SOMATOTYPE OF JUNIOR BADMINTON PLAYERS

Pugliese, L., Cirami, I., Salvati, A., Morino, F., La Torre, A., Faina, M., Gianfelici, A.

*Università degli Studi di Milano*

**Introduction.** Aims of this study were to describe the anthropometric characteristics, body composition and somatotype of male (M) and female (F) Italian junior badminton players and to determine differences between national team (NT) and regional level (RL). **Methods.** 154 (89M; 65F) athletes were divided into groups according to age (under 13-15 and under 17-19), gender and level. Height (H), body weight (BW), skinfolds, circumferences and diameters were recorded to determine body mass index (BMI), % fat mass (%FM) and somatotype. **Results.** In U13-15: anthropometric characteristics and body composition were not significantly different between M-NT and M-RL; F-NT had lower BMI ( $18.0 \pm 2.0$  vs  $20.1 \pm 2.5$  kg/m<sup>2</sup>;  $p = 0.047$ ) and %FM ( $14.3 \pm 6.5$  vs  $19.5 \pm 6.7$  %;  $p = 0.049$ ) compared to F-RL. In U17-19: H was significantly higher ( $181 \pm 3.2$  vs  $176 \pm 6.0$  cm;  $p = 0.048$ ) in M-NT, respect to M-RL and %FM was very low, but similar, in both group ( $6.6 \pm 1.5$  vs  $7.6 \pm 4.4$  %); BW was higher ( $66.1 \pm 10.3$  vs  $58.0 \pm 5.9$  kg;  $p = 0.025$ ) in F-NT than F-RL, without significant differences in %FM ( $21.3 \pm 9.3$  vs  $21.0 \pm 4.7$  %  $p = 0.89$ ). As for somatotype, there were no significant differences between NT and RL in both U13-15 and U17-19. The mean somatotype of M players could be defined as ectomesomorphic and the mean somatotype of F players could be defined as ectomorphic for U13-15 and endomorphic for U17-19. **Conclusions.** The data suggest that anthropometric and body composition parameters are not



able to discriminate Italian national and regional level male U13-15 badminton players. On the other hand, these parameters can be considered for selection of female U13-15, female U17-19 and male U17-19 in national team. Somatotype confirmed differences between M and F, but was not able to distinguish the national level. REFERENCES de Hoyo M, Sanudo B, Paris F. Analysis of the somatotype, body composition and anthropometry in badminton players between 12 and 16 years. Science and Racket sports IV, Taylor & Francis, 2008. Sánchez-Muñoz C, Sanz D, Zabala M. Anthropometric characteristics, body composition and somatotype of elite junior tennis players. Br J Sports Med 41:793-799, 2007.

### THE EFFECT OF 38°C WATER EXERCISE ON ARTERIAL STIFFNESS IN ELDERLY SUBJECTS

Nogami, J., Takehiro, N., Otsuki, T., Maeda, S., Ajisaka, R.

*University of Tsukuba., Teikyo Heisei University., Ryutsu Keizai University*

**Introduction** Age-associated change in the structure and function of arteries might induce increase the risk of cardiovascular disease. It has been reported that aerobic exercise decreased arterial stiffness in humans (Kingwell, et al., 1997, Naka et al., 2003, Hefferman et al., 2007). However, the effect of water exercise on arterial stiffness in humans is unknown. Therefore, the purpose of this study was to investigate the effect of 38°C water exercise on arterial stiffness in elderly subjects. **Method** Six healthy elderly subjects performed a 15min of cycling exercise in 38°C water with 50% peak VO<sub>2</sub>. Carotid-femoral PWV (aortic PWV) and femoral-ankle PWV (leg PWV), blood pressure, heart rate (HR), and rectal temperature (T<sub>rec</sub>) were measured at baseline, 30min, and 60min after the exercise. T<sub>rec</sub> were continuously measured from baseline to 60min after exercise. Resting control study was performed with sitting in air for 15min, measuring as the same method as 38°C water exercise. All measurements were performed in a quiet and air conditioned room at the same time of the day in the morning. Results T<sub>rec</sub> significantly maintain the elevation after the warm water exercise (P<0.0083). HR slightly but significantly increased at 30min after the exercise (P<0.0083). The aortic and leg PWV significantly decreased at 30min after the exercise and SBP also significantly decreased at 30min and 60min after the exercise (P<0.0083). There were no significant changes in the control study. **Conclusion** The effect of acute water exercise on arterial stiffness in elderly humans is unknown. The present study showed that aortic and leg pulse wave velocity decreased significantly after acute 38°C water exercise in the elderly subjects. Although the underlying mechanism is unknown, the results in the present study suggest that 38 °C water exercise may induce decrease of aortic stiffness in elderly subjects similarly to aerobic exercise on land. REFERENCES Kingwell, B. A., Berry, K. L., Cameron, J. D., Jennings, G. L., and Dart, A. M. (1997). Am J Physiol 273, H2186-2191. Hefferman, K. S., Jae, S. Y., Echols, G. H., Lepine, N. R., and Fernhall, B. (2007). Med Sci Sports Exerc 39, 842-848. Naka, K. K., Tweddell, A. C., Parthimos, D., Henderson, A., Goodfellow, J., and Frenneaux, M.P. (2003). Am J Physiol Heart Circ Physiol 284, H970-978.

### PREDICTIONS AND VALIDITY OF MAXIMAL AEROBIC POWER FOR SOUTH KOREAN MALE BY METABOLICAL RESPONSES IN SUBMAXIMAL EXERCISE AND DISTANCE RUNNING

Im, J.H.1, Jeon, Y.J.1, Chang, H.K.2, Kim, H.J.3, Kim, K.H.4, Lee, B.K.4

*1) KAIST(Daejeon, S Korea) 2) Seoul Women's University(Seoul, S Korea) 3) Chosun University(Gwangju, S Korea) 4) SangMyung University(Cheonan, S Korea)*

**Introduction** The purpose of this study was to develop the prediction model of maximal aerobic power or South Korean Male by submaximal metabolic responses from treadmill exercise(Bruce protocol) and general physical variables, and to compare and analyse the validity of these prediction models. The purpose of this study was to report the prediction equation of maximal aerobic power using metabolic responses in submaximal exercise from the Bruce protocol for S Korean adult male, and to validity of these prediction equation. **Methods** The subjects were consisted of 255 South Korean adult male. They were joined maximal treadmill exercise testing with Bruce protocol, and the metabolic responses were measured in the end of the first(3 minute) and second stage(6 minute). Measurement items were VO<sub>2</sub>, VCO<sub>2</sub>, VE, HR of 3 and 6 minute, time to HR 150bpm and HR 170bpm, HR difference between Bruce protocol 6 and 3 minute, 1,200m running record. To determine the predicted model of VO<sub>2</sub>max, multiple and simple regression analysis with stepwise methods and enter method were applied. **Results** Analyzing with all variables using enter method, the multiple R of total variable model was 0.64(p<.01), SEE was 4.4 ml/kg/min, CV was 10.8%. The multiple R of 3 minutes model was 0.46, SEE was 5.72ml/kg/min, CV was 14.1%. The multiple R of 6 minutes model was 0.46, SEE was 5.7ml/kg/min, CV was 14.2%. The R of 6-3 minutes HR difference model, HR 150, and HR 170 equation were 0.15, SEE were 6.4ml/kg/min, CV were 11.9%. The R of 1,200m running equation was 0.44, SEE was 4.8ml/kg/min, CV was 11.9%. **Discussion & Conclusion** Lee, et al.(2012) reported the prediction of maximal aerobic power with general variables and metabolic responses in submaximal exercise for South Korean adult female, and R of total model prediction and general variables model were 0.73 and 0.59(p<.001). In conclusion, the validity of estimation were appeared total, 6 minute, 3 minute, 1,200m running, and 3 HR equation by tunes. With considering usefulness and convenience through the validity of these prediction equations, the prediction equations of maximal aerobic power recommended total model, 6 minute, 3 minute, and 1,200m running. REFERENCES Bruce, R. A., Kusimi, F., & Hosmer, D. (1973). Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. American Heart Journal. 85(5): 546-562. Lee, et al.(2012). Predictions developments of maximal aerobic power by general variables and metabolic responses in submaximal exercise for south korean adult female. Unpublished Data.

### EVALUATION OF PERIPHERAL VASCULAR IMPAIRMENT IN THE FINGERS OF BASEBALL PLAYERS BY USING A LASER DOPPLER BLOOD PERFUSION IMAGER : A COMPARISON AMONG POSITIONS

Terada, K.1, Miyai, N.2, Nadamoto, M.1, Murakami, K.1, Nakatani, T.1, Maeda, S.3, Miyashita, K.2

*1: Tenri University (Nara, Japan), 2: Wakayama Medical University (Wakayama, Japan), 3: Kinki University (Osaka, Japan)*

**Introduction** Digital vessel trauma from repetitive impact on the fingers and hand is a concern in baseball players (Sugawara, 1986). Laser Doppler blood perfusion imaging (LDBPI) involves two-dimensional horizontal scanning of the blood flow in a specific tissue without the need for surface contact (Wårdell, 1993). The LDBPI method may facilitate detection of vasospastic abnormalities and occlusion of the digital artery, which are generally observed during an inhomogeneous reaction to cold (Miyai, 2005). Our previous study suggested that the LDBPI technique can be used to assess peripheral circulatory function in baseball players. This study used LDBPI to examine whether the changes in finger skin blood flow in response to a cold water immersion test depends on the position of baseball players. **Subjects and Methods** The study included 32 male university baseball players (age: 18–21 years) who play at 4 different positions (catcher [3 subjects], outfielder [9 subjects], infielder [12 subjects], and pitcher [8 subjects]). A cold provocation test was performed by immersing the subject's catching hand in 10°C water for 10 minutes. The blood flow in the skin of the palm was repeatedly scanned every 2 min before,

during, and after immersion by using a PIM-3 LDBPI (Perimed, Sweden). Mean blood perfusion values in the index finger were calculated for each color-coded image. Finger skin temperature was recorded using an electrode thermistor attached to the skin on the dorsal side of the index finger. Results Mean blood perfusion values of the infielders were significantly lower than those of the outfielders in the later phase of cold water immersion and early post-immersion. However, the finger skin temperature did not significantly differ among the different player positions at any measurement point. Discussion These findings suggest that the changes in finger skin blood flow in response to cold water immersion, as measured using LDBPI, are dependent on the position. Repetitive trauma caused by the impact of a baseball also leads to peripheral vascular impairment in the index finger of the gloved hand of infielders. References Sugawara M., et al (1986). Digital ischemia in baseball players. *Am J Sports Med*, 14(4), 329-34. Wårdell K., et al (1993). Laser Doppler perfusion imaging by dynamic light scattering. *IEEE Trans BME*, 40(4), 309-16. Miyai N., et al (2005). Preliminary study on the assessment of peripheral vascular response to cold provocation in workers exposed to hand-arm vibration using laser Doppler perfusion imager. *Ind Health*, 43(3), 548-55.

### SIMPLE ASSESSMENT OF PREDNISONE ADMINISTRATION IN ATHLETES

Collomp, K.1,2, Hevor, T.3, Cloix, J.F.3, Lasne, F.2

*Université Orléans*

**Introduction** The aim of this study was to assess prednisone intake and bioavailability using a simple method that takes advantage of (1) the structural similarity of prednisolone, the major prednisone metabolite, and cortisol ; (2) the suppressed adrenal function during glucocorticoid therapy. Given the high positive correlations between blood and saliva steroid hormone concentrations, saliva was taken for cortisol and dehydroepiandrosterone (DHEA) analysis, whether blood was taken for these parameters and adrenocorticotrophic hormone (ACTH) analysis. **Methods** According to a double-blind and randomized protocol, blood and saliva samples were taken from 8 healthy recreationally-trained females after placebo or prednisone (50 mg/day/7days) ingestion, at rest and during a 2-hour submaximal exercise starting 3 hours after the last intake. Prednisolone was estimated using an ELISA kit for cortisol (Maayan et al., 1988). ACTH and DHEA concentrations were measured in parallel by ELISA. **Results** After prednisone intake, "cortisol" concentrations reflected in fact prednisolone concentrations. The marked increase in these "cortisol" concentrations vs placebo (blood: x 3.9-5.7; saliva: x 12.5-20.9, P<0.001) was coupled with a significant decrease in both ACTH and DHEA (x 0.20-0.47, P<0.001). **Discussion** In agreement with the literature, a significant decrease in ACTH and DHEA basal values was observed in our subjects after 1 week of prednisone treatment, without any significant change from these basal concentrations during exercise. This inhibition in ACTH and DHEA lasts at least 24 hours, as shown previously after short-term glucocorticoid intake (Arlettaz et al., 2008; Jollin et al., 2010). This marked decrease in ACTH and DHEA concentrations after prednisone intake is combined with high prednisolone concentrations, resulting in a dramatically increase in the "cortisol"/DHEA ratio in both blood and saliva and in the "cortisol"/ACTH ratio in blood, versus placebo (P<0.001). The results thus suggest that blood ACTH, blood or saliva DHEA and cortisol measurement offer a practical approach for estimating indirectly prednisone, prednisolone or cortisol intake in athletes on a longitudinal basis. However, the practical constraints regarding the hormone circadian variation and the blood conservation for ACTH analysis need to be taken into account. **References** Arlettaz A, Collomp K, Portier H, Lecoq AM, Rieth N, Le Panse B, De Ceaurriz J (2008). *Br J Sports Med*, 42: 250-254. Jollin L, Thomasson R, Le Panse B, Baillet A, Vibarel-Rebot N, Lecoq AM, Amiot V, De Ceaurriz J, Collomp K (2010). *Eur J Clin Invest*, 40: 183-186. Maayan R, Segal R, Feuerman EJ, Sandbank M, Kaufman H (1988). *Biomed Pharmacother*, 42: 419-414.

**14:45 - 15:45**

## Poster presentations

### PP-PM54 Training & Testing 10

#### AGE-RELATED DIFFERENCES IN PEAK MATCH RUNNING SPEED IN HIGHLY-TRAINED YOUNG SOCCER PLAYERS

Al Haddad, H., Simpson, B.M., Buchheit, M., Mendez-Villanueva, A.

*Aspire Academy for Sports Excellence*

**Introduction** Sprint speed is believed to be a prerequisite to successful participation in soccer. However, it has been recently suggested that tactical constraints associated with soccer match-play may modulate the relationship between sprint speed (i.e., an intrinsic physical quality determined via a field test) and actual sprinting performance during the game (Mendez-Villanueva et al., 2011). While sprinting speed (as measured with field tests) increases with age and growth, the impact that age can have on peak match running speed is still unknown. Therefore, the aim of this study was to examine possible differences in maximal sprinting speed (MSS) and peak match running speed (PMRS) in highly-trained young soccer players (age groups U13 to U17). **Methods** Time-motion analysis of running activity was collected in 160 male youth soccer players (U13 = 30, U14 = 36, U15 = 40, U16 = 31 and U17 = 23) during 58 distinct friendly international level matches. A total of 253 player-files were analysed (U13 = 39, U14 = 62, U15 = 66, U16 = 49 and U17 = 35). MSS was determined as the fastest 10-m split time during a 40-m sprint performed on an indoor running track. PMRS was recorded using portable global positioning systems and was also expressed as a percentage of MSS (%PMRS). **Results** MSS ( $25.2 \pm 1.4$ ,  $27.6 \pm 1.9$ ,  $28.8 \pm 1.8$ ,  $29.7 \pm 1.7$  and  $30.7 \pm 1.2$  km.h<sup>-1</sup> for U13, U14, U15, U16 and U17, respectively) was greater in older players compared with younger players (U13 "almost certainly" U16, U17). **Discussion** The main findings of this study were that a) faster (and older) players reached higher absolute running speeds during games than their slower (and younger) counterparts, b) slower (and younger) players tended to use a greater percentage of MSS than their older (and faster) counterparts. Our results indicate that age and associated playing structure (e.g., tactical plays) has an important role in influencing the expression of MSS during soccer match play. **References** Mendez-Villanueva A, Buchheit M, Simpson B, Peltola E, Bourdon P (2011) *Journal of strength and conditioning research* 25:2634-2638.

## THE ACUTE AND CHRONIC EFFECTS OF SMALL-SIDED GAMES TRAINING ON SPECIFIC AEROBIC CONDITION OF YOUNG SOCCER PLAYERS.

Stanganelli, L.C.R., Pasquerelli, B.N., Rabelo, F.N., Matzenbacher, F.

*State University of Londrina*

**Introduction** The small-sided soccer games (SSG) have been indicated as an efficient method stimulate the aerobic energy system and its improvement has been reported to increase physical performance on match-play (Pasquarelli et al. 2010). The aim of the present study was to evaluate the acute and chronic effects of SSG training on aerobic conditioning of young soccer players. **Methods** Twenty soccer players from Londrina City – Brazil participated in the study during the regular season (age: 15.7 ± 0.5 years). Subjects were tested before and after the eight weeks of training for Running Economy (RE) in the laboratory and aerobic endurance in the field YoYo Intermittent Recovery Test Level 1 (YYIR1). According to the YYIR1 results, the players were divided into two groups: higher (HG) or lower (LG) than the median YYIR1 performance score. This division was used during 14 SSG training sessions (any format) when the LG always trained with numerical inferiority. **Results** At any format of SSG training, the average intensity was higher for the LG than for the HG (HRmax: 91.6-89.5%; HRreserve: 87.8-85.5%; RPE: 5.6-4.9) at P<0.5. After eight weeks of training the LG group had a larger increase (14.6%) than HG (4.6%) for YYIR1 maximal speed at P<0.01. The RE values decreased for 7 and 12 km/h but these adaptations were not statistically significant. The Hopkins' model was applied to estimate the practical inferences based on magnitudes. For the YYIR1 test, it was inferred that the LG had 70% chance of a positive improvement when compared to the HG; 27% chance of this improvement being irrelevant when compared to the same group and 3% chance of this type of training promotes a negative effect in the performance of this field test. In both groups there was an increase of the magnitude of changes for RE. The chances of the percent changes being positive, irrelevant and negative were 25/70/4 percent for RE at 7km/h and 20/79/1 percent for RE at 12 km/h. **Discussion** Based on these findings it could be inferred that training using the SSG is an efficient way of training young players. The summed effects of these loads significantly increased the specific aerobic conditioning of the subjects. Moreover, it was observed that LG, at first, may obtain magnitudes of change in aerobic conditioning more specifically, when including them in teams with numerical inferiority. Such changes were explained by higher intensities reached in the SSG (acute effects) and its subsequent effects summation (chronic adaptations). **References** Pasquarelli, B. N.; Souza, A.; Stanganelli, L. C. R. The small-sided games in soccer. *The Brazilian J of Soccer Sci* (2010), 3, 2-27.

## WHOLE BODY VIBRATION TRAINING – EFFECT ON JUMP HEIGHT, BALANCE CONTROL AND STRENGTH ENDURANCE

Ritzmann, R., Kramer, A., Gollhofer, A.

*Albert-Ludwigs-Universität Freiburg*

**Introduction:** Although exercise combined with WBV is becoming increasingly popular among trained adults, the additional effects of WBV on muscle fitness and performance is still controversially discussed in literature. One reason might be the diversity of WBV training settings. Therefore, this study aimed to (1) identify a favourable WBV training setting and to (2) validate this setting in a four-week intervention with respect to performance related parameters. **Methods** (1) In 18 subjects the electromyographic (EMG) activity of six leg muscles was recorded during WBV in order to identify those WBV training conditions that cause highest neuromuscular responses and therefore high activation intensities. The vibration parameters have been varied as follows: a) vibration type (rotational (RV) and vertical vibration (VV)), b) frequency (5-10-15-20-25-30Hz), c) amplitude (2 vs. 4mm) and d) stance condition (forefoot vs. normal stance). The statistical analysis consisted of an ANOVA. (2) In a repeated-measures matched-subject design, 38 participants were assigned in a WBV group (VIB) and training group (CON). Training duration, number of sets, rest periods and task-specific instructions were matched between the groups. The WBV training setting was based on the results of (1). The parameters balance control, jump height and strength endurance were assessed before and after the training period. The statistical analysis consisted of an ANOVA. **Results** (1) The combination of high vibration frequencies (30Hz, p<0.05), high amplitudes (4mm, p<0.05) and forefoot stance (p<0.05) on a RV platform (p<0.05) is associated with the highest EMG activity during WBV. (2) Significant interaction effect of group x time could be observed for balance and strength endurance. Hence, WBV causes an additional effect on balance control (CON +6%, p=0.33 and VIB +13%, p<0.05) and strength endurance (CON +11%, p=0.49 and VIB +36%, p<0.05). The effect on jump performance remained insignificant (CON ±0%, 0.25 and VIB +3%, p=0.82). **Discussion** There are two main outcomes: (1) an appropriate adjustment of specific WBV parameters provides high EMG activations in the selected muscles and therefore high activation intensities can be achieved. Thereby, a RV training setting in combination with high frequencies and amplitudes in the forefoot stance seems to be the most favourable parameter selection. (2) WBV training based on the above-mentioned recommendation causes an additional effect on balance control and strength endurance; however the jump performance remains unaffected. In conclusion this study provides evidence for an additional effect of WBV above conventional exercise alone.

## DOES MATURATION AFFECT THE RELIABILITY OF ANTHROPOMETRIC AND PHYSICAL FITNESS MEASURES?

Buchheit, M., Mendez-Villanueva, A.

*ASPIRE*

**Introduction** Monitoring changes in both anthropometry and physical fitness is important to optimize the training process, especially in young and developing athletes. In addition to accuracy, the reliability of any physiological measurement (i.e., degree of change in a particular measure when repeated on different occasions in similar conditions) is of great importance for practitioners and researchers to avoid biased interpretation when assessing changes in a marker (1). Biological maturity contributes to the inter-individual differences in both anthropometrical and physical fitness factors in young soccer players. Moreover, speed, endurance and power increase faster around the time of peak height velocity, which can increase the variability of these measures. To the best of our knowledge however, whether maturation affects the reliability of anthropometric and performance measures has not been addressed yet. **Methods** Data were collected in 80 highly-trained young soccer players (14.5 ± 1.5 yr) from an elite soccer academy. Anthropometric and performance tests were repeated twice within a month during the competitive season (during 'standardized' weeks), and included: standing height, body mass (BM), the sum of 7 skinfolds, counter movement jump (CMJ), acceleration (Acc, 10-m time), maximal sprinting speed (MSS, best 10-m split time over a 40-m sprint) and peak incremental test speed (used as an indirect measure of maximal aerobic speed, MAS). The reliability of each measure was assessed via the typical error of measurement, expressed as a coefficient of variation (CV) (1). Predicted age at peak height velocity (APVH) was used as an indirect indicator of biological maturation and was calculated from anthropometry during each testing session (2). Players were then allocated to either Pre- (<-1 yr from APVH, n = 14), Circum- (≥-1 yr from/to APVH ≤ 1, n = 32) or Post- (<-1 yr to APVH, n = 34) PHV groups, based on their estimated APVH obtained during the first testing session. **Results** For all players

pooled together, the CV was 0.4% (90% confidence limits [CL]: 0.3;0.5) for height, 1.4% (1.2;1.8) for BM, 4.9% (4.1;6.2) for the sum of 7 skin-folds, 0.6% (0.5;0.8) for APHV, 4.5% (3.9;5.3) for CMJ, 2.2% (1.9;2.5) for Acc, 1.4% (1.2;1.6) for MSS and 3.5% (3.0;4.1) for MAS. When comparing the different CVs obtained for each group, there was no clear difference in reliability: Post-PHV vs. Pre-PHV: effect size (ES) = -0.37 (-1.6;0.9), with chances of greater/similar/lower values of 20/20/60%, Post-PHV vs. Circum-PHV: ES = -0.01 (-0.9;0.8), 33/32/35% and Circum-PHV vs. Pre-PHV: ES = -0.27 (-1.5;1.0), 24/22/54%. Discussion In highly-trained developing soccer players, the reliability of anthropometry and performance measures is unlikely to be affected by biological maturation. Similar thresholds (i.e., 1/2 of the CV) can therefore be used to assess meaningful changes during the season in players differing in age/maturation status. References Hopkins WG. Sports Med. 2000;30(1):1-15. Mirwald RL et al. Med Sci Sports Exerc. 2002;34(4):689-69(2)

### TRAINING LOAD INSIGHTS INTO THE ELITE JUNIOR AUSTRALIAN FOOTBALLER USING GPS AND HR TECHNOLOGIES

Henderson, B.I, Cook, J.2, Kidgell, D.1, Gastin, P.1

1: C-ESS (Deakin University, Australia), 2: ACRISP (Monash University, Australia)

Introduction Physical activity information on the elite junior Australian football (EJAF) player is still under-explored, especially in the area of training load. With the aid of wearable athlete device technologies encompassing global positioning system (GPS) and heart rate (HR) sensors, accurate measures of training load can now be obtained. Methods This investigation examined the training loads within the elite junior AF player across the in season period. Objective measures of physical load were obtained via individual GPS time motion analysis and HR. A total of 187 training session files were collected from three clubs across 19 training sessions within the 2009 TAC Cup competition season. Descriptive analysis of the key summary variables was undertaken to ascertain an accurate account of training load. Results Summary GPS data revealed that the mean duration of training was 87 min. The mean distance covered by EJAF players was 6.0 km a training session. Further breakdown showed that low intensity activity (0-14.4 km/h) predominated with a mean distance of 4.5 km and high intensity running (above 14.4 km/h) contributed 1.5 km. A distance of 71.3 m/min was covered by players within a session. HR data revealed that players were exposed to an internal load relative to 70% of their predicted HRmax across the duration of training. Players spent on average, 21 minutes between 80-90% of their predicted HRmax. Session HRpeak of 190 bpm indicated that a player was exposed to a relative internal load between 90-95% of their predicted HRmax value at least once within a training session. Discussion As this is the first investigation to assess the typical physical training load exposure of the EJAF using GPS and HR technologies, there is limited data to compare the present results against. Further investigations using GPS and HR technology to serially monitor EJAF across the annual periodisation cycle will enable a better understanding of the current training practices and physical load exposure of this cohort. Furthermore, accurate monitoring of training loads has the potential to minimise the risk of injury, burnout and overtraining of elite junior athletes. This could possibly lead to improved performance and enhanced participation longevity across the career of an athlete (Hartwig, Naughton et al. 2009). References Hartwig, T. B., G. Naughton, et al. (2009). Journal of Sports Sciences 27(10): 1087-1094.

### DIFFERENCES IN MAXIMAL GRIP STRENGTH AND ISOMETRIC ENDURANCE BETWEEN ELITE AND NON-ELITE YOUNG JUDO ATHLETES

Ferliche, B., Almeida, F., Bonitch-Góngora, J., Bonitch-Domínguez, J., Padial, P.

FCAFD, University of Granada (Granada, Spain)

Introduction In judo, the grip strength is presented as one of the main determinants of success (Franchini et al., 2011). However, scientific literature has not related directly the role of maximal isometric strength (MIS) endurance with the result of the competition. The aim of this study is to compare the behavior of the MIS during an endurance test between elite and non-elite young judo athletes. Method 45 young judo athletes (U17) were assigned to two groups by their competitive results: medallists (Md) and non-medallists (NMd) in national championships. All participants performed a test to determine the MIS with the dominant hand. After that, subjects executed a MIS endurance test (e-MIS) by performing 8 maximal isometric contractions of 10 s with 10 s of passive rest between them. Results There were no differences in MIS between both groups (Md: 460.69 ± 92.34 N and NMd: 415.05 ± 70.93 N, p > 0.05). The e-MIS test revealed a significant loss of MIS during the first 3 repetitions in Md and during the first two in NMd (p < 0.001). Along of the 8 repetitions, Md group showed higher MIS values than NMd (p < 0.05). The difference between the 1st and the 8th repetition in the e-MIS test reached 24.47 ± 9.10% in the Md group and 18.81 ± 9.09% in the NMd one. Discussion The complexity of the technical and tactical actions of the judo combat makes difficult to establish a direct relationship between improved arm strength and success in the competition (Banobic, 2001). The differences observed between groups during the e-MIS test suggest that Md have better strategies to perform maximum levels of MIS in successive grips and/or better recover between them than NMd. Our findings are in agreement with other investigations (Garcia, 2004; Bonitch-Góngora et al., 2007; Franchini et al., 2011), which claim that endurance to the handgrip MIS appears to be the decisive factor to achieve success in judo above its own maximum value. References Banobic, I. (2001). Kinesiology, 33, 191-206 Bonitch-Góngora, J. (2007) Doctoral Thesis. University of Granada, Spain Franchini et al, 2011. Sports Med, 41, 147-166 Garcia, J.M. (2004) Doctoral Thesys. University of Castilla. Spain

### PERCEPTION OF EFFORT UNDER FATIGUE AND CONTROL OF PACING IN YOUNG SWIMMERS

Scurati, R., Michielon, G., Longo, S., Invernizzi, P.L.

Faculty of Exercise Sciences - University of Milan

Introduction Pacing strategy is critical in middle- and long- distance performances to administer the power production related to the energy lost during the competition. In swimming, positive, negative, and even pacing approaches are then used. They suppose that the swimmer has an accurate and conscious perception of the effort (Borg, 1982), to properly manage his pace. The aim of this study was to observe how fatigue can alter the pacing in swimming, with relation to the perception of the effort. Methods Ten swimmers (12.2±0.5 years, 47.0±5.5 kg, 159±1.0 cm, 18.56±1.36 kg•m<sup>-2</sup>) volunteered to be included in the study. Pushing-off from the wall, the participants performed 50m front crawl at 100% of their maximum velocity and, after 2 minutes of recovery, a second 50m at 90% of their maximum velocity (step 1). Afterwards, once performing a fatiguing task (i.e. 2000m front crawl at the anaerobic threshold velocity), the swimmers repeated the 50m front crawl trials, as before (step 2). Perceived exertion, assessed through the CR10 scale before and after every 50m, as well as stroke length (SL), stroke rate (SR) and velocity (v), have been compared. Results At 100% of the maximum velocity, CR10 measured after the 50m trial was higher in step 2 than in step 1 (p<0.01; 5.1±1.3 vs. 7.3±0.7, AU). On the contrary, SR and v decreased after the fatiguing task (p<0.01, 0.97±0.06 vs. 0.91±0.05 cycles•s<sup>-1</sup> and p<0.001, 1.49±0.07 vs. 1.40±0.10 m•s<sup>-1</sup>, SR and v, respectively). SL did not change. At 90% of the maximum velocity, CR10 was higher in step 2 than in step 1 both before (p<0.01, 5.1±1.3 vs. 7.3±0.8, AU) and after

( $p < 0.05$ ,  $6.2 \pm 1.2$  vs.  $7.6 \pm 1.1$ , AU) the 50m trial. SR and  $v$  decreased ( $p < 0.05$ ,  $0.87 \pm 0.06$  vs.  $0.82 \pm 0.06$  cycles $\cdot$ s $^{-1}$  and  $p < 0.01$ ,  $1.42 \pm 0.10$  vs.  $1.33 \pm 0.09$  m $\cdot$ s $^{-1}$ , SR and  $v$ , respectively), whereas SL did not change. Discussion The drop of the velocity and the increase of the perceived exertion, measured every 500m during the long swimming effort, confirmed that fatigue raised (Knicker et al, 2011). As swimmers experienced after the fatiguing task an overall worsening of both the perceived exertion and the biomechanics parameters, it could be deduced that fatigue affected the 50m trials and, as a consequence, the ability to address to the pace. Therefore, the training of swimming pacing after fatiguing tasks might be recommended in order to practice the perception of proper pace and to manage it, even when fatigue raises and interferes on its administration. References Borg GA (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise*. 1982; 14:377-381. Knicker AJ, Renshaw I, Oldham AR, Cairns SP (2011). Interactive processes link the multiple symptoms of fatigue in sport competition. *Sports medicine*, 41(4), 307-328.

### CARDIOVASCULAR STRAIN IMPOSED BY PHYSICAL EDUCATION CLASSES CONSIDERING CONTEXT VARIABLES

Póvoas, S.1,2, Martins, C.2, Silva, P.2, Soares, J.3, Teixeira, J.2

1: Research Center in Sports, Health Sciences and Human Development, 2: Maia Institute of Higher Education (Maia, Portugal), 3: Centre of Research, Education, Innovation and Intervention in Sport, Fac

CARDIOVASCULAR STRAIN IMPOSED BY PHYSICAL EDUCATION CLASSES CONSIDERING CONTEXT VARIABLES Póvoas, S.1,2, Martins, C.2, Silva, P.2, Soares, J.3, Teixeira, J.2. 1: Research Center in Sports, Health Sciences and Human Development, 2: Maia Institute of Higher Education (Maia, Portugal), 3: Centre of Research, Education, Innovation and Intervention in Sport, Faculty of Sport, University of Porto (Porto, Portugal) Introduction Physical Education (PE) classes comprise regular supervised physical activity aiming to improve physical fitness, among other purposes. Although there is some information regarding the intensity of PE classes, intensity assessments aren't regularly performed, particularly considering if small-sided games or analytical exercises are mainly used. Thus, the purpose of this study was to characterize students' cardiovascular strain during PE classes according to the level of education, gender and type of exercises. Methods One hundred and sixty heart rate (HR) recordings of 24 male and 24 female Portuguese students from the 1st (6 to 10 yrs old), 2nd (10 to 12 yrs old) and 3rd (12 to 15 yrs old) levels of education were registered during PE classes using Polar Team System. Maximal HR was determined during the yo-yo intermittent recovery test-level 1 (Bangsbo, 1994), except in children ages 6 to 10 years old, where maximal HR was estimated (220 bpm-age). Resting HR was determined according to Fairclough & Stratton (2005) and physical activity intensity levels were determined according to Stratton (1996). Results The 2nd and 3rd level students spent more than 50% of effective class time in intensities equal to or above moderate-to-vigorous physical activity. The 3rd level of education students spent a higher percentage of effective class time in vigorous physical activity (VPA) ( $29.2 \pm 20.76\%$  vs.  $19.9 \pm 17.56\%$  and  $10.5 \pm 10.47\%$ ;  $p < 0.05$ ) compared to 1st and 2nd levels of education, respectively. Students spent a higher percentage of time in VPA in small-sided games than in analytical exercises ( $32.4 \pm 31.23\%$  vs.  $18.6 \pm 22.61\%$ ;  $p < 0.05$ ). Boys spent a higher fraction of effective class time in VPA than girls ( $23.8 \pm 21.07\%$  vs.  $16.9 \pm 14.61\%$ ;  $p < 0.05$ ). Discussion Only 2nd and 3rd level PE classes seem to achieve the international recommendations regarding classes' intensity, which depends on students' level of education and gender. These results are in accordance with previous studies (Fairclough & Stratton, 2005). 1st level results may be due to the teacher characteristics, insufficient infrastructural and material conditions of schools, and curriculum, which focuses on coordination activities performed at low intensity. Small-sided games provide a better method for achieving higher intensity levels than analytical exercises. References Bangsbo, J. (1994). Fitness Training in Football: A Scientific Approach. Bagsvaerd: HO & Storm. Fairclough, S., & Stratton, G. (2005). *Health Educ Res*, 20(1), 14-23. Stratton, G. (1996). *Pediatr Exerc Sci*, 8(3).

### EFFECT OF SHORT-TERM HIGH-INTENSITY INTERVAL TRAINING AND CONTINUOUS TRAINING ON LACTATE KINETICS PARAMETERS IN ADOLESCENT GIRLS

Saremi, A., Shavandi, N., Khanjari, M.

Arak university

Introduction Training-induced adaptations have been extensively studied in adults, and some exercise scientists have recommended similar training programmes for young people. However, the subject of the response to training of children and adolescents is controversial. The purpose of this study was to compare the effects of short-term high-intensity interval training (HIIT) and continuous training (CT) (matched for total work) on lactate kinetics parameters in adolescent girls. Methods Twenty-two recreationally active adolescent girls (age:  $13.21 \pm 2.34$  year; height:  $161.25 \pm 8.63$  cm; mass:  $52.81 \pm 5.42$  kg) were randomized to either HIIT ( $n = 11$ ;  $8 \times 2$  min at 90% Vo2peak) or CT ( $n = 11$ ; 40 min at 50% Vo2peak) 4 times per week for 4 weeks. Before and after training, all participants performed an incremental exercise test to assess maximal oxygen uptake (Vo2peak) and a 3 min 90% Vo2peak exercise followed by 15 minutes of passive recovery to determine an individual blood lactate recovery curve fitted to the biexponential time function:  $[La](t) = [La](0) + A1(1 - e^{-\gamma1 \cdot t}) + A2(1 - e^{-\gamma2 \cdot t})$ . Results After training, both groups had significant improvements in Vo2peak ( $P < 0.05$ ), with no significant differences between HIIT and CT ( $P > 0.05$ ). Both training groups also had significant improvements in lactate exchange ( $\gamma1$ ), lactate removal ( $\gamma2$ ), and half-time of the blood lactate ( $t_{1/2} - [La]$ ) ( $P < 0.05$ ), with no significant differences between them. There were no significant changes in peak blood lactate concentration ( $[La]_{peak}$ ), time to reach  $[La]_{peak}$  ( $t - [La]_{peak}$ ), and blood lactate concentration at the beginning of recovery ( $[La](0)$ ) after the training period ( $P > 0.05$ ). Discussion These results indicate that short-term CT and HIIT are equally effective in terms of lactate kinetic improvement in adolescent girls. The present data expand on the principles of exercise prescription for adolescent girls by demonstrating that HIIT elicits substantial training effects, which are similar in magnitude to those produced by CT at half the exercise intensity but double the exercise time. References McKay BR, Paterson DH & Kowalchuk JM. (2009). *J Appl Physiol*, 107(1):128-138. Messonnier L, Freund H, Denis C, Féasson L & Lacour JR. (2006). *Int J Sports Med*, 27(1):60-66. Gharbi A, Chamari K, Kallel A, Ahmaidi S, Tabka Z & Abdelkarim Z. (2008). *J Sports Sci Med*, 7:279-285.

### THE EFFECT OF COMBINED MARTIAL ART AND WEIGHT TRAINING IN ATHROPOMETRIC CHARACTERISTICS AND STRENGTH VARIABLES IN ADOLESCENT BOYS

Ferunaj, P.F., Kavaja, G., Kuvarati, S., Skenderi, D.H., Erindi, A.

University of Sports of Tirana

Introduction Many adolescent boys are highly concerned about their body image perception and combined martial arts and weight training are preferred by them to improve muscle strength. Pubescent boys have presented a higher arm and thigh circumference in relation to prepubescent boys, and this fact may be explained due to the higher increase on the muscular mass in this maturational

stage(I). However, there are controversial data determining the ratio of predominant factor for this change, growth age or physical training. Methods In the study 9 volunteer adolescents (mean age  $17 \pm 0.23$ ) undertook the 3 days per week, 1.5 hour per session, 16 weeks of mixed training, combination of taekwondo (45 minutes) and progressive weight training (45 minutes). We have measured the body mass, anthropometric traits (Chest, biceps, leg girth) and body fat percentage (%BF) via skin fold thickness (SKF) method (2). The maximal and endurance strength for major muscle groups was measured before and after training using 1 RM and 75% of 1RM, respectively. Results Body mass was increased from  $73.77 \pm 13.28$  kg to  $77.43 \pm 13.98$  kg and interestingly, body fat decreased from 18.43 % to 16.75 %. The decrease in body fat was parallel combined with anthropometric changes. Thus, pectorals girth increased from  $87.8 \pm 4.32$  cm to  $90.35 \pm 5.82$  cm, biceps girth from  $30.2 \pm 2.45$  cm to  $32.17 \pm 2.61$  cm, leg girth from  $56.92 \pm 7.07$  cm to  $59.25 \pm 7.86$  cm. Maximal strength in back squat, dead lift and bench press was increased 23 %, 26 % and 18 %, respectively, whereas endurance strength 19 %, 22 % and 17 %. Discussion The major finding of this study was that martial arts and weight training was effective to improve maximal strength and anthropometric traits in adolescent boys. However, data from our study suggest that body weight status is not influenced by concurrent training. But despite of high intensity training, there was no decrease in body mass. Although we did not measure muscle mass, considering the increase in body mass and other anthropometric traits let us conclude that dominant factor for this change is the physical training and not age status. Furthermore, strength is clearly more closed to muscle size (3). However, the weak point of our study is the lack of control group. References 1. Hansen L, Bangsbo J, Twisk J, Klausen K. 1999. Development of muscle strength in relation to training level and testosterone in young male soccer players. *J Appl Physiol*;87:1141-7. 2. Jackson, A. S., and Pollock, M. L. 1985. Practical assessment of body composition. *Physician and Sport medicine* 13(5) : 76 – 90. 3. Thomas Rowland. (2004). *Children's Exercise Physiology*, Second Edition, 4,34 - 35.

### PREDICTIVE VALIDITY OF PREDICTORS IN A NEW TALENT IDENTIFICATION PROGRAMME BY THE GERMAN HANDBALL FEDERATION

Schorer, J., Strauß, B., Pabst, J., Büsch, D.

*University of Muenster, Institute of Applied Training Science Leipzig*

Introduction The German Handball Federation conducts a talent identification programme (TIP) with female (15-16 years) and male (16-17 years) youth handball players every year. In 2008, the DHB launched a modified TIP with anthropometric, motor and psychological tests (Elferink-Gemser et al., 2005; Lidor et al., 2005; Mohamed et al., 2009) with the aim to improve the predictive validity of the talent identification. This study evaluates the modified TIP in general and especially the predictive validity of the different tests. Methods Youth handball players from 20 regional selection handball teams (N = 542, 259 female and 283 male, 14 to 16 years) performed a series of tests. The number of items for the following analyses was reduced to eight potential predictors by ratings. Nomination by the national coaches was the outcome variable. First, a multivariate analysis of variance with the factors nomination and gender was conducted. Results The results showed significant main effects for nomination (Wilks' Lambda = .87, F(6, 169) = 4.39,  $p < .001$ ,  $\eta^2 = .14$ ) and for gender (Wilks' Lambda = .21, F(6, 169) = 101.37,  $p < .001$ ,  $\eta^2 = .78$ ), but no interactions between both. Therefore stepwise discriminant analyses were carried out separately for each gender. For boys, 30-m sprint is mainly responsible for a large explained variance (55.9%). For girls, this is the 30-m sprint, ball throwing velocity, and achievement motivation (67.6%). Discussion The results indicate that singular tests differentiate between nominated and not-nominated female or male youth handball players (Mohamed et al., 2009) but the predictive validity is quite low. The predictors are just not sensitive and specific enough (Lidor et al., 2005). Therefore, TIP will be expanded by tactical tests (Elferink-Gemser et al., 2004) with open skills assuming that an increase of the predictive validity will occur. Additionally, a longitudinal study will be conducted to test long-term effects. References Lidor R, Falk B, Arnon M, Cohen Y, Segal G, & Linder Y. (2005). *J Strength Cond Res*, 19(2), 318-325. Elferink-Gemser MT, Visscher C, Lemmink KAPM, Mulder TW. (2004). *J Sport Sci*, 22, 1053-1063. Mohamed H, Vaeyens R, Matthys S, Multaet M, Lefevre J, Lenoir M, Philippaerts R. (2009). *J Sports Sci*, 27, 257-266.

**14:45 - 15:45**

### Poster presentations

#### PP-PM55 Health & Fitness: Physical Activity 2

##### CHANGES OF SELECTED SOMATIC PARAMETERS OF CZECH SENIOR POPULATION

Hrebickova, S., Sedlacek, J., Cacek, J., Grasgruber, P., Ondracek, J., Hrazdira, E., Vilim, M.

*Faculty of Sports Studies Masaryk University, Brno*

Introduction Nowadays in the life of human being the movement activities play all the time more and more important role. The purpose of any recreational movement activity is the health increase and prolonging of active life. During last several decades changed fundamentally the way of human living. On one side there was step by step minimized the movement activity and on the other side extremely increased the emotion and psychological load and parallel was worsened the quality of life environment. The care of individual health is a first-rate duty of each man. To keep needed level of health and movement performance all the life is a very difficult task. It needs systematic effort, self discipline, endurance and strong willing. At present is stated that the way of living can influence health from about 50%. There are relatively many researches about school population parameters of health and physical fitness. Researches about adults are more rarely. In this contribution there are presented results of 569 Czech adult people (273 males and 296 females) older than 18 years. There are presented and discussed results in 5 somatic parameters: body height, body weight, BMI, fat tissue percentage and waist hips rate. Methods These parameters were measured in Czech Republic during second half of year 2011. There was used special machine apparatus Inbody 720 plus anthropometric parameter body height. Authors compare and discuss trends and changes in groups of decades after 18 years of age. Results and discussion Presented results confirm negative trends that are very often presented by similar researches. Body height trend changes from positive to neutral both in groups male and female, when the oldest groups (over 49) are the lowest, while those under 49 are taller and in each decade they do not differ so much like those older. Like negative can be also considered decade changes in another watched parameters. The lowest body weight is among youngest probands and it also seems, that more progressive negative changes become in age over 59 years of age, both in groups of male and female. Body weight of course influence negatively all watched parameters (BMI, fat tissue percentage and waist hips rate), that are getting worse with getting

older. Males are already from 29 years in zone of overweight, females after 59 years; with it also correspond fat tissue percentage and waist hips rate, too. The project 'Creating a research team for the purpose of determining the level of physical activity (inactivity) in selected age groups of the population of men and women in the Czech Republic' (CZ.1.07/2.3.00/20.0044) is financed by the European Social Fund and the state budget of the Czech Republic. References Sedlacek, J. et al (2007): Kondičná atletická príprava a rekreačná atletika. Univerzita Komenského Bratislava. ISBN 978-80-223-2288-1

### PHYSICAL ACTIVITY AND CARDIOVASCULAR RISK FACTORS IN SCHOLARS

Brito, L., Moser, D.C., Titski, A.C.K., Mascarenhas, L.P.G., Góes, S.M., Lazarotto, L., Carvalho, H.M., Coelho-e-Silva, M.J., Leite, N.

*Federal University of Parana and CAPES*

Introduction Physical activity is part of human life; however, with the gradual changes in lifestyle, daily movements decreased in both children/adolescents and adults (Neri, 2003). These modifications result in chronic diseases related to sedentary lifestyle and increase cardiovascular risk factors (Andersen et al., 2011). The aim of this study was to investigate the historical of physical activity and risk factor cardiovascular in scholars. Methods Cross-sectional epidemiological study was conducted with 1325 scholars (591 boys and 734 girls) from five schools in Curitiba-PR-Brazil. Height, body mass, waist circumference, blood pressure (BP) and the self-reported maturational stage by Tanner criteria were measured. The cardiorespiratory fitness was assessed by Leger test. The physical activity history (PAH) was measured by the 3-day record (3DPAR). Student's t-test for independent sample, Chi-square test and Pearson's partial correlation were performed. These statistical procedures were calculated with significance set at  $p < 0.05$ . Results Boys showed a higher age, height, SBP, DBP,  $VO_2\text{máx}$  and maximum heart rate average compared to girls ( $p < 0.05$ ). Considering the PAH under 300 min/week, scholars exhibited overweight (boys: 30.8%; girls: 37.1%), visceral obesity (boys: 22.6%; girls: 35.9%) and hypertensive levels (boys: 16.4%; girls: 17.2%). There were no significant differences between genders when cardiovascular risk factors and PAH were analyzed. Discussion In this study the frequencies of CVD risk factors were similar between physically active and sedentary, both girls and boys. This might be occurred due to an increased physical activity practice, as an alternative treatment, among children and adolescents previously identified with cardiovascular risk factors (Escrivão, 2000). References Andersen LB, Riddoch C, Kriemler S, HHills. (2011). *Brazilian Journal Sports Medicine*, 45, 871-76. Escrivão MAMS, Oliveira FLC, Taddei JAAC, Lopez FA.(2000). *Jornal de Pediatria*, 76, 305-10. Neri M, Pinto A, Soares W, Costilla H. (2003). *FGV/IBRE/CRS*, p.188.

### FIGHTING AGAINST LOWER PHYSICAL ACTIVITY IN PREGNANCY WITH BODY COMPOSITION CONTROL

Robic, T., Benedik, E., Bratanić, B., Fidler Mis, N., Rogelj, I., Golja, P.

*Biotechnical Faculty*

Introduction Regular physical activity maintains optimal body composition and wellbeing, but in some cases, i.e. pregnancy, its levels are often insufficient. Consequently, body mass during pregnancy can increase not only due to fetal and gestational tissue growth, but also due to accumulation of additional maternal body fat. This alters body composition and can lead to pregnancy diabetes or high blood pressure. Precise determination of body fat content in pregnant women is challenging, as for safety reasons several routine techniques can not be used and only a few specific anthropometric equations for the assessment of body composition have been developed. Therefore, our aim was to compare anthropometric methods for the evaluation of body fat content in pregnant women to select optimal methodology. Methods This study is part of a wider project entitled "The role of human milk in development of breast fed child's intestinal microbiota" (project N° J4-3606) supported by Slovenian Research Agency and approved by the Slovenian Ethics Committee. 150 pregnant women volunteers provided information on their age, gestational week, and pre-pregnancy mass. Body height, mass, six skinfolds, wrist, and upper arm circumference were measured in the (mean (SD)) 32nd (3) week of pregnancy. Their body mass was also noted a few days before and after delivery. Body mass index (BMI) and percentage of body fat tissue according to thirteen different existing anthropometric equations were calculated. Body composition data were analyzed with one-way repeated measures ANOVA and level of 0.05 was adopted as statistically significant. Results Body mass gain was 10.3 (3.8) kg up to the 32nd week of pregnancy, and 14.4 (4.7) kg just before the delivery. During pregnancy, BMI increased from 22.6 (3.7), 26.2 (3.8), and 27.8 (4.0) kg/m<sup>2</sup> for pre-pregnancy, 32nd week, and pre-delivery, respectively, and decreased to 24.7 (3.8) kg/m<sup>2</sup> after delivery. Body composition results differed largely according to the anthropometric method used and ranged from 12 (4) % to 37 (7) % for the same sample of pregnant women during the same period of pregnancy. Discussion Increased BMI after pregnancy, as compared to pre-pregnancy, reflected general changes in body composition. Precise assessment of changes in body composition with anthropometric methods, however, was not reliable due to wide ranging of results. To determine body fat content correctly, it is thus important that the reliability of the existing methods for the assessment of body composition in pregnancy is thoroughly examined. Only so, assessments of body composition can be used as feedback information of health status, adequate physical activity, and the effectiveness of potential targeted exercise programs for pregnant women.

### SUBJECTIVE CHARACTERISTICS, ACTIVE PARENTS, ATTITUDE OF THE PHYSICAL EDUCATION TEACHER AND MOTIVATIONS TO THE PHYSICAL ACTIVITY IN ADOLESCENTS

Zito, V.1, Fischetti, F.1, Moretti, B.1

*University of Bari in Italy*

Introduction: This survey provides data on physical characteristics of young adolescents, family environment and correlations with their Physical Education teachers connected to the interests and motivations towards motor and sports practice. The data is valuable in identifying priorities for action and define strategies to improve young people's health and to prevent further health risks. Methods: We studied 1,250 high school students living in southern Italy city (M:F=712:538, mean age 16±1 yrs, range 15-19) according to BMI, physical activity, parents lifestyle and opinions regarding their physical education teachers. The anonymous questionnaire were made up of 19-items custom designed closed answers and multiple choice. Results: Obese, overweight, lean, and underweight subjects were: 25.5%, 8.7%, 64.5%, 1.3% (M) and 7.3%, 8.4%, 80.3%, 4% (F). Physical activity was more frequent in M (71%) than F (60%). Percentage of subjects practicing at least 2-3 times/wk PA was higher in lean than obese M (66% vs. 51%) and F (63% vs. 33%). 50% of active students appreciate the ability of the physical education teacher to establish positive relationships with pupils compared to 12.7% of active students who do not admire anything. 39.2% students wearing the tracksuit during the hours of physical education because it is necessary to do all the exercises and not only because the professor expects (7.2%). 65.4% of adolescents practice a sport to be fit and 60.2% to feel well. 28.2% of

students are no active mostly because they have no time and 22,8% because they are lazy. 85.2% of students who practice a sport have parents who are physically active, the percentage drops to 61.8% with inactive parents. 39.2% of parents, advised their children to practice a sport. Discussion: Of note, the research showed that a fit body together a positive family environment and a well-delivered PE class can contribute to let students be more active. These data give also the opportunity to develop integrated training programs among the various educational systems such as school, family and teachers to increase the level of physical activity in young adolescents revaluing the role of the family beyond that of teacher. References: Glyn R, (1992). Motivation in sport and exercise, Human Kinetics, pp. 3-29. Thelma S, (2002). Advances in sport psychology (2nd ed.) Human Kinetics, pp. 101-170. Da Molin G, Moretti B, (2008) La cultura della vita, Cacucci Editore, 21-44.

### LIFE QUALITY IN RUNNERS, A BRAZILIAN EXPERIENCE

Benetti, M., Sierra, A., Assumpcao, B.P., Gabriel, E.A., Bastos, F.C., Kiss, M.A.P.D., Martini, J.S.C., Cortez, J.A.A.  
*University of Sao Paulo*

The matter of life quality has been intensely discussed nowadays, and its concept incorporates, in its theoretical construction, a multidimensional nature, as does the definition of health by the World Health Organization. The components of life quality can be divided into eight concepts: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), mental health (MH). The eight concepts are hypothesized to form two distinct higher-ordered clusters due to the physical and mental health variance that they have in common. This research aims at checking the life quality score in runners of Ecorrida de Revezamento (relay race) in São Paulo. Methods: 122 runners, 98 men and 24 women, aged between 19 and 57 years (35.6±9.2 years). They had filled the SF36 Questionnaire, Portuguese version. The group was divided by age and compared in the eight concepts evaluated. For the analysis we established a raw scale (0-100) for each concept; t-Student test to compare the groups and Pearson correlation for practicing time. Results: Concepts - average±STDEV PF - General (G)- 94.87±12.6; Women (W)- 96.87±5.06; Men (M)- 94.38±13.81 RP - G - 85.86±26.5; W - 88.54±23.29; M - 85.2±27.3 BP - G - 77.41±17.78; W - 70.42±9.45; M - 69.98±12.65 GH - G - 70.06±17.78; W - 70.42±9.45; M - 69.98±12.65 VT - G - 74.3±15.01; W - 72.5±16.28; M - 74.74±14.73 SF - G - 81.35±19.43; W - 79.69±19.09; M - 81.76±19.59 RE - G - 84.15±27.84; W - 81.94±31.05; M - 84.69±27.14 MH - G - 77.67±14.7; W - 74±14.78; M - 78.57±14.61 Concepts by age (years) - average±STDEV PF - 19/29 years - 96.3±5.9\*; 30/39 years - 96.8±5.9; 40/49 years - 91.8±16.8\*; 50/57 years - 90±28.3\* RP - 19/29 years - 83.3±27.1; 30/39 years - 89.8±21.8; 40/49 years - 83±32.7; 50/57 years - 86.4±25.9 BP - 19/29 years - 77.8±17.1; 30/39 years - 75.3±17.1; 40/49 years 78.9±19.6; 50/57 years - 80.7±19.8 GH - 19/29 years - 68.3±14.5; 30/39 years - 71.5±11; 40/49 years - 69.6±10.3; 50/57 years - 71.9±11.2 VT - 19/29 years - 68.8±16.1; 30/39 years - 75.4±14.4; 40/49 years - 77.3±13.8; 50/57 years - 81.4±11.8 SF - 19/29 years - 80.4±18.3; 30/39 years - 81.5±21.3; 40/49 years - 80.4±19.4; 50/57 years - 86.4±17.2 RE - 19/29 years - 76.9±31.7\*; 30/39 years - 84.8±28.3; 40/49 years 92.8±16.6\*; 50/57 years - 84.8±31.1 MH - 19/29 years - 74.7±15.1\*; 30/39 years - 75.6±15.1\*; 40/49 years - 82.6±12.6\*; 50/57 years - 84±14.2 \*P<0.05 Pearson Correlation between the concepts and the practice time PF = -0.02; RP = +0.02; BP = +0.24; GH = +0.21; VT = +0.33; SF = +0.12; RE = +0.25; MH = +0.34 Conclusion: We found life quality score greater than 70 for all of the concepts in all sub-groups. It had statistical difference between the age band for: physical functioning (19/29, 40/49, 50/57), role emotional (19/29 and 40/49), and mental health (19/29, 30/39, 40/49). The correlation was positive in all concepts except physical functioning.

### HABITUAL PHYSICAL ACTIVITY IN OPERA ENSEMBLE OF CROATIAN NATIONAL THEATRE

Rupcic, T., Nedic, A., Mejovsek, M.  
*Faculty of Kinesiology*

Introduction There are many scientific evidences linking physical activity to numerous health improvements and substantial benefits that can be gained. Regular physical activity greatly reduces the risk of dying from coronary heart disease. It reduces the risk of developing diabetes, hypertension, and even colon cancer. Physical activity fosters strong muscles, healthy bones and joints and may favourably affect body fat distribution and prevent obesity. In older adults it helps maintain function and greater quality of life. The aim of this study is to establish the level of habitual physical activity in the employees of the opera ensemble of Croatian National Theatre in Zagreb. Methods The sample comprises 110 members (57 males and 53 females) of the opera ensemble of Croatian National Theatre in Zagreb. The level of their habitual physical activity was determined by Baecke questionnaire. The obtained data were analysed by standard statistical procedures, with statistical software package STATISTICA for Windows. Basic descriptive statistical parameters were calculated for the whole sample Results and discussion The answers from Baecke questionnaire are the grounds for the calculation of three basic indices: sport index (SI), leisure index (LI) and work index (WI). The highest possible value of the index was 5.0 and it indicates the highest physical activity, while the lowest physical activity was indicated with the value of indices of 1.0. Male members of the ensemble had significantly higher values of sport index, their experience of work load is slightly higher, while female members had slightly higher leisure time index. In comparison with average population in Croatia work index was, as expected, lower for the members of ensemble, while they results in LI and SI are significantly higher than in average Croats. This data suggests that, both male and female, ensemble members understand the benefits of physical activity for their health. When comparing orchestra members, soloists and chorus, work index is the highest for the soloists, although according to Manchester (2012) musicians spend more energy while playing than singers while singing. The soloists have the highest level of sport activity, while musicians were the most active in their leisure time. References Baadjou VAE, et al. (2011). Med Probl Perform Art, 26(4), 218-222. Manchester R. (2012). Med Probl Perform Art, 27(4), 183-184. Mišigoj-Duraković M, et al (2000). Croat Med J, 41(4), 428-432. The world health report 2003 - shaping the future. <http://www.who.int/whr/2003/en>, 18.1.2012.



**14:45 - 15:45****Poster presentations****PP-PM56 Training & Testing 11****NORMALIZATION OF PHYSICAL TESTS' RESULTS CAN ATTENUATE THE RELATIVE AGE EFFECT IN YOUNG SWISS ALPINE SKIERS**

Gorski, T.1, Hoppeler, H.1, Rosser, T.1, Beltrami, F.G.2, Vogt, M.1

*1: University of Bern (Bern, Switzerland), 2: University of Cape Town (Cape Town, South Africa)*

**Introduction** The occurrence of the relative age effect (RAE), characterized by an over-representation and/or better performance of athletes born in earlier year quarters (Q) of the competitive calendar in comparison to those born in later Qs, has been reported in several sports. Recently, we demonstrated the occurrence of the RAE in young Swiss alpine skiers. This study analyses the effect of normalizing results in physical tests to weight and height on the occurrence of RAE in Swiss alpine skiers between 11 and 19 years old. **Methods** The Swiss Ski Power Test includes anthropometric data assessment, endurance (Cooper test, high-box jump), strength (one-leg and two-legs 5-hop, standing long jump, push-ups), and speed and coordination (two circuits containing obstacles) tests. Data of 6996 tests carried out with 1031 female and 1438 male athletes between 2004 and 2010 were analyzed, with athletes being divided according to sex and category (K1: 11-12 years old, K2: 13-14 years old, JUN1: 15-16 years old, JUN2: 17-19 years old). One-way ANOVAs were used to assess differences between athletes born in different Q for non-normalized results and results normalized to height and weight for each test of each category and sex. Significance level was set at  $p < 0.05$ . **Results** Significant differences in performance between athletes born in different Q (i.e., RAE) were found in several tests for different categories, with RAE occurring in a higher number of tests in categories K1 (male) and K2 (female) in comparison with other categories. For female and male athletes, normalization to height, but not to weight, reverted RAE in most cases. In female athletes, normalization to height, but not weight, was able to revert RAE in all tests of all categories in which RAE was present but the Cooper test of JUN2 athletes. Nevertheless, in male JUN2 skiers normalization to weight seemed to be more adequate than normalization to height. Reverting the RAE using normalization was not possible in some tests (mainly strength tests) of male K2 and JUN1 athletes. **Discussion** Normalization of performance in physical tests to height – and, in some cases, to weight – seems to be a possibility of attenuating RAE occurrence in young alpine skiers. Generally, normalization to height reverted more RAE cases than normalization to weight. RAE cases not reverted by normalization highlight the role played by other factors than anthropometric variables in the development of RAE. Based on these results, normalization to height is recommended when such tests are used for comparisons between athletes born in different Q or talent selection, for example.

**ROWING PERFORMANCE AND ROWING TECHNIQUE OF GERMAN JUNIOR WOMEN IN THE EIGHT FROM 2001-2011**

Mattes, K.1, Manzer, S.1, Boehmert, W.2

*1 University Hamburg*

**Introduction** For several years, regularly in June / July 2000-m race tests in the eight (8+) were performed with the best athletes of each year in preparation for the World Junior Championships (WJC). The data represent the individual rowing technique and the transformation of the motor abilities into rowing performance under the specific conditions of big boats. The cross-sectional data show what kind of medium-term development was completed from 2001-2011 in order to show trends for the junior women as well as for setting a benchmark for powerful rowers. **Methods** Each year two 8+ with junior women ( $N = 156$ ; body height  $1.79 \pm 0.05\text{m}$ , body mass  $70.2 \pm 5.8\text{kg}$ ) were measured over 2000-m races on the same regatta course in "Berlin Gruenau". The race boat was equipped with a mobile measuring system (Boehmert & Mattes, 2003) that captured the inboard handle force as the oar bending moment, with a strain gauge (resolution 0.25N), and the oar angle with a high-resolution magnetic field sensor that is attached to the gate pin (resolution 0.1°). Based on the data, the inboard handle power per stroke (Pih) and its components force (Fih), velocity (vih) and stroke length (sl) were determined. The 2000-m race time from the finals of the WJC in the 8+ was taken as external criteria. For the evaluation a linear regression analysis was calculated. On the basis of the results, different performance groups were formed. **Results** The race times of the winner and the German crews at WJC in the 8+ decreased approximately 1.5s/year during the period studied. The decrease in the body height of the German junior women was not significant in comparison to the body mass. At the same time the stroke rate remained comparable, however a significant increase in the Pih (1.1W/year) and the Fih (1.2N/year) with significant decrease of the sl (-0.2°/year) was found. Based on Pih six performance groups from international level ( $225 \pm 6\text{W}$ ) until national level ( $164 \pm 2\text{W}$ ) were formed. **Discussion** The positive development of the external criteria (race time) corresponds with the increase of the Pih over the 2000m. Since performance development is based on cross-sectional data, various reasons are responsible for it. The trend can be attributed to an improved rowing technique and a more effective transformation of motor abilities in rowing performance, but without making a clear distinction between current exercise-induced effects or selection effects. The individual rowing power can be better assessed on the basis of the new performance groups. **References** Boehmert, W. & Mattes, K. (2003). Biomechanische Objektivierung der Ruderbewegung im Rennboot. In Fritsch, W. (Hrsg.), Rudern - erfahrung, erkunden, erforschen. S. 163-172. Gießen: Wirth-Verlag (Sport Media).

**EFFECT OF THIGH MUSCLE GROWTH ON BALL KICKING PERFORMANCES DURING PRE AND POST ADOLESCENCE IN MALE**

Teshima, T., Tanaka, S., Tsunoda, N.

*Kokushikan University*

**Introduction** The purpose of this study was investigated the effect of thigh muscle growth on ball kicking performance during pre and post adolescence in Japanese male soccer players. **Methods** Participants of this study were 303 Japanese male soccer players. The participants were classified into 4 chronological groups (10-12G, 13-15G, 16-18G, 19-22G). The height, weight, and body composition parameters such as fat-free mass (FFM) were measured using the body impedance analysis method. Muscle thickness of the thigh was measured using the B-mode ultrasonic method in dominant leg. The ball distance (BD) was measured with a tape. The ball velocity (BV) was measured using a radar gun. **Results** Muscle thickness of thigh anterior was obtained significantly difference among the age groups. And also,

FFM such as whole body muscle growth was significantly increased with chronological age. However, Relative muscle thickness (muscle thickness of anterior / FFM1/3) was obtained significantly difference between 13-15G and 19-22G. Ball kicking performances were observed significant difference in each year. Relative muscle thickness of thigh anterior was significantly correlated to BV and BD in 13-15G. And also, these relationships did not show a significant correlation in the 16-18G and 19-22G. Discussion In specific soccer training, repetition of the ball kicking movement, sprint and jump might be occurring muscle growth. However, There is no denying the natural growth in adolescence. Especially, muscle thickness of thigh was affected on ball kicking performance during adolescence. However, muscle thickness of thigh was not correlated to the ball kicking performances after post adolescence. Therefore, the ball kicking performance may vary depending on differences in skill level after the post adolescence. From these results, it was suggested that the ball kicking performance is probably affected by not only the thigh muscle growth but also the individual's ball kicking skills after post adolescence. Reference Masuda K, Kikuhara N, Takahashi H, Yamanaka K. (2003) *J Sports Sci*, 21 851-858. Masuda K, Kikuhara N, Demura S, Katsuta S, Yamanaka K. (2005) *J Sports Med Phys Fitness*, 45(1) 44-52. Hoshikawa Y, Iida T, Muramatsu M, Nakajima Y, Fukunaga T, Kanehisa H. (2009) *J Sports Sci*, 27(2) 129-138

### **CORRELATION BETWEEN MAXIMUM STRENGTH OF THE LOWER LIMBS AND BODY COMPOSITION IN DIFFERENT MATURATIONAL STAGES IN BOYS.**

Portella, D.I., Arruda, M., Cossio-Bolanos, M.A.

*USCS University of São Caetano do Sul*

Correlation between maximum strength of the lower limbs and body composition in different maturational stages in boys. Portella, D.I., Arruda, M., Cossio-Bolanos, M.A. 1: USCS (São Caetano do Sul, Brazil), 2: UNICAMP (Campinas, Brazil) Introduction In human growth and development, the maturation is a factor that generates interference in those aspects. Body composition and physical capacity are influenced by the advent of maturity. However, in course of the maturation the relationship of the body composition and physical capacity change. The aim of this study was to identify the correlation between maturation, components of body composition and maximum isometric strength and their correlations during the maturational process in young boys. Methods Young boys soccer players (N=207, 14.09 age  $\pm$ 1.54, 162.74cm  $\pm$ 11.86, 54.77kg  $\pm$ 13.26). The measurement and classification of maturation (MAT) were obtained from the peak height velocity (PHV) calculated by the model proposed by Mirwald et al (2002). To measure the maximum isometric strength (MIS) was used a load cell coupled to a horizontal leg press and the individual positioned with the knees at 90 degrees. For body composition measurement was used DEXA (Discovery I, Hologic, USA) and the protocol used was the Whole Body. The variables were lean leg mass (LLM), Leg bone mineral content (LBMC), leg bone mineral density (LBMD) and leg bone area (LBA). Used the Pearson linear correlation ( $p < 0.01$ ) Results The maturation correlation between body composition and MIS were very strong (MATxLLM=.855; MATxLBMC=.879; MATxLBMD=.859; MATxLBA=.806; MATxFMI=.872). The correlations between MIS and the body composition were strong (FMIxLLM=.775; FMIxLBMC=.781; FMIxLBMD=.807; FMIxLBA=.689). The correlation of the MIS with the LLM, LBMC, LBMD and LBA across maturational stages, observed an increase in the strength of correlation between all variables in the advancement of the maturation process. Discussion Just as the maturation generates positive influence on physical performance in young athletes (Malina, Bouchard & Bar-Or, 2004) the positive influence of body composition in the performance of athletes was also observed in this study. Regarding the MIS and its relations with the bone component, Vicente-Rodriguez et al (2003) identified a similar pattern to the current study, very strong correlation between the MIS and the components in young athletes. The correlations between MIS and body composition suggest the importance not only of muscle mass to better performance, but also components of bone. References Malina R, Bouchard C, Bar-Or, O (2004). Growth, Development and Maturation. Human Kinetics: Illinois Mirwald, R, Baxter-Jones ADG, Bailey DA, Beunen GP (2002). An assessment of maturity from anthropometric measurements. *Sports Med Sci Exerc.*, 34(4):689-694. Vicente-Rodriguez G, Jimenez-Ramirez J, Ara I, Serrano-Sanchez JA, Dorado C, Calbet JA (2003). Enhanced bone mass and physical fitness in younger footballers. *Bone*, 33(5):853-9.

### **TEN YEARS OF A FITNESS ASSESSMENT PROGRAMME FOR HIGH-LEVEL JUNIOR BADMINTON PLAYERS**

Hughes, M.G.1, Andrew, M.2, O'Donoghue, P.1, Stembridge, M.1

1: Cardiff Metropolitan University (Cardiff, UK), 2: Badminton England (Milton Keynes, UK)

Introduction English Badminton has a well-established programme of fitness assessment designed to provide feedback for the optimisation of fitness development in its junior players. Here, some key conclusions from the first ten years of this testing programme are presented. These findings may inform the development of similar testing programmes in other sports and may educate about fitness development in this population. Methods Since the year 2001, the most talented English junior players (n = 95 females; n=118 males; age range of 10 to 18 years) in this Olympic sport have performed fitness testing twice a year. Many of these players have gone on to become senior international players ('future elite players'; n=29). The tests include anthropometry and performance tests of jumping (vertical jump and standing long jump) and movement speed (sport-specific speed and lateral movement speed). Results Mean performance test data between males and females were similar across the age groups until the age of 13 years, after which male players showed increasingly superior performance; a pattern which persists into adulthood. Regarding test validity, for the future elite players the movement speed results of both male and females were superior to non-elite age-matched peers. Similarly, jump performance also discriminated between future elite and non-elite in females only (e.g., vertical jump, 50.4 $\pm$ 6.2 vs. 46.7 $\pm$ 5.2 cm, respectively;  $P < 0.05$ ). Neither mean stature nor body mass were different between groups. However, the broad distribution of the data shows that future success can not be predicted from test results alone. Across the ten years of the programme, there was evidence that age-matched players during the more recent tests (2007-10) were significantly fitter during some activities than players from earlier years (2001-3, 2004-6). Finally, and in keeping with many other similar reports, the players displayed a relative age-effect, with those born in the last third (Sep-Dec) of the selection year (Jan - Dec) significantly under-represented (17.5%) compared with those from the other thirds (Jan-Apr, 45%; May-Dec, 37.5%). Discussion The testing programme has provided valuable information on the development of fitness for this sport. The governing body has amended its selection policy to account for any relative age effect. The data have allowed for the establishment of fitness targets for the players who are implementing increasingly advanced fitness development programmes to optimise their likelihood of future success in the face of rule changes and increased international competitiveness. The trend for higher fitness in the recent players may reflect improved physical preparation or preferential selection of fitter junior players.

## FACTORS THAT IMPACT ON TALENT DEVELOPMENT WITHIN A TALENT DETECTION PROGRAM

Morley, E.

*Australian Institute of Sport/Victoria University*

Elissa J. Morley 1,2, Jason P. Gulbin 1, Juanita R. Weissensteiner 1, Clare MacMahon 2. 1. Australian Institute of Sport, Canberra, Australian Capital Territory, Australia 2. Victoria University, Melbourne, Victoria, Australia Introduction Talent detection is a form of talent identification that identifies athletes from outside the sport of interest as distinct from talent selection which selects athletes from within the sport (Vaeyens et al., 2008). Systematic talent detection and development (TDD) programs have become increasingly prevalent in recent years however their viability has not been well established in the literature. Therefore, the aim of this study was to examine the characteristics of a successful TDD program and to investigate why some talent detection athletes transition successfully into high performance sport, while others do not. Methods A case study approach was adopted using talent detected flatwater kayakers. Athletes were matched in pairs with the key differentiating factor being their highest level of achievement in kayaking with one athlete reaching Australian team representation and the other unable to reach this benchmark. Athletes (n=14) and their coaches (n=4) participated in semi-structured interviews and completed questionnaires based on Gagne's (2009) Differentiated Model of Giftedness and Talent. Additionally, on water and off water performance data was collected prospectively and analysed. Results Coaches, successful athletes and underachieving athletes raised a variety of contrasting explanations for performance. Coaches emphasised the importance of athletes' natural ability, intrapersonal characteristics including determination and 'coachability', and environmental and process factors such as the importance of early and ongoing success and a satisfying social setting. Successful athletes attributed their achievements to environmental provisions such as quality training programs and international competition, influential others including parents and coaches, and intrapersonal factors such as motivation and perseverance. The impact of poor injury management, competing priorities, performance plateaus, and ambiguous expectations were highlighted as consequential by underachieving athletes. Discussion Factors found to facilitate and constrain successful athlete development within a TDD setting will be presented. Discussion will focus on theoretical insights gained and recommendations for improving current TDD practices and maximising athlete retention. References Gagne, F. (2009). Building gifts into talents: Brief overview of the DMGT 2.0. In B. MacFarlane, & T. Stambaugh (Eds.), *Leading change in gifted education* (pp. 61-80). Waco: Prufrock Press. Vaeyens, R., Lenoir, M., Williams, A., & Philippaerts, R. (2008). Talent identification and development programmes in sport: current models and future directions. *Sports Med*, 38(9), 703-714.

## MEASURING CORE STABILITY: THE FEASIBILITY OF THE MCGILL CORE ENDURANCE PROTOCOL IN YOUNG FEMALE ATHLETES

Verschueren, J., De Pauw, K., Meeusen, R.

*Vrije Universiteit Brussel*

Introduction: Recent studies have shown that a lack of core stability can be an intrinsic risk factor for sport injuries, not only in sports with a high load on the spine, but also in young female athletes (4). The ability to sustain a muscle contraction for a prolonged period of time is of great importance to core stability (1). McGill published a test protocol for core endurance and reported a good reliability (3). The goal of our study is to examine the reliability of the McGill test protocol in young female athletes. Methods: 19 young female hockey players (age  $12.7 \pm 1.6$ ) participated in the study. An a-priori power measurement determined the sample size. The McGill test protocol consists of four tests in which the instruction is to maintain the position for as long as possible. The four tests are the flexion endurance test, left side bridge test, right side bridge test and the Biering-Sørensen extension test. Participants performed the McGill test protocol on 3 consecutive days, the only difference being the observer on day 2. Statistical analysis was performed following the method of Hopkins (2) using SPSS and the spreadsheets on sportssci.org. Results: The ICC for the flexion endurance test was 0.56, 0.45 for the Biering-Sørensen extension test, 0.67 for the right side bridge test and 0.60 for the left side bridge test, indicating a moderate reliability of the test protocol. The test-retest reliability of the flexion endurance test was poor to moderate for the flexion endurance test ( $R = 0.46 - 0.74$ ), the Biering-Sørensen extension test ( $R = 0.29 - 0.64$ ), the right side bridge test ( $R = 0.33 - 0.70$ ) and the left side bridge test ( $R = 0.17 - 0.58$ ). Conclusions: Given the moderate to poor reliability, we do not recommend the McGill test protocol in a population of young female athletes. Other protocols to measure core endurance should be developed. References: 1. Biering-Sørensen F. Physical measurements as risk indicators for low back trouble over a one-year period. *Spine* 9:106-19., 1984. 2. Hopkins W.G. Measures of reliability in sports medicine and science. *Sports Med* 30(1):1-15., 2000. 3. McGill, S.M., Childs, A. and Liebenson, C. Endurance times for low back stabilization exercises: clinical targets for testing and training from a normal database. *Arch. Phys. Med. Rehab* 80:941-4., 1999. 4. Steffen, K., Mykeblust, G. and Olsen, O. Preventing injuries in female youth football – a cluster-randomized controlled trial. *Scand. J. Med. Sci. Sports* 18:605-614., 2008.

## AGE AND GENDER RELATED DIFFERENCES OF THE RELATIONSHIP BETWEEN ANAEROBIC POWER PRODUCTION CAPACITY AND SKATING PERFORMANCE IN JAPANESE JUNIOR SPEED SKATERS

Kumagawa, D., Tanaka, S., Tsunoda, N.

*Japan Institute of Sports Sciences*

Introduction It is well known that the muscle force and power generation capacities are improved by speed skating training (Nemoto et al. 1990, de Koning et al. 1991). And also, these muscle functional characteristics are closely relation to the short-distance skating performance. However, it is not clear whether the effects of age and gender on the strength of relationship between anaerobic power and skating performance. Therefore, this study investigated the age and gender related differences of the relationship between anaerobic power production capacity and skating performance among Japanese male and female speed skaters aged 10-20 years. Methods Body compositional parameters for body height, body mass, and fat-free mass of the whole body were measured using the body impedance analysis method. Maximal anaerobic power (MANP) generation capacity was determined using a bicycle ergometer. In addition, the mean 500m skating velocity (SV), calculated from recently attained individual best times, was used as a measure of athletic performance. Furthermore, the subjects (both males and females) were divided into ten groups according to chronological age, and the correlation coefficients between MANP and SV were examined, respectively. Results MANP and SV values increased with chronological age in both males and females. The MANP of male skaters was significantly higher than that of female skaters after 13 years of age. SV greatly improved from 11 to 14 years in both male and female skaters, and gender-related differences in SV were observed in all ages except at 11 years. MANP were significantly correlated with SV in all the age groups. The 12-17-year-old groups among the males and the 10-14-year-old groups among the females showed the high correlation coefficients in terms of the relationships between MANP and SV. However,

significant correlations were not found in any other age groups. Discussion From these results, it was considered that the growth tendency of anaerobic power and 500m skating velocity were almost the same. However, it was cleared that the contributions of anaerobic power production capacity to speed skating performance may differ with age and gender. References de Koning J J, Bakker F C, de Groot G, van Ingen Schenau G J, (1994), *J Appl Physiol*, 77, 2311-2317. Nemoto I, Kanehisa H, Miyashita M, (1990), *J Sports Med Phys Fitness*, 30, 83-88.

### PHYSIOLOGICAL PERFORMANCE TESTS IN TRACK AND FIELD ATHLETES AGED 15 TO 18 YEARS

Gürol, B.1, Kale, M.1

*anadolu university health sciences institution*

PHYSIOLOGICAL PERFORMANCE TESTS IN TRACK AND FIELD ATHLETES AGED 15 TO 18 YEARS Gürol, B.1, Kale, M.1 1: School of Physical Education and Sports, Anadolu University, Turkey Introduction Physiological performance tests offer some insight into the factors contributing to success and to describe how physiological and technical performance evolves in young track and field athletes. The purpose of this study was to determine the differences in physiological performance test results related to ages in young track and field athletes. Methods Nineteen young female athletes (15-16 age group; height: 165.03±5.73cm, body weight: 55.85±9.04kg, 17-18 age group; height: 163.65±5.71cm, body weight: 54.18±5.98kg), and twenty-two young male athletes (15-16 age group; height: 172.95±8.18cm, body weight: 56.73±8.97kg, 17-18 age group; height: 176.15±5.15cm, body weight: 59.47±4.89kg) were volunteered to participate the study. Sit and reach test, squat jump, counter movement jump, standing long jump, medicine ball throw, 20m shuttle run test, 10m, 20m, 30m, and 40m sprint tests were performed. Unpaired sample t test was used to analyze the differences in two age groups (15-16 year and 17-18 year) both female young athletes and male young athletes. Results There were statistical significant differences in sit and reach test, squat jump, counter-movement jump, horizontal jump, and medicine ball throw in two young female athlete groups ( $p < .05$ ). There was a statistical significant difference in medicine ball throw between two young male athlete groups ( $p < .05$ ). Discussion In conclusion, there were more significant differences between 15-16 ages and 17-18 ages in young female athletes than young male athletes. References Bangsbo, J., Mohr, M., Poulsen, A., Perez-Gomez, J., Krstrup, P. (2006), *J Exerc Sci Fit*, 4 (1), 1-14. Mero, A., Kauhanen, H., Peltola, E., Vuorimaa, T., Komi, P.V. (1990), *J Sports Med Phys Fitness*, 30:57-66.

### EFFECTS OF A REPEATED SPRINT ABILITY TRAINING PERIOD ON CARDIO-RESPIRATORY FITNESS IN ADOLESCENT TENNIS PLAYERS

Moya, M.1, Sarabia, J.M.1, Guillén, S.1, Fernández-Blasco, M.J.1, Aracil, A.1, Torres-Luque, G.2

1.- *Research Group on Healthy Physical Conditioning, Centro de Investigación del Deporte, Universidad Miguel Hernández de Elche, Spain*  
2.- *UJAEN (Universidad de Jaén, Spain)*

Introduction Repeated and brief explosive movements separated by short recovery periods are very common during a tennis match. Consequently, training this intervallic form of exercise should be considered when designing tennis training schedules. Therefore, the present study was carried out in order to exclude any detrimental effect of the addition of a repeated sprint ability (RSA) training period on cardio-respiratory fitness adaptations in young tennis players. Methods Twenty-two male tennis players (age: 14±1,3 years) were included after parental informed consent. All of the subjects followed a similar training schedule before starting the study. For the study, subjects were divided in three training groups: a) a control group (C; n=6) that continued the previous training schedule; b) a first experimental group (E1; n=7) that continued the previous training schedule, and in addition performed one RSA training session per week; and c) a second experimental group (E2; n=9), similar to E1, but that performed two RSA training sessions per week. The intervention period lasted six weeks. Before and after the intervention period the subjects were subjected to a maximal stress test on a treadmill with continuous monitoring of the cardio-respiratory function. Mean  $\dot{V}O_{2max}$ , HR<sub>max</sub>, HR and  $\dot{V}O_2$  at VT1 and VT2 were compared among the three groups as well as intra-group before and after the intervention period. The statistical analysis was performed in a simple masked fashion. Results The three groups were comparable in age and in general anthropometric measurements. No statistical differences were found in the  $\dot{V}O_{2max}$  among the groups neither before (C=48,5±1,5; E1=50,04±3,3; E2=52,2±1,1 mL/Kg/min; ANOVA) and after the intervention (C=49,9±1,4; E1=51,9±1,7; E2=53±1,6 mL/Kg/min; ANOVA). Similarly, no differences were noted among the groups in the  $\dot{V}O_2$  and HR at both VT, as well as in HR<sub>max</sub> before the intervention. After the intervention: a)  $\dot{V}O_2$  and HR at VT1 were significantly higher in group E1, in comparison with C but not with E2 ( $p < 0,05$ , ANOVA); and b) HR at VT1 was significantly higher in E1 in comparison with the other groups ( $p < 0,05$ , ANOVA). No statistical differences were noted among the groups in the other variables. Discussion Our results support the idea that adding up to two sessions per week of RSA training to the regular training schedule during six weeks does not interfere with the cardio-respiratory fitness adaptation in adolescent male tennis players.

### THE EFFECTS OF ROPE JUMP TRAINING ON SPRINT, AGILITY, JUMP AND BALANCE TESTS IN YOUNG BASKETBALL PLAYERS

Boccolini, G., Costa, N., Alberti, G.

*UNIVERSITÀ DEGLI STUDI DI MILANO, ITALY*

INTRODUCTION Rope jumping has been a major training tool for many sports like boxing and tennis. In recent years, it has also been a favourite training tool for basketball players in addition to many other training options. Studies in the literature have demonstrated that the rope jump training is a valid training method for volleyball players [1], and that weighted rope jumping is a viable alternative to high impact plyometric exercises [2]. The aim of this study is to evaluate the effects of rope jump training on sprint, agility, jump and balance tests in young basketball players. METHODS The study was conducted on 28 amateur basketball players of two different team. The players were randomly divided into two groups: Rope Group (RG; n=14; 14.0±0.0 yr; height 169.6±11.1; weight 59.1±11.3) and Control Group (CG; n=14; 14.0±0.0 yr; height 164.1±8.3; weight 52.0±10.0). In this way, and (19.1±4.8 yr; height 176.8±5.8; weight 69.6±7.8). RG received a technical training program and in addition a rope jump training twenty minutes per session, three times a week, for four weeks. Rope training consisted always in jumps forwards. The control group followed only a technical training program for the same duration. Before and after four weeks, sprint test on 10m (SpT), lane agility drill test (LADT), stiffness test (StT), counter movement jumps test (CMJ) and balance test (BaT) have been performed. CMJ and BaT have been performed on one and two legs. All subjects performed 3 trials for each tests. The data were analyzed using paired T-test using SPSS software v. 17 (SPSS Inc, Chicago, IL). The significant level was set up to  $p < .05$ . RESULTS Following rope jump training, the RG obtained significant improvement in SpT ( $p < .001$ ), LADT ( $p < .001$ ), StT ( $p < .001$ ), CMJ with right leg ( $p < .05$ ) and BaT ( $p < .05$ ) for 3.76%, 3.07%, 6.29%, 7.24% and 13.37% respectively. Regarding the CG, there were no signifi-

cant increases in any of the variables analyzed. **DISCUSSION** These findings indicate that rope jump training is a valid method to improve the sprint capacity on 10m, the agility test, the stiffness and balance ability with two legs. We suggest to use rope jump training during warm-up and also strength and coordinative trainings. **REFERENCES** [1]Duzgun I et al. The effects of jump-rope training on shoulder isokinetic strength in adolescent volleyball players. *J Sport Rehab* 19:184-199, 2010. [2]Masterson GL and Brown SP. Effects of weighted jump rope training on power performance tests in collegians. *J Strength Cond Res* 1993.

### **EFFECTS OF THE SPORT-SPECIFIC TRAINING BACKGROUND ON SEATED MEDICINE BALL THROW IN YOUNG BASKETBALL AND VOLLEYBALL PLAYERS**

Battaglia, G.1,2, Bellafiore, M.1,2, Caramazza, G.2,3, Palma, A.1,2

*School of Sports Science, University of Palermo*

**Introduction** A sport-specific training background (SSTB) based on the nature of sport might affect explosive power of upper limbs in athletes (Izquierdo et al., 2002). However, there have been no attempts to study this in young female players from different ball games background. Therefore, the purpose of this study was to evaluate the effects of sport-specific training background on explosive power of upper limbs in basketball [BP] and volleyball players [VP]. **Methods** In the present study, thirty one short-limbed girls (Scelic Index  $\geq 54.6$ ) of which 11 age-matched control sedentary subjects [SS] (age: 15.00 $\pm$ 0.52 years, BMI: 21.10 $\pm$ 2.09, SI: 55.45 $\pm$ 1.45, sedentary life: 3 years); 10 basketballers (age: 15.60 $\pm$ 1.34 years, BMI: 22.67 $\pm$ 3.13, SI: 54.70 $\pm$ 1.37, SSTB: 3 years) and 10 volleyballers (age: 14.50 $\pm$ 0.97 years, BMI: 22.17 $\pm$ 1.87, SI: 55.29 $\pm$ 2.12, SSTB: 3 years), performed seated backward overhead ball throw (SBOBT) and seated chest pass throw (SCPT) using a 3-kg rubber medicine ball. All tests were performed for three times but only the best performance was considered. All data were compared using non-parametric test of Kruskal-Wallis and statistical significance was determined using a probability level of  $P < 0.05$ . **Results** Players showed higher performances than sedentary subjects in SBOBT and SCPT. However, we found only a significant difference ( $P < 0.05$ ) in the comparison between BP and SS during SCPT; instead, in SBOBT test, basketballers' performance was lower than volleyballers' one ( $P > 0.05$ ). **Discussion** These results showed that sport-specific training backgrounds affect the seated medicine ball throw performance. Indeed, basketball training background appears to affect much more the explosive power of upper limbs than volleyball training background in SCPT. For these reasons, in agreement with Izquierdo M et al. (2002) we suggest that the magnitude of the sport-related differences in explosive power output by upper limbs may be explained by sport-specific neuromuscular adaptations. **Reference:** Izquierdo M, Häkkinen K, Gonzalez-Badillo JJ, Ibañez J, Gorostiaga EM. (2002). *Eur J Appl Physiol*, 87(3), 264-71.

**14:45 - 15:45**

## **Poster presentations**

### **PP-PM57 Training & Testing 12**

#### **SEASONAL VARIATION IN ANTHROPOMETRIC AND PERFORMANCE CHARACTERISTICS OF ELITE HURLING PLAYERS**

Collins, D.K.1, Morton, J.P.2, Reilly, T.P.2, Doran, D.A.2

*ITT Dublin (Ireland) 1, LJMU (UK) 2*

**Introduction** The seasonal change in anthropometric and performance characteristics is well documented in many team sports though no data are available on elite hurlers. The information may be useful in identifying effectiveness of training regimen. Therefore the aim of the current study was to examine the seasonal variation of anthropometric and performance characteristics of elite hurling players. **Methods** Twenty-three male competitive hurlers (age 23  $\pm$  3 yrs; height 183.5  $\pm$  6 cm) underwent anthropometric and performance assessment on three separate occasions during the competitive season (January; March; June). The anthropometric variables of body mass, sum of 5 skinfolds ( $\Sigma$ SKF) (Reilly, Maughan and Hardy, 1996) and body-fat percentage (BF%) (Durnin and Womersley, 1974) were determined. The performance measures of broad jump, countermovement jump (CMJ), linear sprint speed over 5, 10, and 20 m; and estimated VO<sub>2</sub>max were determined. A one-way ANOVA with a Tukey post-hoc test was used to identify significant change. **Results** The anthropometric variables of body mass (83.4  $\pm$  9.5; 81.7  $\pm$  8.4; 81.1  $\pm$  8 kg),  $\Sigma$ SKF (43  $\pm$  10; 39  $\pm$  6; 39  $\pm$  6 mm) and BF% (12.9  $\pm$  2.9; 12.2  $\pm$  2; 12.4  $\pm$  2.1 %) showed little seasonal change. Significant seasonal change were evident in broad jump (2.3  $\pm$  .3; 2.4  $\pm$  .2; 2.5  $\pm$  2 m) ( $p = .006$ ) and sprint speed over 5- (1.06  $\pm$  .03; .99  $\pm$  .04; .99  $\pm$  0.4 sec) ( $p < .01$ ), 10- (1.84  $\pm$  .05; 1.78  $\pm$  .04; 1.78  $\pm$  .04 sec) ( $p < .01$ ) and 20-m (3.16  $\pm$  .08; 3.03  $\pm$  .06; 3.04  $\pm$  .07 sec) ( $p < .01$ ) from January to March. The performance measures of CMJ (43.6  $\pm$  5.6; 45.7  $\pm$  6.3; 47.3  $\pm$  6.3 cm) and estimated VO<sub>2</sub>max (53.1  $\pm$  3.5; 54.3  $\pm$  3.1; 54.8  $\pm$  2.7 mL.kg<sup>-1</sup>.min<sup>-1</sup>) showed little seasonal variation. **Discussion** Anthropometric characteristics show little change over the course of the season. The broad jump and sprint speed performance improved significantly from January to March (pre-season). As a measure of seasonal adaptation to training, estimated VO<sub>2</sub>max seems to lack the required sensitivity for elite hurlers. Future research should consider if the YOYO test is sensitive to seasonal adaptation to training within a hurling population. **References** Durnin, J., Womersley, J. (1974) *Br J Nutr*, 32, 77-97. Reilly, T., Maughan, R, Hardy, L. (1996) *Sports Exerc Inj*, 2, 46-49.

#### **EFFECTS OF RHYTHMICAL AND EXTRA RHYTHMICAL MUSICAL QUALITIES ON SPINNING PERFORMANCE**

Iuliano, E., Aquino, G., Moffa, S., Fiorilli, G., Giombini, A., Di Cagno, A., Calcagno, G.

*University of Molise*

**Motivational music benefit** has been found to improve sport performance. The aim of the present study was to evaluate ergogenic effects of rhythmical and extra-rhythmical qualities of the music on Spinning performance. **Methods** Twenty health adults, 8 males and 12 females, aged 25.70  $\pm$  3.97, volunteered this study and performed three 50 min-spinning sessions, under each of the three conditions: LOW-BPM music tracks, with a tempo in the range 120-150 BPM, HI-BPM music tracks with a tempo in the range 150-180, and RHYTHMICAL BASE, using only bass and drums, without melody, with a tempo in the range 150-180 BPM. Heart Rate (HR) and fatigue rate perception were monitored during the tests (Lopez-Minarro and Muyor Rodriguez, 2010). **Results** MANOVA revealed a significant difference for the parameter 'time to 75% MTHR' (time taken to reach the 75% of the Maximum Theoretical HR) ( $F_{3,20} = 3,811$ ;  $P < 0,05$ ). Post hoc analysis

showed that the 'time to 75% MTHR' in LOW-BPM session, was significantly longer than in the HI-BPM and RHYTHMICAL BASE sessions ( $p < 0,05$ ), while no significant differences were found between HI-BPM vs. RHYTHMICAL BASE sessions. After reaching the 75% MTHR, in the RHYTHMICAL BASE session, the HR showed a trend of reduction, not founded on the LOW-BPM and HI-BPM sessions. Discussions The BPM of music influenced the HR, such as a 'pacemaking' effect (Karageorghis et al., 2007), more in the first phase of Spinning performance (start of session - reaching of 75% of the MTHR), than in the second one (reaching of 75% of the MTHR - end of session) (Karageorghis et al., 2010). In the second phase, the extra rhythmical effect of the music, as melody, influenced the spinning performance, probably increasing the participant ability to sustain the effort. References Karageorghis C.I., Priest D.L., Williams L.S., R.M. Hirani, Lannon K.M., B.J. Bates. *Psychology of Sport and exercise* 11(2010) 551-559 López - Minarro P.A., Muyor Rodriguez J. M. *Science sports* (2010) 25, 238-224 Karageorghis C.I., Jones L., Low D.C. *Research Quarterly for Exercise and Sport* (2007) 77,2, pp.240-250

### THE INCIDENCE OF RULE CHANGES ON PHYSIOLOGICAL CHARACTERISTICS OF MALE AND FEMALE CANOE SLALOM PADDLERS: A 14-YEAR LONGITUDINAL STUDY.

Tremblay, J.1, Cormery, B.2,3, Frechengues, E.2, Paillard, T.2, Marcil, M.M.3, Bouvard, M.3

1:Université de Montréal, 2:Université de Pau, 3:Hôpital de Pau

**Introduction** The sport of competitive canoe slalom has greatly evolved within the last fifteen years and this brought changes in the physiological demands placed on the paddler. A reduction in boat length (4.0 to 3.5 m), race duration (~30%) and a greater number of events to reach the finals in international competition are some of the significant changes introduced after the 2000 Olympics that might have altered the athlete's training in order to prepare for competition. **Methods** A total of 31 men and 22 women were studied, all were elite french canoe slalom paddlers (125 and 56 maximal tests completed, respectively). The human ethics committee of Pau's hospital approved all procedures. All maximal tests were conducted on a calibrated ergometer adapted for seated arm cranking. Maximal oxygen consumption ( $VO_{2max}$ ) was measured using an automated gas analysis system during an incremental test to volitional exhaustion. Ventilatory threshold (VT) and respiratory compensation point (RCP) were also determined. A 6s all-out force-velocity test was used to measure maximal power ( $P_{max}$ ) for the upper limbs (Vandewalle, 1987). Statistical analyses (ANOVA) were carried out to determine the interaction between the gender and the effect of the change in rules (since 2000) on the physiological characteristics of the paddlers ( $p < 0.05$ ). **Results** Significant main effects of "before" vs. "after" rule changes were found for maximal and submaximal  $O_2$  consumption in men, which increased by 9.9% at VT ( $32.5 \pm 0.8$  to  $36.1 \pm 0.8$  mL.min<sup>-1</sup>.kg<sup>-1</sup>), 11.1% at RCP ( $39.2 \pm 0.7$  to  $44.1 \pm 0.7$  mL.min<sup>-1</sup>.kg<sup>-1</sup>) and 7.6% at  $VO_{2max}$  ( $48.4 \pm 0.7$  to  $52.4 \pm 1.1$  mL.min<sup>-1</sup>.kg<sup>-1</sup>). Changes in women were only found at VT ( $25.9 \pm 1.3$  to  $28.3 \pm 1.6$  mL.min<sup>-1</sup>.kg<sup>-1</sup>, 8.4%). Maximum power in the force-velocity test remained stable between the two periods for both men and women ( $1152.1 \pm 20.9$  and  $563 \pm 21.9$  W, respectively). **Discussion** While force-velocity characteristics stayed constant during the last decade, the changes in boat length, competition rules and race duration since 2000 might have contributed to a modification of the physiological profile of paddlers, by generally increasing their level of fitness. It is well accepted that an increase in the volume of high-intensity training, even for short repeated bouts of a few seconds, can significantly improve fitness level (Gibala, 2008). In the present study, results might be indicative of an improvement in the general conditioning of athletes allowing them to support a greater training volume at a higher quality. References Gibala, M. J., & McGee, S. L. (2008). Metabolic adaptations to short-term high-intensity interval training: a little pain for a lot of gain? *Exercise and sport sciences reviews*, 36(2), 58–63. Vandewalle, H., Peres, G., and H. Monod (1987). Standard anaerobic exercise tests. *Sports Med*, 4(4), 268-89.

### RESPONSE TIMING AND MUSCULAR COORDINATION IN FENCING: A COMPARISON OF ELITE AND NOVICE FEMALE EGYPTIAN FENCERS

Aboalmaty, H., Alreni, A.

Tanta University

**Introduction** Although the coordination and control of fencing lunge were investigated in many Egyptian reports, numerous of fundamental questions concerning response organisation and accuracy still unanswered. Therefore, this study was undertaken. The effects of choice on response timing, the differentiation of levels of skill, the effects of different lengths of lunge and the nature of neuromuscular coordination of elite and novice female Egyptian fencers were the main concern of this study. **Methods** Three recent female Egyptian champions formed the elite group. They were ranged in age between 20 to 24 years with at least 5 years of high level of active training and competition. The three novice subjects were in their second year of active training and competition at the Muslim Youth Club team in Tanta (Egypt). They ranged in age between 17 to 21 years. Statistical procedures included ANOVA (program DMPD 4F), chi-square and Pearson product-moment correlation were used. The accuracy of elite and novice subjects was examined in three levels of target choice (single, two, and four targets) with three variations of movements distance (short, medium and long lunge). In addition, electromyographic activity (EMG) of selected upper and lower limb muscles was used to compare the two groups. **Results** The elite subjects reported higher level of accuracy; also they were faster for reaction time and total response time. The hypothesis that increasing choice would cause increases in reaction time was not upheld, except for some differentiation between the short and the two longer distances. The effects of distance movement were not marked. Qualitative and quantitative analysis of EMG revealed the high consistency of response patterns within subjects and highlighted the synergistic roles of selected muscles in distinguishing between elite and novice fencers. **Discussion** The findings of this study confirm that differences in the technical skill of fencers can be distinguished in the laboratory through a combination of response timing measures in association with measures of muscle action. They also draw attention to practical implication for individual skill assessment and training. Analysis of pre-movement muscle activity provided moderate support for the hypothesis that it was part of a single control process and indicates that a dual process can involve both the maintenance of postural stability and the generation of movement. It is also suggested that different movement contexts can lead to different levels of coordination between the system controlling posture and that controlling movement. References Ahmed M. (1992), Effect of A Proposed Training Programme For Developing Speed of Motor Response of Fencers, H.U. Egypt. Dsouky M. (1995), Relationship Between The Speed of Motor Response and Performance Level of Fencers, Z. U. Egypt. Galal A. (2005). Accuracy, Book Centre of Publication, Cairo, Egypt. Salah S. (1995), Effect of Using Static and Dynamic Targets of Accuracy in Fencing, T. U. Egypt.

## DETERMINATION OF CLIMBING SPECIFIC MAXIMAL OXYGEN UPTAKE DURING CLIMBING WITH INCREASING INCLINATION AND CONSTANT SPEED

Balas, J., Panackova, M., Strejčova, B., Kalab, M., Kodejska, J.

*Faculty of Physical Education and Sport*

**Aim** The aim of the study was to determine climbing specific maximal oxygen consumption (VO<sub>2</sub> max) during climbing with increasing inclination and constant speed. **Methods** Twenty six climbers volunteered to perform the climbing test on an incline wall and running test on a treadmill until exhaustion. The climbing test started with submaximal climbing on a known climbing circuit at 90° and 105° (15° overhang) and speed 25 movements•min<sup>-1</sup>. Rest of 4 minutes followed before the maximal test on the second climbing circuit. The less advanced climbers started with 95° (more advanced 105°) and after every 3 minutes, the wall was inclined by 10°. The test finished by the fall of the climber. Respiratory analysis was undertaken during the whole test. **Results** The VO<sub>2</sub> and heart rate (HR) significantly correlated with climbing ability during the submaximal test at 90° (VO<sub>2</sub>,  $r = -0.82$ ; HR,  $r = -0.66$ ) and at 105° (VO<sub>2</sub>,  $r = -0.84$ ; HR,  $r = -0.78$ ). The attained inclination at the moment of exhaustion was the strongest predictor ( $r = 0.89$ ) of climbing performance. There was a plateau of climbing specific VO<sub>2</sub> with mean  $40.3 \pm 3.5 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$  (68 % for the running test) independent of climbing ability. Maximal ventilation was  $74.9 \pm 4.9 \text{ l} \cdot \text{min}^{-1}$  (54% for the running test). **Discussion** Climbers with higher climbing ability demonstrated lower VO<sub>2</sub> and HR during easy climbing and, therefore, greater economy of movement. The maximal VO<sub>2</sub> during climbing corresponded to the peak values of de Geus et al. (2006) during top-rope climbing and bouldering at self-selected speed and near-maximal difficulty ( $41.3 \pm 4.9 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ). However, Magalhaes et al. (2007) stated peak oxygen uptake during self-paced lead climbing of near-maximal route at only  $33.4 \pm 2.1 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ . The discrepancy might be explained by the lower speed during lead climbing. The role of speed on oxygen uptake was stated by Booth et al. (1999) who used increasing speed, instead of inclination, on a motorized climbing treadmill to determine VO<sub>2</sub> max. The climbers achieved values of  $43.8 \pm 2.2 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ , slightly higher than our study. Lower speeds and overhanging climbing involve considerable static contractions of the upper limb which can deteriorate the pulmonary ventilation and therefore, transport of oxygen. It seems that the climbing test with increasing inclination until exhaustion is suitable for controlled training status, but maximal specific oxygen uptake may not be achieved. **References** Booth J, Marino F, Hill C, Gwinn T (1999). *BJSM*, 33, 14-18. Geus Bd, O'Driscoll SV, Meeusen R (2006). *Eur J of Appl Physiol*, 98, 489-496. Magalhaes J, Ferreira R, Marques F, Olivera E, Soares J, Ascensao A (2007). *Med Sci Sports Exerc*, 39 (6), 955-963.

## ANALYSIS OF CARDIO-RESPIRATORY AND METABOLIC VARIABLES MEASURED DURING LABORATORIAL AND SPORT-SPECIFIC INCREMENTAL TESTS FOR TABLE TENNIS PERFORMANCE PREDICTION

Papoti, M.2, Dos Reis, I.G.M.3, Gobatto, C.A.3

*1: UFMS (Campo Grande, Brazil), 2: UNESP (Presidente Prudente, Brazil), 3: Unicamp (Limeira, Brazil)*

**Introduction** The aerobic energy system is very important in table tennis performance. It enables generation of repeated powerful strokes, rapid on-court movements, and ensures fast recovery for the next effort during the match (Lees, 2003; Zagatto et al, 2010). However, the procedures used to estimate aerobic aptitude for table tennis are not well documented in literature. The purposes of this study were: i) to compare physiological responses measured during a specific table tennis incremental test with physiological responses measured during cycling, arm crank, and treadmill running tests; and ii) to verify the accuracy of table tennis performance prediction based on the physiological responses from these tests. **Methods** Eleven national level male table tennis players participated in the study performing four graded exercise tests (GXTs): cycle ergometer, arm ergometer, treadmill, and specific table tennis exercise. Oxygen uptake (VO<sub>2</sub>), heart rate (HR), blood lactate concentration ([La]) and rate of perceived effort (RPE) were measured in all GXTs. Parameters were estimated at peak intensity and respiratory compensation point intensity (RCP). Table tennis performance was defined as the ranking position obtained during a simulated tournament between participants. **Results** VO<sub>2</sub> peak during specific table tennis test ( $39.9 \pm 1.5 \text{ ml/kg/min}$ ) was similar to cycling ( $41.2 \pm 1.4 \text{ ml/kg/min}$ ), but statistically lower than treadmill ( $43.9 \pm 1.5 \text{ ml/kg/min}$ ) and higher than arm crank ( $26.6 \pm 1.5 \text{ ml/kg/min}$ ). At RCP intensity, [La] ( $2.8 \pm 0.4 \text{ mM}$ ,  $4.6 \pm 0.5 \text{ mM}$ ,  $3.9 \pm 0.3 \text{ mM}$  and  $3.7 \pm 0.4 \text{ mM}$ , respectively) and RPE ( $13.3 \pm 1.1$ ,  $15.1 \pm 0.7$ ,  $14.4 \pm 0.8$  and  $14.5 \pm 1.0$ , respectively) were not statistically different between ergometers; however, arm crank VO<sub>2</sub> and HR at RCP ( $18.0 \pm 1.1 \text{ ml/kg/min}$  and  $130.7 \pm 3.1 \text{ bpm}$ ) were lower ( $p < 0.05$ ) than the other ergometers ( $35.2 \pm 2.2 \text{ ml/kg/min}$  and  $180.8 \pm 5.7 \text{ bpm}$  from specific table tennis;  $33.8 \pm 1.5 \text{ ml/kg/min}$  and  $169.3 \pm 3.7 \text{ bpm}$  cycle ergometer; and  $37.7 \pm 1.7 \text{ ml/kg/min}$  and  $178.9 \pm 5.0 \text{ bpm}$  treadmill). Stepwise multiple regression analysis revealed significant correlation between table tennis performance (TTP) and [La] at RCP and RPE at RCP during cycling ( $r = 0.89$ ,  $p < 0.05$ ); the prediction equation is described below.  $\text{TTP} = (-2.139 \times [\text{La}] \text{ at RCP}) + (0.675 \times \text{RPE at RCP}) + 5.492$  **Conclusion** The significant differences between the specific and laboratory ergometers highlighted the need for a specific test to measure physiological parameters in table tennis, whereas both RPE and [La] at RCP measured during cycling showed good correlations with table tennis performance. **References** Lees A. (2003). Science and the major racket sports: a review. *J Sports Sci*, 21(9), 707-732. Zagatto AM, Morel EA, Gobatto CA. (2010). Physiological responses and characteristics of table tennis match determined in official tournaments. *J Strength Cond Res*, 24(4), 942-949.

## EFFECT OF EQUITATION ON BODY COMPOSITION AND CARDIORESPIRATORY FITNESS OF HORSEBACK RIDERS.

Faludi, J., Virág, A., Komka, Zs., Trájer, E., Bosnyák, E., Udvardi, A., Zsidegh, M., Tóth, M.

*Semmelweis University*

**Background** Limited information exists on analyzing equitation as a training strategy to develop the fitness level of young and adult equestrians. In fact, horses' performance referred to as a crucial determinant of competitive performance in all equestrian disciplines. It is therefore rare in the horse riding disciplines to analyse body constitution and conditional capabilities of riders. The aim of the study was to quantify the effects of regular equitation training programs on body dimensions and cardiorespiratory fitness of young and adult equestrians. **Methods** Fourteen young female horseback riders of olympic disciplines (vaulting, dressage and jumping), 12 horseback archers and 20 jockeys were observed. They took part in the investigation on a voluntary basis. For estimation of body composition, percentages of bone, muscle, fat and residual was applied. All of methods were accepted by the International Biological Program. (Weiner and Lourie 1969) Conventional cardiorespiratory parameters were measured while running on a treadmill applying all out testing protocol. Data of VO<sub>2</sub>max, VE, O<sub>2</sub>P and physical performance (duration of running and estimated power output) were applied as an estimation of aerobic fitness. Predicted values of VO<sub>2</sub>max, VE, O<sub>2</sub>P of each participant served as a control (Wasserman et al. 1994). Group differences between the measured and predicted values were analysed by independent samples t-tests. Level of significances in each case was 5%. (\* =  $p < 0.05$ ) **Results** Fat proportion of young equestrians was near to threshold of overweight ( $23.88 \pm 4.71\%$ ), while their

muscle proportion was relatively low (40,12±2,07). Data of VE, VO<sub>2</sub>max, O<sub>2</sub>P of young riders were similar to predicted values of normal population. Archers and jockeys had higher proportion of muscle mass, lower proportion of fat mass, and greater values of VE, VO<sub>2</sub>max, O<sub>2</sub>P, than predicted values of their non athletic counterparts. Conclusion In spite of the fact, that young equestrians met ACSM criteria for aerobic activity (5days/week >30 min) no significant improvement in parameters of cardio-respiratory function and body composition were found. Riding a horse is not an adequate to improve fitness for young equestrians. Riders for olympic disciplines should participate in supplemental training sessions consisting of aerobic exercises and strengthening, which also help to avoid injuries. References Weiner, J.E.S., Lourie, J.A. (Eds.) (1969): Human Biology. A Guide to Field Methods. IBP Handbook, No. 9. Oxford, Blackwell. Wasserman, K., Hansen, J.E., Sue, D.Y., Whipp, B.J., Casabury, R. (1994) : Principles of exercise testing and interpretation. Second Edition. Lippincott Williams & Wilkins, Philadelphia, USA.

### **RUNNING PERFORMANCE DURING A COMPETITIVE MATCH OF THE GERMAN NATIONAL RINK HOCKEY TEAM**

Baumgart, C., Hoppe, M.W., Freiwald, J.

*Research Center for Performance Diagnostics and Training Advice, University of Wuppertal (Germany)*

Introduction: Rink hockey is an indoor team sport played with roller skates, hockey sticks made of wood and a hard rubber ball towards two goals. The playing field has a size of 20x40 m and is surrounded by bounds. A rink hockey team consists of four field players and one goalkeeper. At the present, there is no study which assessed the running performance during rink hockey matches. The knowledge of these informations (e.g. distance and speed) can be used to design training programs and to evaluate players' performance during matches (Carling et al., 2008). Methods: Eight field players of the German national team (mean ± SD: age 24.1 ± 5.0 years, body mass index 24.3 ± 1.8 kg/m<sup>2</sup>) were analysed during a 2x20 min match against the actual European Champion (Spain) with the help of a two 25 Hz video system (720x480 pixel). Each camera covered approximately one half of the field and was calibrated using the field dimensions (9 points). Players were tracked by one person manually. Running speed of the players was calculated with the coordinates given by the video system. The following parameters were analysed: total distance, mean and maximum speed as well as relative time and distance in seven speed categories (<5, <9, <13, <17, <21, <25, >25 km/h). Results: Elite rink hockey players cover a total distance between 1252-5970 m with a playing time between 469-2322 s during a competitive match. The assessed values for mean and maximum speed of all players were 9.2 ± 0.68 km/h and 29.2 ± 2.0 km/h. The relative time which was spent in each speed category was 27%, 28%, 20%, 14%, 8%, 3% and 1%. Moreover, the relative distance which was covered in the speed categories was 8%, 22%, 24%, 22%, 15%, 7% and 2%. Furthermore, the mean time which was spent in the defined speed categories ranged from 0.87-1.9 s. Discussion: The results of the present study revealed that running performance of elite rink hockey players during competitive matches is highly intermittent similar to other team sports (Carling et al., 2008; Ziv et al., 2009). Therefore, training programs should notice the assessed running performance. Also rink hockey specific performance tests can be designed on the basis of the present findings. References: Carling, C., Bloomfield, J., Nelsen, L., & Reilly, T. (2008). The role of motion analysis in elite soccer: contemporary performance measurement techniques and work rate data. *Sports Med*, 38(10), 839-862. Ziv, G., & Lidor, R. (2009). Physical characteristics, physiological attributes, and on-court performances of handball players: A review. *European Journal of Sport Science*, 9(6), 375-386.

### **THE COMPARISON OF BALANCE, REACTION TIME AND SOMATOTYPE PROFILES OF TENNIS AND BADMINTON PLAYERS**

Kılınç, H., Babayigit Irez, G., Saygın, O.

*Mugla University*

The Comparison of balance, reaction time and somatotype profiles of Tennis and Badminton players Hilal Kılınç, Gonul Babayigit Irez, Ozcan Saygın Mugla University, School of Physical Education and Sports, Mugla, Turkey Introduction In racket sports some physical fitness components are important. This can determine success level of players (Omesagaard, 1996). Badminton and tennis requires quick anticipation and response time (Mahoney and Sharp, 1995) and balance (Mantis, 1998). Methods A total of 40 university team tennis players (N=10 women, N=10 men) and badminton players (N=10 women, N=10 men) participated in this study. The Heath-Carter formula was used to determine the somatotype profile. Dynamic balance was measured by using Lafayette balance device and Nelson reaction time technique was used for measuring Reaction time. Results An independent sample of t-test was (SPSS 16 statistical package) used comparing group differences. As a result, There were no significant differences in reaction time (p>0, 05) and somatotype profiles (p>0, 05) between tennis players and badminton players although there was significant difference (p<0, 05) in dynamic balance measurements. Discussion Reaction abilities and balance (Omesagaard, 1996) seem to be valuable in racquets sports as in other sports (Mori, 2002). In this study, it was found these are important skills and when compared with each other, there was differences in their balance ability rather than reaction time. Singh and Singh, (2011) studied a comparison of somatotypes of tennis and badminton players. The Tennis players in their study were highest in their mesomorphic components while in our study can not found any significant differences although tennis players have high endomorphic components. References Omesagaard, B.(1996). Physical Training for Badminton. Denmark: Malling Beck. Mantis K, Zachopoulou E, Mavridis T. A battery of tests for evaluating abilities related to the tennis serve. *Journal of Human Movement Studies* 35: 73 - 88, 1998. Mori S, Ohtani Y, Imanaka K. Reaction times and anticipatory skills of karate athletes. *Human Movement Science* 21: 213-230, 2002. Mahoney, C.A and Sharp, N.C.C.(1995). The physiological profile of elite junior squash players. In: T.Reilly; M.Hughes and A.Lees(Eds.), *Science and Rackets Sports* (76-80). London: E and FN Spon. Singh, B.B., Singh, J.(2011). A Comparative Study on Somatotypes of North Zone Badminton and Tennis Players. *Variorum, Multi-Disciplinary e-Research Journal* Vol.-02, Issue-I, August

### **EFFECT OF SPEED OF MOVEMENT DURING CLIMBING IN FEMALE CLIMBERS**

Panackova, M., Balas, J., Strejčova, B., Kalab, M., Kodejska, J., Bunc, V., Kalabova, M.

*Charles University*

Introduction Climbing is a fast expanding sport in the recreational and performance area. Watts (2004) counts sport climbing among activities with moderate energy expenditure. The average oxygen consumption is around 20-34 ml•kg<sup>-1</sup>•min<sup>-1</sup> and maximum oxygen uptake is around 30-45 ml•kg<sup>-1</sup>•min<sup>-1</sup>. Up to now published studies were focused on men or mix population. For the assessment of adaptation to climbing, it can be used comparison with the activities, where it can expect the highest adaptation, which is run. We observed oxygen consumption given to specific activity. The aim of this study was to determine the effect of speed on VO<sub>2</sub> during climbing specific test until exhaustion. Methods Nine female climbers (aged 17-29 years) volunteered to participate in the study. Climbers were



divided according to their actual climbing performance into recreational (5/7- UIAA) and performance (7+/9- UIAA) climbers. They undertook maximal specific climbing test and maximal test on the treadmill. Climbers climbed a route in shape of ring in slightly overhanging profile (105°). They climbed 3 minutes according to their own speed. Then the speed was determined by the metronome. The starting speed was 20 movements•min<sup>-1</sup> (movement means a move of body from one hold to next hold) and increasing every 3 minutes by 5 movements until individual exhaustion. Results Relationship between the performance and the speed of climbing was the highest ( $R = -0.65$ ) at submaximal loads (30 movements•min<sup>-1</sup>). Maximal consumption ( $VO_{2peak}$ ) on the treadmill was  $55.0 \pm 0.82 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  in recreational climbers, while the performance climbers was  $VO_{2peak} 51.6 \pm 2.51 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ . Specific consumption ( $VO_{2spec.peak}$ ) was  $34.2 \pm 7.03 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  ( $62.2 \pm 12.78\%$  of running value) in recreational climbers and  $VO_{2spec.peak} 42.3 \pm 3.44 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  ( $81.4 \pm 6.67\%$ ) in performance climbers during climbing. The climbers with higher performance reached higher speed of movement ( $R = 0.94$ ). Discussion Differences of  $VO_2$  between recreational and performance climbers were the highest in 30 movements•min<sup>-1</sup>. Female climbers with high climbing performance (over 7+ UIAA) use from 80% to 90%  $VO_{2peak}$  during climbing, while climbers with low climbing performance only from 49% to 77%  $VO_{2peak}$ . We agree with Booth et al. (1999) who reached  $VO_{2spec.peak} 43.8 \pm 2.2 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  on climbing ergometer in climbing protocol with increasing speed. Climbing experience was confirmed by a higher percentage of consumption. In the current study, it was showed that speed of climbing in female climbers is determining factor in oxygen consumption. References Watts PB. (2004). *Eur J Appl Physiol*, 91(4), 361-372. Booth J, Marino F, Hill C. (1999). *Br J Sports Med*, 33, 14-18.

## TRUNK MUSCLE VOLUME AND POSTURAL STABILITY IN JAPANESE FEMALE DANCERS AND NON-DANCERS

Kuno-Mizumura, M., Yokohata, E., Yoshida, Y., Kumagawa, D., Tsunoda, N., Ikegawa, S.

*Ochanomizu University*

Introduction Stability of the trunk, often referred to as core stability, has gained attention recently. Core stability training has become major element of training programs for dancers as well as for the athletes. Several studies have indicated that better balance control in dancers than in control groups (Mouchnino et al 1992, Crottes et al 1996, Golomer et al 1997). In addition, recent studies have suggested that trunk muscle such as psoas muscles would contribute to attain better balance and mobility (Suri et al 2009, 2011). The authors hypothesized that trunk muscle attributes would be closely linked to postural stability and dancers would show high postural stability compared with the controls. So the purpose of this study was to investigate trunk muscle volume by MRI images and postural stability by COP trajectory during standing in Japanese female dancers and non-dancers. Methods Subjects were seven female dancers with ballet training more than ten years as the dance group and nine female university students as the control group. Control subjects had no experience of any dance training and no regular exercise in past three years. This study was divided into two testing. For evaluating muscle volume of the trunk, MRI images were prepared using a 1.5 T MRI scanner (TOSHIBA EXCELART Vantage). Contiguous transverse images with 1.0cm slice thickness were obtained from the seventh thoracic vertebra to the hip joint. Cross sectional area were digitized for psoas major muscle, abdominal rectus muscle, erector spinae muscle, external oblique muscle, and quadratus lumborum muscle. For evaluating postural stability, subjects stood barefoot on the force platform (Kistler) for 20 seconds in six different conditions. Results There was no significant difference in all trunk muscles between two groups. Total trajectory of COP in six different standing conditions were significantly shorter in dancers than those in controls. Significant correlations between total trajectory of COP during eye-opened two-legged standing and muscle volume of psoas major muscle and that of external oblique muscle were obtained only for dancers, while significant correlations between COP and muscle volume of abdominal rectus muscle and that of erector spinae muscle only for controls. Discussion From the results of this study, it is indicated that long-term dance training would induce stable posture, while there was no significant difference in muscle volume of the trunk. It is also speculated that trunk muscle volume might contribute to maintain stable posture.

16:05 - 17:35

## Invited symposia

### IS-PM12 Benefits of High Intensity Intermittent Training (HIIT) in Untrained and Diseased People (\*)

#### APPLICATION OF HIIT TO CLINICAL POPULATIONS AND EFFECT ON MARKERS OF DISEASE RISK

Gibala, M.

*McMaster University*

High-intensity interval training (HIT) can serve as an effective alternate to traditional endurance-based training, inducing similar or even superior physiological adaptations in healthy individuals and diseased populations, at least when compared on a matched-work basis. While less well studied, low-volume HIT can also stimulate physiological remodeling comparable to moderate-intensity continuous training despite a substantially lower time commitment and reduced total exercise volume (1). For example, as little as six sessions of HIT over 2 wk, totaling ~15 min of "all out" cycle exercise within a total training time commitment of ~2 h, increases the maximal activity of mitochondrial enzymes and improves performance during tasks that rely heavily on aerobic energy provision. These data suggest that HIT may be a potent and time-efficient strategy to induce skeletal muscle metabolic adaptations that are linked to improved health. Many low-volume HIT studies have employed relatively extreme variable-load exercise interventions (e.g., repeated Wingate Tests) that may not be safe or well tolerated by certain individuals. Recent work has shown that short-term training using a more "practical" model of HIT (e.g., 10 x 1 min repeats at ~90% maximal aerobic work capacity, interspersed by 1 min of recovery) increased muscle oxidative capacity and improved endurance performance (2). Low-volume HIT studies in persons who might be at risk for cardiometabolic disorders or patients with chronic disease are very limited. However, it was recently demonstrated that low-volume HIT was effective and well tolerated in people with type 2 diabetes (3). Two weeks of HIT reduced average 24-h blood glucose concentration and postprandial glucose excursions, measured via continuous glucose monitoring under standardized diet but otherwise free-living conditions. Given that "lack of time" is the most commonly cited barrier to regular exercise participation, it is tempting to speculate that low-volume HIT may represent a time-efficient alternative to traditional endurance training. While the preliminary evidence from small, short-term studies are intriguing, large-scale studies are clearly needed to resolve whether low-volume HIT is a realistic, time-efficient exercise alternative to improve health and reduce the risk of cardiometabolic disease. References: (1) Gibala MJ et al. *J Physiol*. 590:1077-1084, 2012; (2) Little JP et al. *J Physiol* 586:1011-1022, 2010; (3). Little JP et al. *J Appl Physiol* 111: 1554-1560, 2011.

**THE EFFECTS OF HIIT ON THE ABILITY TO OXIDIZE FAT IN HUMAN SKELETAL MUSCLE**

Spriet, L.

*University of Guelph*

It is now well established that models of high intensity intermittent training (HIIT) produce robust increases in mitochondrial volume. Mitochondrial biogenesis occurs rapidly with this training model with increased mitochondrial protein content observed after as little as 3-4 training sessions in humans. The HIIT models ask subjects to perform short bouts of exercise anywhere from ~90% VO<sub>2</sub>max for 1-4 min to all out sprints at power outputs as high as 300% of what is needed to elicit VO<sub>2</sub>max for 30 sec. These workouts are usually completed every other day. The ability to exercise at high aerobic intensities (~90% VO<sub>2</sub>max) is not surprisingly drastically improved following HIIT. Interestingly, when subjects are asked to exercise at ~60-65% of the pre-training VO<sub>2</sub>max following HIIT, the reliance on fat as a fuel is also increased. This is similar to what is seen following the classical endurance training protocols where subjects exercise for 1-2 hours/day at ~60% VO<sub>2</sub>max, 5 times a week. These results demonstrate that the HIIT exercise stress is able to activate the molecular machinery to produce the many proteins needed to increase mitochondrial volume and capacity. Numerous studies have assessed these adaptations by directly measuring either the activity and/or the protein content of enzymes and intermediates involved in the major mitochondrial pathways, including citrate synthase from the TCA cycle, cytochrome IV from the electron transport chain, beta-hydroxyacyl dehydrogenase from the beta-oxidation pathway, enzymes of the electron transport shuttle into the mitochondria, and pyruvate dehydrogenase or regulatory elements of this complex. An impressive aspect of these adaptations is how rapid they occur where increases have been shown after as little as 3 HIIT workouts. HIIT also increased the amount of mitochondrial and plasma membrane fat transport proteins in human skeletal muscle. Hormone sensitive lipase activity was increased by 13% and the use of intramuscular triacylglycerol was increased by 35% during 1 hour of submaximal exercise, but these changes were not significant. The important conclusion seems to be that the high intensity exercise bouts during HIIT maximally or near-maximally activate the aerobic system at the onset of exercise and also the various molecular signals that lead to increased production of mitochondrial fat-metabolizing proteins. This leads to rapid upregulation of the pathways that metabolize fat resulting in an increase in the capacity to oxidize fat during submaximal exercise following HIIT.

**MOLECULAR MECHANISMS UNDERPINNING RAPID MITOCHONDRIAL ADAPTATIONS TO HIIT**

Perry, C.G.R.

*University of Guelph, Guelph, Ontario*

Contraction signals a plethora of genomic events designed to increase the efficiency by which muscle responds to future energetic challenges. Central to this improved metabolic regulation is an increase in mitochondrial content described by Holloszy 45 years ago. This mitochondrial biogenesis is linked to lower substrate phosphorylation, carbohydrate sparing and increased fat oxidation, all of which contribute to improved endurance performance. Furthermore, Dudley et al demonstrated in the 1980's that the rate and magnitude of mitochondrial protein accumulation during training is proportional to the training intensity. Multiple breakthroughs were then made ~15-20 years ago establishing nuclear genomic expression as the critical link between contraction and improvements in glucose uptake which later led to similar nuclear/mitochondrial genomic links for exercise-induced mitochondrial biogenesis. Initial explorations into contraction/exercise-induced gene expression by Neuffer, Wasserman and others were followed by an explosion in research into the regulation of contraction-induced gene expression by transcription factors and co-activators. Most notably, the discovery of the PPAR, NRF, and PGC1 family of transcriptional regulators (and others) drastically improved our understanding throughout the last ~15 years of exercise-induced transcriptional regulation of mitochondrial biogenesis. In the past ~5 years, these same questions have been applied to HIIT in human muscle. We now possess a detailed understanding that the fast increases in mitochondrial content in human muscle during HIIT are likely mediated by multiple transcriptional regulators. Several groups have demonstrated that HIIT activates a variety of signaling cascades sensing specific signals generated during exercise which then activate transcription factors (PPARs, NRFs, etc) that are likely co-ordinated by co-activators (eg. PGC1s). These transcriptional regulators also increase in content at a rapid rate which precedes increases in mitochondrial proteins. This process requires repeated exercise sessions in order to accumulate sufficient genomic messages (mRNA) to drive translation of mitochondrial proteins at a level that sustains a greater mitochondrial content. Future studies should examine if the balance between net transcriptional repression (RIP140, etc) and activation (PGC1 regulators, etc) determines 1) the rate of mitochondrial biogenesis and 2) the onset of plateaus in protein content and performance improvements during training, with no single factor being essential but rather all cooperating to maximize the rate of adaptation. It is now clear that HIIT invokes rapid improvements in muscle energy homeostasis via a coordinated expression of multiple transcriptional programs controlling substrate uptake and catabolism. These molecular responses underscore the impressive efficacy of HIIT as a tool to stimulate robust increases in endurance performance and metabolic health in humans.

**16:05 - 17:35****Oral presentations****OP-SH07 Sport Psychology 3****ASSESSING MOOD STATE, STRESS AND RECOVERY IN ENDURANCE RUNNERS WEARING COMPRESSION SOCKS**

Welman, K., Venter, R., Terblanche, E.

*Stellenbosch University*

Introduction Adequate training and recovery are both important factors to enhance endurance performance and to avoid overtraining. Recovery and stress are also dynamic in nature and sport specific (Nicolas et al., 2011). A recent survey reported that compression garments are the most popular recovery intervention amongst endurance athletes (Nusser & Senner, 2010). Still limited scientific evidence support these anecdotal claims. This study set out to investigate distance runners' perception of stress and recovery following an ultramarathon race while wearing compression socks. Methods Psychological states were assessed in 40 runners (42±8years) before and for 72 hours after a 56km race. Participants were men who participated in regular endurance races over the past 3 years. Runners were

randomly divided in either an experimental group (CS), wearing knee-high compression socks (20–30mmHg), or a control group (C) wearing knee-high sport socks (<5mmHg). Runners completed the Recovery-Stress-Questionnaire for Athletes (RESTQ-Sport) twice, Stel-lenbosch Mood Scale (STEMS) five times and five muscle damage and energy level questionnaires. To quantify muscle damage myoglobin (Mgb) was assessed. Results The CS ran 13 minutes faster than the C ( $P>0.05$ ;  $ES=0.32$ ). Results revealed significant changes in all variables in both the C and CS after the race, which recovered in both groups by 72 hours. The CS demonstrated less anger at 24 hours after the race ( $P=0.01$ ;  $ES=0.58$ ). C were more confident when wearing the control sock compared to the CS ( $P=0.06$ ), specifically directly after the race ( $P=0.04$ ;  $ES=0.49$ ). CS reported 25% and 75% less fatigue directly ( $P=0.03$ ;  $ES=0.44$ ) and 48 hours after the race ( $P=0.03$ ;  $ES=0.61$ ). Runners wearing control socks stated to have less energy on average compared to the CS ( $P=0.03$ ). C perceived 37% more total stress at 72 hours after the race compared to CS ( $P=0.05$ ;  $ES=1.97$ ). Even though Mgb was 46% more reduced directly after the race compared to C ( $P=0.04$ ;  $ES=0.67$ ), the CS did not perceive a faster recovery rate. Discussion The results suggest that an ultra-endurance race induces perceived stress and leads to subsequent changes in perceived recovery. In addition, CS seems to contribute to an improved perception in fatigue, energy levels and reduces stress, but not necessarily improved perception of recovery and confidence. Conclusions This investigation added to our knowledge of the use of compression socks as a recovery technique, which may form part of a balanced training program for optimal performance. In addition, the results give us insight to the psychological challenges of a demanding distance running event. References Nicolas M, Banizette M, Millet GY (2011). *Psychol of Sport and Exerc*, 12(4), 368–374 Nusser M, Senner V (2010). *Procedia Engineering*, 2(2), 2845-2850.

### **‘YES, WE CAN!’: PERCEPTIONS OF COLLECTIVE EFFICACY SOURCES IN VOLLEYBALL**

Fransen, K., Vanbeselaere, N., Exadaktylos, V., Vande Broek, G., De Cuyper, B., Berckmans, D., Ceux, T., De Backer, M., Boen, F.

*KU Leuven (University of Leuven)*

Introduction ‘We have to believe that we can make it as a team!’ Coaches, players and other sport enthusiasts routinely talk about the importance of team confidence. Psychologists refer to this concept as collective efficacy, defined as ‘a group’s shared confidence that they will successfully achieve their goal’. Previous research findings revealed that teams with a strong sense of collective efficacy set more challenging goals, exert more effort, and are ultimately more likely to succeed. Nevertheless, little is known about the sources contributing to the development of collective efficacy. Therefore, in this study we examined which behaviours and events are perceived as sources of collective efficacy beliefs in volleyball. Study 1 In Study 1, volleyball coaches from the highest volleyball leagues ( $n=33$ ) in Belgium indicated the most important sources of collective efficacy. This list was then adapted based on the literature and on feedback given by an expert focus group, resulting in a 40-item questionnaire. Study 2 In Study 2, coaches and players from all levels of volleyball in Belgium ( $n=2,365$ ) rated each of these sources on their predictive value for collective efficacy. A principal component analysis revealed that the 40 sources could be divided into eight internally consistent components. Positive supportive communication (e.g. enthusiasm after making a point) was identified as the component most predictive for positive collective efficacy beliefs. The component referring to negative emotional reactions of players (e.g. discouraged body language) was most predictive for negative efficacy beliefs. Discussion Previous research has focused on sources of collective efficacy that take place before the game. Within that perspective, past performance was found to be the strongest source of efficacy beliefs. By contrast, in the present study, positive supportive communication, including sources during the game, was rated even more predictive for collective efficacy. Until now, collective efficacy has never been measured during the game. One of the reasons for this research lacuna is the fact that in most team sports it is not possible to interrupt a player repeatedly during a game to measure his or her collective efficacy beliefs. Observational data might provide a viable alternative for these self-report measures. It is therefore noteworthy that in the present study the sources that were most predictive for positive collective efficacy as well as those most predictive for negative collective efficacy are clearly observable behaviours during the game. These sources may thus offer a starting point for the design of a continuous measure of players’ collective efficacy beliefs through observation.

### **A COMPARISON OF FOOTBALL PLAYERS’ SPORT CONFIDENCE AND SELF-EFFICACY BELIEFS IN TURKEY**

Kocaeksi, S.2, Koruc, Z.1, Bozkurt, O.1, Arsan, N.1

*1) Hacettepe University, School of Sport Sciences and Technology, Ankara, TURKEY, 2) Anadolu University, School of Physical Education and Sport, Eskişehir, TURKEY* Introduction

Most sport psychology researchers, applied consultants, coaches, and athletes agree that confidence is an essential contributor to optimal sport performance. Research has identified confidence as a characteristic that clearly distinguishes between successful and unsuccessful athletes. Self-efficacy as defined by Bandura is an individual’s belief that she / he has the necessary skills to produce the desired outcome. Self-efficacy is considered as a situation-specific issue. Vealey applied these ideas of Bandura to the sport domain and developed sport confidence. Sport confidence is the athletes’ certainty that they have the ability to be successful in their sport (Manzo et al., 2005). The purpose of the present study was to examine the sport confidence and self-efficacy beliefs in football players participating in either super league or second league. Methods Super league ( $N=48$ ) and second league ( $N=53$ ) football players were participated in this study. Athletes completed the TSCI, SSCI, and SES. Data collection was carried out by researchers, and participant requirements and basic information about the nature of the research were explained. Data were analyzed by using descriptive statistics, Pearson Moment Correlations, MANOVA, and linear regression. Results Pearson Moment Correlation results indicated a positive significant relationship between SSCI and SES ( $r = .492, p < .05$ ), TSCI and SES ( $r = .493, p < .05$ ), and SSCI and TSCI ( $r = .766, p < .05$ ) of the Super League players. Results also revealed a non-significant relationship between SSCI and SES ( $r = .227, p > .05$ ), and a positive significant relationship was found between TSCI and SES ( $r = .271, p < .05$ ) and SSCI and TSCI ( $r = .787, p < .05$ ) of the Second League players. MANOVA analyses revealed significant differences between the Super League and Second League players’ self-efficacy beliefs ( $F(1,99) = 7.188, p = .009$ ). The linear regression results revealed that for both the Super League and Second League players, trait sport-confidence predicted state sport-confidence and self-efficacy. Discussion Positive correlations between the self-efficacy measures and positive effect. For performance, only the correlation between outcome confidence and place was statistically significant (Martin, 2002). All athletes compared themselves to someone who played at or above their level, except for college females, who sometime compare themselves to high school athletes. In general, the higher the comparison athlete, the lower the confidence score (Schultz&Short, 2006). Finally, it was revealed that the super league and second league football players were similar with regard to sport confidence, whereas, they had different self-efficacy beliefs. References Manzo, L.G., Mondin, W.G., Clark, B. & Schneider, T. (2005). *Applying Sport Psychology Four Perspectives* (p. 21-33). Champaign, IL: Human Kinetics Martin, J.J (2002). *The Sport Psychologist*, 16, 384-395 Schultz, R.M., & Short, S.E., (2006), AAASP Conference Proceedings, 82-83

## INTERRELATIONSHIPS BETWEEN TEAM COHESION, COACHING ENVIRONMENT, NEED SATISFACTION, AND WELL-BEING IN HOCKEY PLAYERS.

Merrett, C.K., Duda, J.L.

*University of Birmingham*

Interrelationships between team cohesion, coaching environment, need satisfaction, and well-being in hockey players. Introduction In their work involving basketball players and grounded in Basic Needs Theory (BNT; Deci & Ryan, 2002), Blanchard and colleagues (Blanchard, Amiot, Perrault, & Vallerand, 2009) found perceived team cohesion to positively predict players' basic need satisfaction, which in turn, predicted greater satisfaction in basketball and positive emotions. A perceived controlling coach climate negatively impacted on feelings of autonomy. Extending their work, this study considered both controlling and autonomy-supportive features of the coach-created environment and distinguished between task- and social cohesion. Further, both positive and negative indicators of athletes' well-being were taken into account. The interplay between the variables was examined in both an elite and recreational sample of hockey players. More specifically, the present research: i) determined the links between player perceptions of task and social cohesion, the coaching climate (both controlling and autonomy-supportive features), BN satisfaction, and reported indicators of well-being (i.e. subjective vitality) and ill-being (i.e., emotional and physical exhaustion), and ii) as assumed in BNT, tested for invariance in these relationships between elite and non-elite hockey players. Method Elite and non-elite (school/club level) (M age =17.59 years) field hockey players completed a multi-scale questionnaire pack assessing the targeted variables. Results Structural equation modeling supported the hypothesized models for elite (CFI= .91, TLI= .90, RMSEA= .06, Chi-squared= 1209.8, df 606 p< .01) and non-elite (CFI= .90, TLI= .90, RMSEA= .07, Chi-squared= 1184.1, df 606, p< .01) hockey player samples. The overall hypothesized structural models were invariant albeit some specific paths between variables were significantly different between elite and non-elite models. Most notably the paths between social cohesion and the three basic needs were variable between the two models. Discussion Findings support the assumed universality of BNT across elite and non-elite hockey samples but highlights variance in specific relationships between variables within the BNT framework. The theoretical and applied implications of these results are discussed. References Adie, J.W., Duda, J.L., & Ntoumanis, N. (2008) Autonomy support, basic need satisfaction and the optimal functioning of adult male and female sport participation: A test of basic needs theory. *Motivation & Emotion*, 32:189-199. Deci, E.L., & Ryan, R.M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press. Blanchard, C.M., Amiot, C.E., Perrault, S., & Vallerand, R.J. (2009). Cohesiveness, coach's interpersonal style and psychological needs: Their effects on self-determination and athletes' subjective well-being. *Psychology of Sport and Exercise*, 10, 545-551.

## SMALL-SIDED FOOTBALL GAMES: INFLUENCE OF PLAYERS' NUMBER ON PERCEIVED SOCIAL LOADING, STATE OF FLOW AND ENJOYMENT

Bondarev, D.

*Lund University*

Introduction. Game-based approach using small-sided football games (SSGs) to develop various fitness aspects has become popular among recreational population. Previously, it was found that changing variables, such as the pitch area, player number, coach encouragement, training regimen (continuous vs interval training), rules, has an influence on physiological responses of the participant. At present, there is relatively little information regarding how variations of these factors affect psychological variables. Therefore the aim of this study is to explore how perceived social loafing, state of flow and enjoyment might be affected by variations of players' number in SSGs performing with recreational athletes. Methods. Twenty four recreational athletes participated in a series of SSGs of varying player number (three-, four-, five- and six-a-side games) with a goalkeeper. The heart rate, rating of perceived exertion (RPE), perceived social loafing, anticipated effort reduction, state of flow and enjoyment were assessed for each different SSG format. Results. For the variable "perceived social loafing" there was a statistically significant increase between different SSGs format ( $P < 0.05$ ). HR and RPE were greater in three-a-side game compared to six-a-side game. There was no effect of player number on state of flow and enjoyment ( $\beta = .08, P < 0.05$ ). However, the effect of perceived social loafing on enjoyment ( $\beta = -.34, P < 0.05$ ) and anticipated effort reduction ( $\beta = .25, P < 0.05$ ) has been found. Discussion. The results indicate that perceived social loafing may indirectly contribute to decreasing training stimuli when players' number increases. Furthermore, perceived social loafing may affect motivation and lead to frustration with regards to the team's achievement. Further researches needed to clarify how achievement goals of participants contribute to the social loafing in recreational football.

**16:05 - 17:35**

## Oral presentations

### OP-PM35 Rehabilitation 1

#### EFFECTIVENESS OF AN INTEGRATIVE BIOPSYCHOSOCIAL REHABILITATION PROGRAM FOR THE INPATIENT REHABILITATION OF CHRONIC LOW BACK PAIN

Pfeifer, K.1, Hofmann, J.1, Buchmann, J.2, Meng, K.2, Vogel, H.2, Faller, H.2, Bork, H.

*(1) Institute of Sport Science and Sport, University of Erlangen-Nuremberg, (2) Rehabilitation Sciences Unit, University of Würzburg (3) Rehab Centre. St. Josef Stift. Sendenhort*

Introduction In chronic low back pain (clbp), intensive biopsychosocial rehabilitation programs are effective in the short term (van Middelloop et al., 2011). The long-term effectiveness of such programs in Germany has yet to be proven. Besides, the practice of rehabilitation rarely includes a goal-oriented combination of interventions which are directed towards knowledge, behavior and physical activity. In this context, we developed and implemented the integrative rehabilitation program PASTOR. The attempt was to foster self-management in patients with clbp and to evaluate the program compared to inpatient standard-rehabilitation (usual care, UC). Methods A quasi-experimental study with control group design was conducted (three points of measurement: directly before and after rehabilitation, 12 months follow-up). The sample consisted of 537 patients with non-specific clbp (women: 51%; mean age  $49 \pm 8.4$ ). UC was ana-

lyzed in three rehabilitation clinics (n=270). Afterwards PASTOR was implemented as the new program and evaluated (n=267). PASTOR consists of five modules and was delivered in closed groups (48 hours altogether, comparable to UC). Subjective function was analyzed as primary outcome besides various secondary outcomes: e.g. pain, pain-directed cognitions, physical activity, health-related quality of life. ANCOVA was used for statistical analysis. Results After 12 months data of 382 patients (71%) can be analyzed. There is a significant, small effect for function in favor of PASTOR ( $\eta^2=0.036$ ;  $p<0.001$ ) as well as small to medium effects for most secondary outcomes (e.g. pain ( $\eta^2=0.012$ ;  $p<0.032$ ), amount of sports activities ( $\eta^2=0.015$ ;  $p=0.024$ ), mental distraction ( $\eta^2=0.080$ ;  $p<0.001$ ). Discussion PASTOR had small to medium long-term effects regarding function, pain and multiple other outcome variables compared to standard rehabilitation. Therefore, we strongly recommend the implementation and dissemination of interdisciplinary and especially integrative rehabilitation concepts for patients with chronic low back pain. A recent review on multidisciplinary rehabilitation in clbp did not find evidence for long-term effects on function and pain (van Middelkoop et al., 2011). The effects of PASTOR in comparison demand further research to identify the key factor(s). References van Middelkoop, M., Rubinstein, S.M. et al. (2011). A systematic review on the effectiveness of physical and rehabilitation interventions for chronic non-specific low back pain. *European Spine Journal* 20: 19-39.

## EXERCISE TRAINING AS TREATMENT OF NECK PAIN AMONG FIGHTER PILOTS

Murray, M.1, Lange, B.1,2, Andersen, H.C.1, Sjøgaard, G.1

*1 Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense C, Denmark*

Introduction Neck and shoulder pain is a common complaint among fighter pilots and a growing aero-medical concern. Unfortunately, previous intervention studies have been unsuccessful in relieving such pain within this occupational group. The aim of this study was to investigate if an exercise intervention could reduce the high prevalence of neck pain among fighter pilots. Methods F-16 pilots were randomized in a controlled intervention trial, to either an exercise-training-group (ET, n=27) or reference-group (REF, n=28). ET underwent 24 weeks of strength, endurance, and coordination training, 3 times a week, targeting deep and superficial neck muscles (see: [www.sdu.dk/f16pilots](http://www.sdu.dk/f16pilots)). REF received no training but was scheduled for corresponding training 6 months later. Main outcome: Three months prevalence of neck pain assessed on a ten point visual analog scale, VAS (0 corresponded to "no pain" and 10 to "pain at worst"). Compliance was evaluated by training diary as mean training sessions completed per week, and by questionnaire on a six-step scale, 1) regular, 2-3 times a week, 2) less regular, 1-2 times a week, 3) irregular, but > 4 times a month, 4) very irregular, 2-3 times a month, 5) seldom, trained but stopped, 6) no participation at all. Maximal Voluntary Isometric Contraction (MVC) and Rate of Force Development (RFD) for cervical flexion and extension were measured by strain-gauge transducers. Results Prevalence of neck pain was significantly reduced in ET from baseline (mean  $\pm$  SD)  $2.0 \pm 0.4$  to follow-up  $1.0 \pm 0.2$ , change  $-1.0 \pm 0.4$  ( $P = 0.01$ ), but not in REF from  $2.1 \pm 0.4$  to  $2.3 \pm 0.4$  ( $P = 0.80$ ). Comparison between groups found the reduction significant ( $P = 0.01$ ). Compliance for ET according to the training diary was  $1.9 \pm 0.6$  times per week, and according to questionnaire 58% participated more than once a week (scale 1+2). Compliance according to the questionnaire correlated with registrations in the training diary ( $r = -0.745$ ,  $P < 0.000$ ). MVC measures for cervical flexion and extension at baseline in ET were  $183.6 \text{ N} \pm 47.1$  and  $286.5 \text{ N} \pm 48.0$ , and in REF  $160.7 \text{ N} \pm 51.4$  and  $265.2 \text{ N} \pm 60.8$ , respectively. No significant differences were found between groups at follow-up for cervical flexion or extension. RFD for cervical-flexion increased significantly in ET from  $866.6 \text{ N/s} \pm 263.5$  at baseline to  $968.9 \text{ N/s} \pm 295.9$  at follow-up ( $P = 0.04$ ), but not in the REF group, from  $807.0 \text{ N/s} \pm 286.2$  to  $867.8 \text{ N/s} \pm 274.3$  ( $P = 0.33$ ). No difference was found between groups at follow-up. Discussion The exercise intervention reduced neck pain among F-16 pilots with a modest effect size. Compliance according to the questionnaire correlated well with participation based on the training diary, but only 58% of the training group trained regularly once or more a week. Higher compliance may be requested to attain strength gain and larger effect size. The intervention incorporated deep neck muscle training, which may be an important factor in the success of the training regime.

## BENEFICIAL EFFECTS OF LIFE-LONG PHYSICAL EXERCISE ON BRAIN FUNCTIONS OF AGED RATS

Nyakas, C.

*Semmelweis University Budapest*

BENEFICIAL EFFECTS OF LIFE-LONG PHYSICAL EXERCISE ON BRAIN FUNCTIONS OF AGED RATS Nyakas C.1,2, Marosi K.1, Kobor-Nyakas DE.2, Mehra RD.3, Radak Z.1, Luiten PGM.2 1: Research Institute of Sport Sciences, Semmelweis University, Budapest, Hungary, 2: Institute of Molecular Neurobiology, University of Groningen, The Netherlands, 3: All India Institute of Medical Sciences, Department of Anatomy, New Delhi, India Introduction Accumulating evidence shows that long-term physical exercise may interfere with the symptoms of brain aging under both normal and pathological conditions in human (Tierney et al., 2010) and animals (O'Callaghan et al., 2009). The aim of present experiments was to study how long-term, regular and moderate intensity physical exercise does interfere with the functional decline of aging brain in the light of behavioural, cellular and molecular mechanisms of action in rats. Methods In male rats the moderate intensity treadmill exercise started either in the young age of 3-months and in the advanced age of 18-months. The physical training was continuous until the age of 24 months in both groups. The cognitive behaviour of trained and control aged rats were measured at the end of exercise training: open-field activity, novel object recognition (NOR) to measure attention, and Morris water maze spatial learning ability. Biochemical and morphological analyses were performed in the hippocampus. The phosphorylation of Akt (protein kinase B), and that of AMP kinase (AMPK), brain derived neurotrophic factor (BDNF), acetylcholine synthesizing enzyme (ChAT), and glucose transporter 1 (Glut1) levels were measured with Western blot technique. Morphologically immune-cytochemical technique was used to measure the cholinergic (ChAT positive) fibre and the Glut1 positive capillary densities, and the neuronal expression of BDNF in the hippocampus. Results The results showed that contrary to the 6 months long exercise training, the life-long training (LLT) increased attention (NOR) in the age of 24 months. The Morris water maze learning was also positively influenced but only by the LLT. The life-long training markedly increased pAkt and pAMPK levels, as well as Glut1 and BDNF concentrations. The ChAT positive cholinergic fibre density, capillary Glut1 and neuronal BDNF levels were also increased by the LLT. Discussion It was concluded that the life-long exercise is much more powerful for interfering with the age related decline in cognitive and neurobiological markers in the brain of aged rats as compared to the long-term moderate exercise started only at the beginning of aging. The energy providing neuronal capacity is increased markedly which was supported by enhanced neurotrophic and glucose transport processes. Supported by Neuropeptide Foundation and by NWO 'bezoekersbeurs' in The Netherlands References O'Callaghan RM, Griffin EW, Kelly AM. (2009). *Hippocampus*, 19, 1019-1029. Tierney MC, Moineddin R, Morra A, et al. (2010). *J Alzheimers Dis*, 22, 1331-1338.

## THE EFFECTS OF PRESCRIBED PHYSICAL ACTIVITY ON PATIENTS WITH SCHIZOPHRENIA

Curcic, D.J.1, Radivojevic, N.2, Dikic, N.2, Vukasinovic-Vesic, M.2, Andjelkovic, M.2, Antic, T.2, Baralic, I.2, Djordjevic, B.2  
*Special Hospital for Mental Disorders "Dr Laza Lazarevic", Belgrade 1, Sports Medicine Association of Serbia2*

**Introduction** Schizophrenia is a chronic, severe, and disabling mental disease. It has negative influence, not only on psychological functions, but also on physical state of patients. People with schizophrenia are overall less physical active than the general population. Unfortunately, no general concept for a therapeutic application of physical exercise has been developed so far. The purpose of this study is to examine the effects of 12 weeks of prescribed physical exercise on mental states, quality of life and side effects of drugs on individuals with schizophrenia. **Methods** Pilot study involved eight patients, and they were split into two groups, one exercise group (4 patients), and control group (4 patients). There were no personal differences such as gender, age, disorder duration and medication use between groups. Twelve weeks program of physical activity (45 minutes four times per week) were made for every patient, and their target heart rate (HR) were controlled by Polar F4 monitors (between 65-75% of max HR). Functional ability (VO<sub>2</sub>max) as an indicator of aerobic endurance has been obtained by ergospirometric test on a treadmill. Mental state data were collected by using Positive and Negative Symptoms Scale (PANSS) and World Health Organization Quality of life Scale (WHOQOL-BREF). Side effects of drugs were measured by Clinical Global Impression Scale (CGI). All tests were repeated after 8 and 12 weeks. T test and Wilcoxon test was used for statistical analysis. **Results** After 12 weeks, subjects in exercise group showed significantly increases of VO<sub>2</sub> max ( $p=0.004$ ), and significantly higher level of VO<sub>2</sub> max compared to the control group ( $p=0.032$ ). The results also showed significant difference between two groups in scores on PANSS Scale ( $p=0.044$ ) and in scores on WHOQOL-BREF Scale ( $p=0.037$ ) after 12 week of programmed physical activity. CGI score was significantly higher in exercise group ( $p=0.041$ ), which means that index of treatment efficacy was better in subjects who exercised. **Discussion** These results suggest that prescribed physical exercise significantly improves aerobic capacity, and also is effective adjunct treatment for patients with schizophrenia. Prescribed physical exercise is effective for decreasing psychiatric symptoms and side effects of drugs, and for increasing quality of life in people with schizophrenia. This is just preliminary results and the total number of patients will be much bigger at the end of study. **References** Meyer T, Brooks A (2000) Therapeutic impact of exercise on psychiatric diseases. *Sports Medicine* 30(4):269-79 Holley J, Crone D, Tyson P, Lovell G (2011) The effects of physical activity on psychological well-being for those with schizophrenia A systematic review. *British Journal of Clinical Psychology* 50:84-105

## THE INFLUENCE OF A 4-WEEK TREADMILL TRAINING USING UNSTABLE SHOES IN PATIENTS WITH LOW BACK PAIN

Stegen, C., Schellendorfer, S., Bauer, C., Kool, J.  
*Zurich University of Applied Sciences*

**Introduction** Low back pain (LBP) is one of the major health and socio-economic problems in western countries (Hoy et al. 2010/12), generating an enormous amount of direct and indirect costs for health care systems (Hoy et al. 2010/4). The working-age population is frequently affected. Lifetime prevalence is between 60-80% (Krismer and Tulder 2007). Unstable shoes, such as MBT shoes, claim to have the potential to stimulate muscle activity. LBP reduction after wearing MBT shoes was shown in a study with golf players suffering from LBP (Nigg et al. 2009). The purpose of this study was to investigate the effect on pain and disability of a four week treadmill training comparing jogging in unstable shoes and sport shoes in patients with LBP. **Methods** A randomized controlled trial in 22 patients suffering from LBP was conducted. Subjects were randomly assigned to two training groups. Both groups received the same supervised treadmill training sessions, two times a week for four weeks. One group wore unstable shoes during the training, as well as during daily activities; the other group performed the training with normal sport shoes. Outcomes were disability (Roland Morris Questionnaire, RM) and individual main complaints (patient specific functional scale, PSFS). We used SPSS 19 and analysed within group differences before and after treatment with the Wilcoxon-test, and between group differences with the Mann-Whitney-U-test. Alpha was set at 0.05. **Results** A significant reduction in disability (RM) was shown after the training in both groups. The individual main complaints (PSFS) showed a significant improvement and less pain. Differences between groups were not significant. **Discussion** High intensity aerobic training alleviated pain, disability and psychological strain in patients with chronic LBP (Chatzitheodorou et al. 2007). Treadmill training could influence pain reduction in patients with non-specific LBP positively. The non-significant between group differences might be caused by insufficient power in this pilot study. An alternative explanation is that the effect of treadmill training is much stronger than the effect of the unstable shoes. Further investigations are needed to evaluate the effect of wearing unstable shoes on pain reduction in patients with LBP. **References** Chatzitheodorou, D., Kabitsis, C., et al.(2007). *Phys Ther* 87 (3): 304-312. Hoy D, March L, Brooks P, Woolfs A, Blyth F, Vos T, Buchbinder R (2010/4). *Best Prac Res Clin Reumatol* 24 (2), 155-165. Hoy D, Brooks P, Blyth F, Buchbinder (2010/12). *Best Pract Res Clin Rheumatol*. 24 (6), 769-81. Krismer M, van Tulder M (2007). *Best Practice & Research Clinical Reumatology* Vol 21, No. 1, 77-91. Woolf A.D., Pfleger, B (2003). *Bulletin of the World Health Organization*, 81 (9).

## IS BLOOD FLOW-RESTRICTED EXERCISE SAFE FOR PATIENTS WITH ISCHEMIC HEART DISEASE?: A PILOT STUDY ON MARKERS OF COAGULATION AND INFLAMMATION

Madarame, H., Kurano, M., Fukumura, K., Fukuda, T., Nakajima, T.  
*The University of Tokyo*

**Introduction** Since resistance exercise with blood flow restriction (BFR) increases muscle size and strength with relatively low intensity, it might be a feasible method of cardiac rehabilitation for patients with ischemic heart disease (IHD). Although previous studies with healthy subjects showed relative safety of low-intensity resistance exercise with BFR (Madarame et al., 2010; Clark et al., 2011), we cannot exclude the possibility of unfavorable effects in IHD patients. We therefore investigated the effects of low-intensity resistance exercise with BFR on markers of coagulation and inflammation in IHD patients. **Methods** Nine stable IHD patients (aged 49-70 yr) who were not taking anticoagulant drugs performed leg extension exercise with and without BFR at an intensity of 20% 1RM. Two exercise sessions were separated at least for 1 week, and the order was randomly assigned. In each exercise session, one set with 30 repetitions was followed by 3 sets with 15 repetitions. Blood samples were taken before, immediately after and 1 h after the exercise. Fibrin degradation products (FDP) and D-dimer were measured as markers of coagulation, whereas white blood cell counts (WBC) and high-sensitive C-reactive protein (hsCRP) were measured as markers of inflammation. The data were analyzed with a two-factor (condition x time) repeated measures ANOVA. **Results** Neither a condition x time interaction nor a main effect of time was observed for FDP. For D-dimer, WBC and hsCRP, there was a significant main effect of time but no condition x time interaction. D-dimer, WBC and hsCRP increased significantly after the exercise independent of the condition. **Discussion** There was no statistical difference between the conditions (with and without BFR) for markers of coagulation and inflammation. This result, which is in line with previous studies with healthy subjects (Madarame et al., 2010; Clark et al.,

2011), suggests that low-intensity resistance exercise with BFR would be relatively safe not only for healthy individuals but also for IHD patients, at least for coagulation and inflammatory responses. It should be noted, however, that two patients in this study showed an apparent increase in FDP after the exercise with BFR (one of them showed increases in both conditions), though the values were within a clinically normal range. In addition, this is only a pilot study with a small number of stable IHD patients. Therefore, it should still be cautious to prescribe BFR to IHD patients. References Clark BC, Manini TM, Hoffman RL et al. (2011). *Scand J Med Sci Sports*, 21, 653-662 Madarame H, Kurano M, Takano H et al. (2010). *Clin Physiol Funct Imaging*, 30, 210-213

## 16:05 - 17:35

### Oral presentations

#### OP-PM36 Reliability and Validity of testing procedures

##### RELIABILITY OF CARDIORRESPIRATORY PARAMETERS DURING CYCLING EXERCISE PERFORMED AT SEVERE DOMAIN IN ACTIVE INDIVIDUALS

Barbosa, L.F.1, Montagnana, L.1, Denadai, B.S.1, Greco, C.C.1

HPL - UNESP - Univ Estadual Paulista

**Introduction** Exercise intensity domains (i.e., moderate, heavy and severe) have been defined based on the oxygen uptake (VO<sub>2</sub>) and blood lactate responses to constant-work rate cycling exercise (Gaesser and Poole, 1999). Studies have proposed that the reliability of the VO<sub>2</sub> kinetic parameters may be influenced by the exercise intensity (Ozyener et al., 2001) and that the amplitudes of the VO<sub>2</sub> response were more robust than the temporal parameters (time constants and time delay) (Carter et al., 2002). Limited data related to the reliability of cardiorespiratory parameters during exercise performed at severe domain have been published. Thus, the purpose of this study was to determine the test-retest reliability of the cardiorespiratory parameters during cycling exercise performed at severe domain in active individuals. **Methods** Thirteen active males (24.5 ± 4.5 yr; VO<sub>2</sub>max = 42.9 ± 6.1 ml.kg<sup>-1</sup>.min<sup>-1</sup>) performed the following tests: 1) An incremental test to determine VO<sub>2</sub>max and the intensity associated with VO<sub>2</sub>max (IVO<sub>2</sub>max), and; 2) 4 repetitions of square-wave transitions from rest to a power corresponding to 95%IVO<sub>2</sub>max to determine parameters of VO<sub>2</sub> kinetics and time to exhaustion (Tlim). **Results** While the two measures of Tlim were moderately related (ICC = 0.78; p < 0.01; CV = 9.6%), Tlim from the second test (545.2±103.1 s) was significantly higher than that of the first (492.5±100.9 s; p = 0.02). Moderate to high reliability (ICC = 0.76-0.93) for the amplitudes of the VO<sub>2</sub> kinetics responses was found. Poor reliability, however, was found for time constants and time delays of the VO<sub>2</sub> kinetics responses. **Discussion** To our knowledge, this is the first study that used multiple transitions to examine the reproducibility of the VO<sub>2</sub> kinetic response during severe cycling exercise. In non-familiarized individuals, Tlim shows a relatively low within-subject coefficient of variation. However, the second score in a series of two Tlim tests may be significantly greater than the first. Additionally, the amplitudes of the VO<sub>2</sub> response have significantly moderate to high reliability. The time-based parameters, however, present an important day-to-day intra-individual variation. Therefore, multiple transitions are recommended to increase confidence of data. **References** Carter H, Jones AM, Maxwell NS, Doust JH. (2002). *J Sports Sci*, 20, 901-909. Gaesser GA, Poole DC. (1996). *Exerc Sports Sci Rev*, 24, 35-71. Ozyener F, Rossiter HB, Ward SA, Whipp BJ. (2001). *J Physiol*, 533, 891-902.

##### PERCEIVED FUNCTIONAL ABILITY RELATES TO LABORATORY AND FIELD MEASURES OF EXERCISE CAPACITY IN CANCER PATIENTS

Schmidt, K., Vogt, L., Thiel, C., Banzer, W.

Goethe-University Frankfurt a. M.

**Introduction** Cardiopulmonary exercise testing (CPET) and the 6-minute walk test (6MWT) have found widespread acceptance for the evaluation of functional capacity in chronic diseases. Self-rating instruments may be more economic and sufficiently precise to estimate fitness in the everyday clinical setting or in large clinical trials. However, in cancer patients it is unknown how such scales relate to results derived from CPET and 6MWT. Therefore the present study in cancer patients compared the results of a self-rating instrument to assess perceived functional ability (PFA) with the gold standard in both, laboratory and field exercise testing. **Methods** Fifty cancer patients (36 f, 14 m; 57.4 ± 10.2 years; BMI: 25.3 ± 4.2; during (56%) or after (44%) treatment) rated their PFA on an adapted 13-point scale (George et al. 1997) by estimating the walking or running velocity they could keep up for 1 mile. Subjects also performed a 6MWT and, after sufficient rest, a CPET to assess peak oxygen consumption (VO<sub>2</sub>peak). Test-retest reliability of the PFA was determined in a subsample (n = 26) by repeated measures within 2-7 days. **Results** Participants' VO<sub>2</sub>peak was 21.2 ± 4.8 ml•kg<sup>-1</sup>•min<sup>-1</sup>, and mean distance covered during the 6MWT 593 ± 81m. Their PFA averaged 7.1 ± 2.6 points, corresponding to a self-estimated speed of 6.1 km•h<sup>-1</sup> to cover 1 mile. PFA was significantly (p < .001) correlated with VO<sub>2</sub>peak (r = .62) and 6MWT distance (r = .65). Grouped for PFA estimated walking or running velocity (≤ 5; >5-7; > 7 km•h<sup>-1</sup>) ANOVA and Scheffé's post hoc tests revealed significant differences in VO<sub>2</sub>peak (17.7 ± 3.7; 21.6 ± 4.1; 26 ± 4.9 ml•kg<sup>-1</sup>•min<sup>-1</sup>) and 6MWT (538 ± 62; 598 ± 72; 687 ± 60 m). The intraclass-correlation coefficient (2,1) for test-retest reliability was .879 (95%CI: .748 - .944) (p < .001). **Discussions** The present findings in cancer patients revealed linear relationships between PFA and VO<sub>2</sub>peak/6MWT which are almost comparable to the correlation established between field and laboratory outcome measures (r = .67). From sub-group analyses it emerges that different grades of PFA seem to be able to distinguish between varying levels of exercise capacity. Future studies might evaluate the responsiveness of PFA to intervention-induced exercise capacity changes. **References** George JD, Stone WJ, Burkett LN (1997). Non-exercise VO<sub>2</sub>max estimation for physically active college students. *Med Sci Sports Exerc* 29(3), 415-423.

**HIGH PREVALENCE OF FALSE-POSITIVE PLATEAU PHENOMENA DURING VO<sub>2</sub>MAX TESTING IN ADOLESCENTS.**

Beltrami, F.G.1, Wong, D.P.2, Noakes, T.D.1

1: UCT (Cape Town, South Africa), 2: The Hong Kong Institute of Education

Background: It is believed that a plateau in oxygen consumption (VO<sub>2</sub>) at the end of an incremental exercise test identifies the upper limits of cardiovascular capacity. We investigated how the choice of different mathematical criteria used to define a plateau influences the frequency with which the "plateau phenomenon" is detected and the prevalence at which "false" plateau phenomena occur during submaximal exercise. Methods: We employed six different criteria to identify the "plateau phenomenon" from a single data set comprising 63 incremental exercise tests in adolescent soccer players. Tests were performed on a motorized treadmill set at 5.5% grade, and had a initial speed of 7km.h<sup>-1</sup> for four minutes and subsequent increases of 1km.h<sup>-1</sup> every minute thereafter until participants could no longer tolerate the running speed. The different criteria were based on either absolute or relative stage-to-stage VO<sub>2</sub> differences for the individual or group. All criteria were tested using the highest sampling intervals of 15s, 30s or 1min within each stage for comparison with the previous stage, thus totalizing 18 different criteria. A single criterion (less than half of expected stage-to-stage change in VO<sub>2</sub> for the specific subject) was also used to detect the incidence of the plateau phenomena at any point of a test (except the linear portion between minutes two and four). If a plateau was identified during a test but VO<sub>2</sub> increased on a subsequent stage the plateau was deemed to be "false". The prevalence of secondary criteria based on Heart Rate within 10 beats of age-predicted maximum (HR) and respiratory exchange rate (RER) in excess of 1.1 were also measured. Results: The plateau phenomenon was detected in 16-83% of the tests depending on the criteria used, and only 3 different criteria produced an identical prevalence (49%). The single criterion method identified the presence of 103 "plateau phenomena" but 73 (70.9%) of these occurred during submaximal exercise and so were "false". False plateau were verified by one or both secondary criteria in 15.5% of cases. Subjects reached the HR and RER secondary criteria for determining a maximal test after 83.6 ± 11.7 % and 81.9 ± 18.1 % of total test duration, respectively. Conclusion: The wide range in the percentage of plateau phenomena detected by different criteria in the same data set could indicate that this phenomenon maybe is a calculation artifact rather than an indicator of an absolute limitation in oxygen delivery to or use by the exercising muscles. The high rate (71%) of "false" plateau phenomena further supports this interpretation. Secondary criteria can be reached early in exercise and often identifies "false" plateau phenomena as "true".

**THE USE OF HEART RATES AND GRADED MAXIMAL TEST VALUES FOR DETERMINING POSITIONAL DIFFERENCES IN RUGBY UNION GAME INTENSITIES**

Sparks, M., Coetzee, B.

*North West University*

Introduction In order to construct sport and position specific training regimens for players, the physiological demands players of different positions experience during match play have to be available (Duthie, Pyne & Hooper, 2003a). Therefore, the purpose of this study was to determine the positional differences in tertiary institution rugby game intensities, using heart rates and graded maximal test values. Methods In the weeks between three rugby matches ten forwards and eleven backs performed a standard incremental maximal oxygen uptake (VO<sub>2</sub>max) test to the point of exhaustion. The test was used for determining two ventilatory threshold points by which the low, moderate and high-intensity heart rate zones were categorized for each of the players (Chicharro, Hoyos & Lucia, 2000). Results The telemetry heart rate values recorded during each of the matches revealed that forwards spent significantly more (P < 0.05) time in the high-intensity zone compared to the backs (54.6% vs. 32.7%), whereas the backs spent significantly more time in the low-intensity zone during the match compared to the forwards (34.2% vs. 11.3%). Also, the mean duration of high-intensity bouts also lasted longer for the forwards than for the backs (1min:51s versus 38s) when the matches were analyzed as a whole. Discussion Sport scientists and conditioning coaches should construct different training programs for the two positional groups, concentrating more on frequent high-intensity activities lasting more or less 40 s for the backs and more or less 111 s for the forwards. In conclusion, this is the first study to make use of heart rate and graded maximal test values to show that significant differences exist with regard to the game time spent in the different heart rate intensity zones between rugby union forwards and backs. References Chicharro, J.L., Hoyos, J. & Lucia, A. (2000). Effects of endurance training on the isocapnic buffering and hypocapnic hyperventilation phases in professional cyclists. *British J of Sports Med*, 34(6), 450-455. Duthie, G., Pyne, D. & Hooper, S. (2003a). Applied physiology and game analysis of rugby union. *Sports Med*, 33(13), 973-991.

**METHODOLOGICAL ISSUES IN THE DETERMINATION OF THE OPTIMAL LOAD TO OBTAIN ANAEROBIC MAXIMAL PEAK AND MEAN POWER**

Santos, A.M.C.1, Lopez, R.1, Correia, C.1, Fontes Ribeiro, C.A.1,2

*Universidade de Coimbra*

Introduction The majority of studies have used the Wingate Anaerobic Test (WANT) to determine peak power in any 1 or 5 s period but it is well documented that the resistance typically applied - 75 g.kg<sup>-1</sup> - may not be optimal for eliciting true peak power. The Force Velocity test (FVT) circumvents this problem by determining individual force-velocity curves from which optimal peak power (OPP) may be derived. Although WANT is the anaerobic evaluation test over known and applied. In this investigation we attempt to verify if the optimum load determined, by force-velocity test can be the optimal load for WANT anaerobic mean and peak power. We also want to check that the values obtained in the WANT mean and peak power are sensitive to variations in 0.010 Kg.Kg body mass<sup>-1</sup> in the applied loads. Methods The subjects performed a WanT and FVT on a calibrated Monark cycle ergometer ( Monark model 824 E), that was individually adjusted for seat-saddle height and equipped with toe-clips to secure the feet to the pedals. The test preceded with a standardised warm-up, for both tests, that consisted of four minutes of constant pedalling at 60 rpm against a minimal force, interspersed with three all-out intensity sprints of 3-5s at the test applied force. Subjects were then taken through a two-minute series of standardised stretches for the quadriceps and hamstring group of muscles. The WanT commenced from a rolling start of 60 rpm and the subjects were verbally encouraged to cycle as fast as they could against an applied force that was set equivalent to 0.74 N.s<sup>-1</sup>. The 1s interval peak power (PP) and mean power over 30s of the test (MP) were derived from the WanT. The FVT consisted of 4 to 6 sprints on a Monark cycle ergometer lasting 5 to 8 s against a range of randomly presented resistances (30 to 95 g.kg<sup>-1</sup>) selected according to age and sex. Each sprint commenced also from a rolling start of 60 rpm. OPP was determined according to the procedures described by Winter et al., 1996. Results Subjects were 19 boys aged 21.3 ± 1.6 y, and 14 girls aged 20.3 ± 1.4 y, mass and stature were 76.79 ± 10.33kg and 174.43 ± 6.42 for boys and 56.07 ± 6.63 kg and 160.89 ± 4.72 cm for girls. The results indicate that peak power (PP) and mean power (MP) Obtained with optimal



load (OL) were significantly greater than those achieved with the standardized load (75 g.kg<sup>-1</sup>) We also found that determination of PP and MP with the WANT protocol is sensitive to variations of 0.010 Kg.Kg MC-1, both for heavy and light loads. Discussion The data suggest that to accurately determine the PP and MP using the want, it is necessary to determine in advance the OL of each subject, rather than a standardized load. We suggest that FVT can be used to determine the OL. This study suggests also that the OL for PP is the same for MP. References Winter, E.M., Brown, D., Roberts, A.K.A., Brookes, F.B.C. and Swaine, I.L. *J Sports Sci* 14: 513-521, 1996.

### CONCURRENT VALIDITY OF INERTIAL MEASUREMENT UNIT FOR THE ASSESSMENT OF COUNTERMOVEMENT JUMP IN YOUTH SOCCER

Cortis, C.1, Picerno, P.2, Pesce, C.3, Capranica, L.3

1: University of Cassino (Italy), 2: Sensorize motion sensing technology (Rome, Italy), 3: University of Rome "Foro Italico" (Italy)

Introduction Countermovement jump (CMJ) is considered a suitable test to determine muscle power, a good indicator of functional performance and a relevant index in soccer (Wisloff et al., 2004; Holsgaard et al., 2007), reflecting the players' ability to perform stretch-shortening cycle activities. In field conditions, CMJ measurements are usually performed by means of optical cells and contact mats, which can only be used on a flat surface, limiting the ecological validity of the evaluation when investigating athletes who compete on different surfaces (i.e., clay, artificial turf, natural grass). Thus, the aim of this study was to evaluate concurrent validity and reliability of wearable accelerometers with photocell system measurements for measuring flight time, thus estimating vertical jump height. Methods After obtaining parental, club and coach informed consent forms, 14 young elite ("Esordienti" team of the Italian first league S.S. Lazio Club) soccer players (age: 12±1 years; body mass: 40.3±9.1 kg; height: 151.9±11.8 cm; BMI: 19.1±1.3) were asked to perform maximal countermovement jumps (CMJ). To evaluate concurrent validity, athletes' CMJ flight times were recorded by means of an inertial measurement unit (IMU, FreePower Jump Module, Sensorize, Italy) wore on the trunk at the level of L5 and, at the same time by means of Optojump photocells (Microgate, Italy) considered as a gold standard (Glatthorn et al., 2011). To investigate test-retest reliability of the IMU, athletes participated in two experimental sessions separated by one week. Repeated measures ANOVA (p<0.05) was used to evaluate differences in experimental sessions. Intra-class correlation coefficients (ICCs) were used to evaluate validity and reliability. Results No differences emerged between experimental sessions (Test: Optojump = 0.448±0.027 s; IMU = 0.471±0.021 s; Retest: Optojump = 0.455±0.026 s; IMU = 0.478±0.022 s). High (p<0.001) ICCs were found between measurement systems for both experimental sessions (test = 0.891; retest = 0.959). Furthermore, IMU system showed an excellent test-retest reliability (ICC = 0.976). Discussion The IMU system demonstrated good concurrent validity and excellent test-retest reliability for the measurement of flight time in young soccer players. Therefore, this tool can be used as a valid method to measure CMJ flight time to estimate jump height in field settings, independently from testing surface, thus improving the ecological validity of the measurement. References Glatthorn et al *J Strength Cond Res* 2011:556-560 Holsgaard et al *Scand J Med Sci Sports* 2007:43-53 Wisloff et al *Br J Sports Med* 2004:285-288

## 16:05 - 17:35

### Oral presentations

#### OP-PM37 Muscle Physiology

##### MUSCLE DAMAGE PROTECTIVE EFFECT BY LOW-INTENSITY ECCENTRIC EXERCISE IN THE ELDERLY

Trevor, C.1, Hsin-Lian, C.1, Jui-Hsin, L.1, Wei-Chin, T.1, Guan-Ling, H.1, Kou-Wei, T.2, Kazunori, N.3

1NCYU (Taiwan), 2TPEC (Taiwan), 3ECU (Australia)

Introduction A bout of eccentric exercise with a light (10%) dumbbell that does not change any muscle damage markers attenuates muscle damage in the subsequent maximal eccentric exercise (MaxECC) of the elbow flexors (EF) performed 2-14 days later in young men (1). It is unknown whether such effect is evident for knee extensors (KE) of elderly individuals. Since KE are less susceptible to eccentric exercise-induced muscle damage than EF (2), and are used and perform low-intensity eccentric contractions in daily activities, it might be that the protective effect by a low-intensity eccentric exercise is minimum. Thus, the present study investigated whether an initial low-intensity (10%) eccentric exercise of the KE would reduce muscle damage induced by MaxECC of the same muscle performed 7 days later by elderly men. Methods Twenty-six untrained elderly men (66.4 ± 4.6 y) were assigned to two groups (n=13 per group); Group A performed 6 sets of 10 MaxECC (30°.s<sup>-1</sup>) of the KE using non-dominant leg, and Group B performed 6 sets of 10 light eccentric contractions of the KE by lowering a weight (10% of maximal voluntary isometric knee extension strength) on a leg extension machine (10%ECC) 7 days prior to MaxECC. Changes in maximal voluntary isokinetic (30°.s<sup>-1</sup>) concentric (MVC) strength, optimum angle (OA), range of motion (ROM), leg girth, muscle soreness (SOR), plasma creatine kinase activity (CK) and myoglobin concentration (Mb), and echo-intensity of the B-mode ultrasound images before to 5 days following MaxECC were compared between the groups by a two-way repeated measures ANOVA. Changes in the variables following the 10%ECC were analysed by a one-way repeated measures ANOVA. Results The 10%ECC did not change any variables. Changes in all variables except for OA following MaxECC were smaller (P<0.05) for Group B than Group A. For example, maximal changes in MVC strength (Group B: 18 ± 2 % vs Group A: 28 ± 2 %), ROM (6 ± 1 vs 8 ± 1 °), leg girth (4.6 ± 0.6 vs 5.9 ± 0.6 mm), SOR (8 ± 2 vs 14 ± 3 mm), CK (879 ± 285 vs 1822 ± 626 IU/L), and Mb (126 ± 19 vs 265 ± 86 ug/L) following MaxECC were reduced (P<0.05) by performing 10%ECC (Group B). Discussion The results suggest that non-damaging KE eccentric exercise conferred protection against muscle damage induced by MaxECC of the KE for the elderly, which is in line with the results shown by the previous study using the EF of young men (1). Preconditioning muscles by low-intensity eccentric contractions can be used as a strategy to minimise the magnitude of muscle damage in resistance training for both young and elderly individuals. References 1. Chen et al. (2012). *Eur J Appl Physiol* 112,555-565. 2. Chen et al. (2011). *Eur J Appl Physiol* 111,211-223.

**INFLUENCE OF PRIMING EXERCISE ON MUSCLE DEOXY[Hb+Mb] DURING RAMP CYCLE EXERCISE**

Boone, J., Bourgois, J.

*Ghent University*

**INTRODUCTION** The aim of the present study was to get a better insight into the mechanisms underpinning the sigmoid pattern of deoxy[Hb+Mb] during incremental exercise by assessing the changes in the profile following prior high-intensity exercise. **METHODS** Ten physically active students performed an incremental ramp (25 Watt.min<sup>-1</sup>) exercise preceded on one occasion by an incremental arm (10 Watt.min<sup>-1</sup>) and on another occasion by an incremental leg exercise (25 Watt.min<sup>-1</sup>)(RT) until exhaustion. Deoxy[Hb+Mb] was measured at the M. Vastus Lateralis throughout the exercises by means of near-infrared spectroscopy. Deoxy[Hb+Mb] was set out as a function of work rate (% peak power) and compared between the different exercises. **RESULTS** These procedures showed that the sigmoid pattern provided the best fit for the pattern of deoxy[Hb+Mb] during the RT and also when the incremental exercise was preceded by the arm exercise. However, when the incremental exercise was preceded by the leg exercise (RT), deoxy[Hb+Mb] started to increase immediately from the onset of the ramp exercise and thus the sigmoid model no longer provided a good fit to the data. **CONCLUSIONS** In the present study it was observed that the sigmoid pattern of deoxy[Hb+Mb] was disturbed when the ramp exercise was preceded by a high-intensity leg exercise but not by a high-intensity arm exercise. This observation suggests that the sigmoid pattern of deoxy[Hb+Mb] is probably related to the sequential recruitment of different muscle fibre types.

**PROTECTIVE EFFECT CONFERRED BY MAXIMAL ISOMETRIC CONTRACTIONS AT A LONG MUSCLE LENGTH**

Nosaka, K.1, Chen, T.C.2, Lin, M.J.3, Chen, C.H.4, Chen, H.L.2

*1: Edith Cowan University (Australia), 2: NCYU (Taiwan), 3: CCU (Taiwan), 4: NTU (Taiwan)*

**Introduction** The magnitude of muscle damage induced by maximal eccentric contractions is reduced by preconditioning exercise consisting of light eccentric contractions (1) or maximal isometric contractions (2) that do not change indirect muscle damage markers. In the last ECSS conference, we reported that only 2 or 10 maximal voluntary isometric contractions of the elbow flexors performed at 20° elbow flexion (MVIC) attenuated the magnitude of muscle damage induced by 30 maximal eccentric contractions (MaxECC) performed 2 days later (2). However, it is unknown whether the protective effect is still conferred when 2MVIC are performed immediately before MaxECC, and how long the protective effect lasts. The present study investigated whether the magnitude of muscle damage induced by MaxECC would be reduced when 2MVIC were performed immediately before, or 2, 4 or 7 days prior to MaxECC. **Methods** Sixty-five untrained young men were assigned into one of the five groups (n=13 per group) based on the timing of the 2MVIC performed prior to MaxECC; immediately before (0d), 2 (2d), 4 (4d) or 7 days (7d), and no 2MVIC (control). The subjects in the 0d, 2d, 4d, and 7d groups performed 2MVIC on a Biodex dynamometer before performing 5 sets of 6 maximal isokinetic (60°/s) eccentric contractions of the elbow flexors using non-dominant arm. Changes in maximal voluntary isokinetic (60°/s) concentric contraction strength, optimum angle (OA), range of motion, upper arm circumference, muscle soreness, plasma creatine kinase activity and myoglobin concentration, and ultrasound echo-intensity following 30 MaxECC were compared among the groups by a two-way repeated measures ANOVA. Changes in the variables following 2MVIC were also analysed by a one-way repeated measures ANOVA. **Results** No significant changes in any of the variables were evident following 2MVIC. The 2d and 4d groups showed smaller (P<0.05) changes in all variables following MaxECC when compared with the control, 0d and 7d groups. The 2d group showed smaller (P<0.05) changes in all variables except for OA when compared with the 4d group. The changes in the variables were similar amongst the control, 0d and 7d groups. **Discussion** The results suggest that non-damaging isometric contractions performed within 4 days prior to maximal eccentric contractions attenuated the magnitude of muscle damage, but no such effect was conferred if the isometric contractions were performed immediately before or 7 days before the eccentric contractions. It appears that some time lag is necessary for the protective effect to be implemented, and the effect is relatively short-lived. **References** 1) Chen et al. (2012). *Eur J Appl Physiol*, 112, 555-565. 2) Chen et al. (2012). *Appl Physiol Nutr Metab*, under review.

**THE EFFECTS OF EXERCISE-INDUCED MUSCLE DAMAGE ON INCREMENTAL TREADMILL PERFORMANCE**

Twist, C.1, Burt, D.1, Magalhaes, J.2, Ascensao, A.2, Highton, J.1

*1University of Chester, UK; 2University of Porto, Portugal.*

**Introduction** Exercise-induced muscle damage (EIMD) is known to alter the physiological and perceptual responses during sub-maximal running at fixed intensities (Chen et al. 2007). However, the effects of EIMD on incremental running to exhaustion are yet to be elucidated. Therefore, this study sought to investigate the effects of EIMD on the physiological, perceptual and performance characteristics of incremental treadmill exercise to exhaustion. **Methods** Nine physically active participants performed measurements of perceived muscle soreness, isokinetic strength and creatine kinase (CK) before performing an incremental treadmill test to exhaustion. The treadmill test commenced with participants walking at 5 km/h against a gradient of 1%, increasing by 1 km/h every 2 minutes until volitional exhaustion. Participants then performed muscle-damaging exercise comprising 100 barbell squats against a load corresponding to 80% of body mass. Measurements of muscle soreness, isokinetic strength and creatine kinase were repeated at 24 h and 48 h after muscle-damaging exercise. The incremental treadmill test to exhaustion was repeated at 48 h. **Results** Reductions in peak torque and increases in muscle soreness and CK (all P < 0.05) confirmed the presence of EIMD at 24 and 48 h. Oxygen uptake, heart rate, minute ventilation and blood lactate concentration at all submaximal speeds of the incremental test remained unchanged between trials (all P < 0.05). Although unchanged at slower treadmill speeds, RPE at 11 and 12 km/h was increased 48 h after squatting exercise (P < 0.05). Reductions in time to exhaustion (1333 +/- 205 c.f. 1211 +/- 198 s, P < 0.05) and peak running speed (14.9 +/- 1.8 c.f. 14.0 +/- 1.6 km/h, P < 0.05) accompanied lower peak values for blood lactate concentration (11.6 +/- 2.5 c.f. 8.2 +/- 2.1 mmol/l) and heart rate (198 +/- 7 c.f. 192 +/- 10 b/min) at 48 h after squatting exercise. However, peak oxygen uptake (48.3 +/- 6.9 c.f. 47.4 +/- 7.2 ml/kg/min), peak minute ventilation (128.7 +/- 34.9 c.f. 126 +/- 31.3 l/min) and peak RPE (19.9 +/- 0.3 c.f. 19.8 +/- 0.4) were unchanged between trials. **Discussion** The reduction in exercise tolerance and lower peak running speeds observed after muscle-damaging exercise are not explained by impaired oxygen delivery. Instead it is proposed that performing incremental treadmill exercise with weaker and painful muscles increases perceived effort that leads to a premature termination of the exercise. **Reference** Chen TC, Nosaka K, Tu J-H (2007). *J Sports Sci*, 25, 55-63.

**16:05 - 17:35****Invited symposia****IS-SH07 Role and Competences of PE Teacher and Coaches****SPORT AND EXERCISE PEDAGOGY: THE PROFESSIONAL LEARNING FOUNDATION FOR PE TEACHERS AND SPORT COACHES**

Armour, K.

*University of Birmingham*

Sport and exercise participants have not been served well by the professional structures that exist to support them. In the case of children and young people there are numerous examples to support this claim. For example: (i) Historically, physical education and sport – and teaching and coaching – have been viewed as opposites rather than as points on a shared continuum of professional practice. (ii) School curricula have been designed around specific activities to be taught, coached or delivered, with a lesser emphasis on diagnosing the specific learning needs of children. (iii) Academics in sport and exercise sciences produce discipline-based knowledge that might be of excellent quality, but is often fragmented – and too specialist – to readily inform practice; (iv) Professional development opportunities for teachers and coaches are rarely adequate to support their progressive and essentially inter-disciplinary learning needs over a career. In other words, it can be argued that there is a degree of pedagogical dissonance at the heart of these structures. This paper discusses the need for the development of a stronger interdisciplinary theoretical foundation to inform the practices of teaching and coaching. Drawing on the work of Hodkinson et al (2008); Kirk, Macdonald, and O'Sullivan (2006); Lee (2010); Shulman (2000); Tinning (2010); and Wathne, (2011) this paper will present a case for the development of 'Sport and Exercise Pedagogy' as the mechanism to ensure that knowledge developed in Sport & Exercise Sciences is made available to practitioners and, as a result, to participants. It is argued that this new, interdisciplinary knowledge should form the basis of professional learning and development in both teaching and coaching. Hodkinson, P., Biesta, G., & James, D. (2008). Understanding learning culturally: Overcoming the dualism between social and individual views of learning, *Vocations and Learning*, 1, 27-47. Kirk, D., Macdonald, D. & O'Sullivan, M. (2006). (Eds). *The Handbook of Physical Education*, London, Sage. Lee, C.D. (2010). Understanding the ecologies of human learning and the challenge for education science. *Educational Researcher*, 39, 9, 643-655. Shulman, L. (2000). From Minsk To Pinsk: Why A Scholarship Of Teaching And Learning? *Journal of Scholarship of Teaching and Learning (JoSoTL)*, 1, 1, 48-53. Tinning, R. (2010). *Pedagogy and Human Movement*, London, Routledge Wathne, K. (2011). Movement of large bodies impaired: the double burden of obesity – somatic and semiotic issues. *Sport, Education and Society*, 16, 4, 415-429.

**VALUE EDUCATION IN SCHOOLS**

Naul, R.

*University of Duisburg-Essen*

VALUE EDUCATION IN SCHOOLS Naul, R. WGI-UDE (Essen, Germany) Introduction The term value education seems to be an essential part of the teaching domain in school based physical education and school sport around the world (cf. Siedentop, 1994; Pühse & Gerber, 2005; Naul, 2010). Today, however, values in PE, school sports and daily life are somewhat differently assessed, experienced and realized, by teachers, pupils and coaches at school in physical education, physical activities and in extra-curricular school sports (cf. Goncalves 1998; 2007). Methods The paper will address three items which will be discussed and pointed out on the basis of a qualitative literature review: 1. What means value education and what is it about to achieve in a local school setting? 2. What means value education in the context of the subject of physical education and school sports (PESS)? 3. Finally, in how far value education in physical education and school sports is linked with "active Olympism" or "Olympic value education programmes" (OVEP) for school aged children and youth? Results Traditionally, values are embed in individual physical activities, in team sports related social interactions, and in mental gathering of the "spirit" of games and sports inside and outside curricular based physical education and extra-curricular sport activities. Discussion Experiences of values in physical education, physical activities and sports are not limited to any type/concept of physical education, any kind of organized sports or unorganized physical activities and sports. However, some research underpin: the more competitive sports children and youth experience and exercise in life the more moral attitudes and social value grounded behavior patterns seem to be omitted (cf. Bockrath & Bahlke, 1996; Shields & Bredemeier, 1995). References Bockrath, F. & Bahlke, S. (1996). *Moral und Sport im Wertebewußtsein Jugendlicher*. Köln: Strauß. Goncalves, C. (1998). Values in Youth Sport: Coaches' Views. In R. Naul, K. Hardman, M. Pieron & B. Skirstad (eds.) *Physical Activity and Active Lifestyle of Children and Youth* (pp.181-189). Schorndorf: Hofmann. Goncalves, C. (2007). Education through Sport Activities: On the Responsibility of PE Teachers and Youth Sport Coaches. In P. Heikinaro-Johansson, R. Telama & E. McEvoy (eds.) *The Role of Physical Education in Promoting Physical Activity and Health* (pp.223-229). Jyväskylä: Kopijyvä Oy. Naul, R. (2010). *Olympic Education* (2nd edition). Oxford: Meyer & Meyer. Pühse, U. & Gerber, M. (eds.) *International Comparison of Physical Education*. Aachen: Meyer & Meyer. Shields, D. & Bredemeier, B. (1995). *Character Development and Physical Activity*. Champaign/Ill.: Human Kinetics. Siedentop, D. (1994). *Sport Education. Quality PE through positive sport experiences*. Champaign/Ill.: Human Kinetics. Siedentop, D., Hastie, P.A. & van der Mars, H. (2004). *Complete Guide to Sport Education*. Champaign/Ill. Human Kinetics.

**THE INTERNATIONAL SPORT COACHING FRAMEWORK: IMPLICATIONS FOR SPORT COACHES IN SCHOOL AND COMMUNITY CONTEXTS**

Duffy, P.

*Leeds Metropolitan University*

The International Council for Coach Education (ICCE) and the Association for Summer Olympic International Federations (ASOIF) have established a Joint Project Group to develop the International Sport Coaching Framework (ISCF). ISCF, to be published in its first version at the Global Coaches House in London 2012, will provide a reference point for national organisations, International Federations and other agencies, for the education and development of sport coaches. A key feature of the Framework, supported by recent research on coaching expertise and coaching as a profession, is the proposal that coaching as a 'blended professional area' consists of both participation

and performance oriented occupations. Within these occupations there are a number of coaching domains that are linked to the orientation of key participant groups. One of these domains is Coaching Children. The emphasis on children's coaching highlights the need to identify the specific capabilities required by coaches working in the 5-15 age range. The implications for the role, education and qualification of coaches operating within school and community contexts are examined in this paper. These include the need for clearer role definitions for children's coaches at each stage of participant development and their relationship between the work of these coaches and others working in the field, particularly teachers and physical education teachers. In addition, the importance of recognising the social and organisational context for this work is outlined. This includes recognition of coaching status and whether coaches act in volunteer, part-time paid and full time paid roles. The significance of 'pre-coaching' roles played by parents and others in the children's sport context is also addressed. Finally, the presentation summarises the process to date and further steps in its evolution.

**16:05 - 17:35**

## Invited symposia

### IS-BN08 Biomechanics and Optimizing Performance in Elite Sports

#### BIOMECHANICS FOR PERFORMANCE OPTIMIZATION IN ELITE CROSS-COUNTRY SKIING

Stöggl, T.

*University of Salzburg*

Cross-country skiing (XCS) demonstrates a large variety in a) skiing techniques (skating and classical as basic technique categories with up to five sub techniques) that use both the upper and lower body to various extents for propulsion, b) race distances in the World Cup ranging from ~1k up to 90k (Vasaloppet), and c) competition modes (single start, sprint, team sprint, pursuit). Altogether, XC skiing is determined by a multiplicity of factors such as aerobic and anaerobic capacity, power, strength, speed, technical level, equipment, etc. This variety in XC skiing constitutes a challenge for athletes, coaches and scientists, and gives wide scope for research to study and enhance performance. Biomechanics can serve for detailed technique description, to determine performance predicting variables, to develop test concepts in diagnostics and provide input data for sport equipment analysis and development. Applied methods reach from simple stationary 2D video analysis up to complex measures combining pole/plantar forces, EMG, 3D measurements and positioning data. Associated with this, recent studies proposed new strategies in the double poling technique (Holmberg et al 2005), the double-push (Stöggl et al 2008,2010), and the running diagonal stride (Stöggl&Müller 2009) and characterized modern technique by high peak forces and force impulses combined with enlarged recovery phase and cycle length. By application of a dGNSS system combined with 2D video analysis, absolute skiing speeds, technique use and tactical skills during a sprint competition were determined (Andersson et al. 2010). Furthermore, based on biomechanical findings, new test concepts for XCS diagnostics were established, demonstrating that short duration maximal skiing speed together with general and specific maximal and explosive strength tests were shown to be good predictors of XCS performance (Stöggl et al. 2007, Andersson et al. 2010, Sandbakk et al 2010). Biomechanical data further allows for analysis of skiing equipment e.g. pole behaviour (Stöggl&Holmberg 2011) or the clap skate (Stöggl&Lindinger2006). Goals for XCS biomechanics are improvements in measurement technology towards a single measure and data collection unit for collection of pole/plantar forces, EMG, 3D, etc., with low weight and size, wireless data transmission over large distance at high sampling rate. As a consequence subject preparation, data collection and data analysis might be greatly accelerated, and allow for greater sample sizes and larger measurement area in the field. References Andersson et al(2010) EJAP,110,585-95. Holmberg et al(2005) MSSE,37,807-818. Sandbakk et al(2010) SJMSS, Epub. Stöggl et al(2007) SJMSS,17, 362-372. Stöggl et al (2008) JSS,26,1225-1233. Stöggl et al(2010)MSSE,42,187-96. Stöggl&Müller (2009)MSSE,41,1476-87. Stöggl&Holmberg(2011)SJMSS,Epub Stöggl&Lindinger(2006)ISBS

#### THROWING PERFORMANCE IN ELITE TEAM HANDBALL

Wagner, H., von Duvillard, S.P., Müller, E.

*University of Salzburg*

THROWING PERFORMANCE IN ELITE TEAM HANDBALL Wagner, H.1, von Duvillard, S.P.2, Müller, E.1 1: US (Salzburg, Austria), 2: UTAD (Oslo, Norway) In team-handball, the objective of the game is to score goals. To succeed in scoring goals, team-handball players utilize different throwing techniques to maximize throwing precision and ball velocity. When comparing elite vs. low level players in the team-handball jump throw, it was shown that team-handball players, who were taller and weigh more, achieved a higher ball velocity in the jump throw. In addition, an increase in trunk flexion and rotation angular velocity improves the performance in team-handball jump throw that results in an increase in ball velocity (Wagner et al., 2010b). No significant differences were found in the throwing precision, we therefore conclude that there is no speed-accuracy trade-off in team-handball throwing. In the over-arm movements with high endpoint-speed, an optimal transfer of momentum from proximal to distal is important to improve performance. In team-handball throwing a specific proximal-to-distal sequence of the joint movements was found (Wagner et al., 2012), where the elbow flexion occurred before the shoulder internal rotation. This specific proximal-to-distal sequence was found in elite, experienced and highly experienced players; however, length of playing experience resulted in a delayed start of the trunk flexion. In team-handball competition, 73-75% of all throws during the game constitute jump throws, followed by the standing throw with run-up (14-18%), penalty throw (6-9%), diving throw (2-4%) and direct free throw (0-1%) (Wagner et al., 2008). Comparing different throwing techniques in team-handball, it was shown that depending on the floor contact (standing vs. jump throws), elite players used two different strategies (lead leg braced the body vs. opposed leg movements during flight) to accelerate the pelvis and trunk to yield differences in ball velocity (Wagner et al., 2011). However, elite players were able to adapt to differences in the lower body and trunk movements that enable similar movements of the throwing arm. These similar movements of the throwing arm were also found when comparing team-handball throws with different arm positions; however, trunk movements and ball velocity was significantly different (Wagner et al., 2010a). References Wagner H, Buchecker M, von Duvillard SP, Müller E. (2010a). J Sports Physio Perform, 5, 469-483. Wagner H, Buchecker M, von Duvillard SP, Müller E. (2011). J Sports Sci Med, 10, 73-80. Wagner H, Pfusterschmied J, von Duvillard SP, Müller E. (2010b). J Sports Sci Med, 9, 15-23. Wagner H, Pfusterschmied J, von Duvillard SP, Müller E. (2012). J Sports Sci, 30, 21-29. Wagner H, Kainrath S, Müller E. (2008). Leistungssport, 38, 35-41.

**GOLF SPORTS SCIENCE SERVICES - BIOMECHANICAL CONCEPTS AND CHALLENGES**

Wallace, E.S.

*University of Ulster*

GOLF SPORTS SCIENCE SERVICES - BIOMECHANICAL CONCEPTS AND CHALLENGES WALLACE, E.S. SPORT & EXERCISE SCIENCES RESEARCH INSTITUTE, UNIVERSITY OF ULSTER The purpose of the golf drive is to propel the ball a large distance with a degree of accuracy to optimise the playability of the next shot. The pioneering work of Cochran and Stobbs (1968) proposed a double pendulum model of the down-swing to explain the basic mechanics and showed that the combined effect of inertia and centripetal force acting on the lower lever can create a well-controlled swing. Since then there have been a plethora of studies on the biomechanics of the golf swing (leg kinematics, kinetics, EMG) yet less than a decade ago it was claimed that our understanding of golfer's interaction with the club is still too crude to fit clubs to people properly. Betzler et al., (2008) provided a comprehensive review of existing biomechanical models and simulations of the golf swing in order to progress the design of future modelling and simulation studies. Over the last couple of decades we aimed to gain a better understanding of not only the biomechanics of the golf swing but also the effect of golf equipment on the swing and ultimately how we can translate this knowledge to the coaching process. The method by which the coach achieves technical improvements has been illustrated for gymnastics as a conceptual model of technique and performance by Irwin and Kerwin (2007). The most widely measured kinematic parameters related to golf performance outcomes are hip and shoulder rotations and in particular, the resulting X-factor (Horan et al., 2010). Wallace et al. (2007) studied the effects of shaft length on driving performance and showed a significant difference in initial ball launch speed due to a main effect of club length, a significant difference between participants, but no difference between the intra-subject trials. Betzler et al. (2012) showed greater variability in a range of clubhead presentation variables for lesser skilled golfers compared to highly skilled players, while in a study focussing on elite female golfers, Brown et al. (2011) showed there was no common technique for optimal performance and the need remains to focus on individual aspects. Ball and Best (2006), using a cluster analysis method, identified 2 centre of pressure patterns which were associated with both highly skilled players and lesser skilled players and highlighted the importance of identifying different movement strategies before evaluating performance measures (Ball and Best, 2007). References . Ball and Best, 2007a J Sports Sci, 2007,757-70. Ball and Best, 2007b,25,771-79. Betzler et al. 2008, Sports Technol,1,175-88. Betzler et al. 2012, J Sports Sci,30,439-48. Brown et al. 2011, J Sports Sci,29,1483-91. Cochran and Stobbs,1968,The search for the perfect swing. Horan et al, 2010. J Biomech,43,1456-462. Irwin and Kerwin, 2007. Introduction to sports coaching. Wallace et al. 2007, J Sports Sci25,731-737.

**16:05 - 17:35****Oral presentations****OP-BN08 Sports Biomechanics 3****OPTIMAL FORCE-VELOCITY PROFILE FOR EXPLOSIVE PERFORMANCES: THEORETICAL AND EXPERIMENTAL EVIDENCES**

Samozino, P., Edouard, P., Gimenez, P., Morin, J.B.

*Universités de Savoie et de Saint-Etienne*

OPTIMAL FORCE-VELOCITY PROFILE FOR EXPLOSIVE PERFORMANCES: THEORETICAL AND EXPERIMENTAL EVIDENCES Samozino P, Edouard P, Gimenez P, Morin JB Laboratory of Exercise Physiology, University of Savoie (Le Bourget-du-Lac, France) Laboratory of Exercise Physiology, University of Lyon (Saint Etienne, France) Explosive performances have been shown to directly depend on power capabilities of lower limb neuromuscular system (e.g. Yamauchi et al. 2007). Recently, through an integrative model, Samozino et al. (2012) put forward that jumping performance was mostly determined by lower limb maximal power (Pmax), but also by their mechanical force-velocity (Fv) profile describing the balance between force and velocity capabilities. For each individual, an optimal Fv profile maximises performance, while unfavourable Fv balances leads to performance alterations up to 30%. Even if the model was validated through experimental data, contributions of both Pmax and Fv profile to explosive performances have not been experimentally reported yet. This study aimed to bring experimental supports to the effect of F-v profile on jumping performance, independently from the effect of Pmax. Jumping performance, Pmax, Fv profile and lower limb extension range (Hpo) were measured in 33 high-level soccer players and athletes (including a sub-10 s sprinter). Subjects performed maximal squat jumps with different additional loads from 0 to 100% of body mass. During each jump, mean force, velocity and power output were measured using flight time in a simple computation method (Samozino et al. 2008). Individual linear Fv relationships were obtained to determine Fv profile and Pmax values for each subject (Samozino et al. 2012, Yamauchi et al. 2007). The optimal Fv profile was computed (Samozino et al. 2012) and used to determine Fv imbalance as: 1-(Fv profile / optimal Fv profile). Based on the recent model, a multiple regression analysis was performed with unloaded jump height as dependent variable and Pmax, Fv imbalance and Hpo as independent ones. The multiple regression presented a high adjustment quality ( $r = 0.977$ ,  $r^2 = 0.955$ ,  $P < 0.001$ ,  $SEE = 0.013$  m) and showed high significant contributions of the three independent variables to explain interindividual differences in jumping performance ( $P < 0.001$ ). Regression coefficients were positive for Pmax and Hpo and negative for Fv imbalance. This experimentally confirmed the theoretical predictions obtained from the integrative biomechanical model recently proposed (Samozino et al. 2012). Jumping performance depends on Fv profile independently from the large effect of Pmax: a Fv imbalance induces lower performances for a given Pmax. Moreover, for given Pmax and Fv profile, individuals with higher Hpo presented higher performances. Samozino P, Rejc E, di Prampero PE, Belli A, Morin JB (2012) Med Sci Sports Exer 44 : 312-22 Samozino P, Morin JB, Hintzy F, Belli A (2008) J Biomech 41: 2940-5 Yamauchi J, Ishii N (2007) J Strength Cond Res 21: 703-9

## **BODY-WEIGHT SUPPORTED SPRINT RUNNING – AN EFFECTIVE METHOD TO GENERATE REDUCED GROUND CONTACT TIMES IN WELL TRAINED SPRINTERS**

Kratky, S., Müller, E.  
*University of Salzburg*

Introduction Time on the ground is the crucial part of sprinting as the available time frame to apply force to the ground diminishes with increasing running velocity (Mero et al. 1992; Weyand et al. 2000). Data of elite sprinters indicate that faster athletes realize shorter ground contact times compared to slower individuals (Mann 2010). The aim of this study was to investigate effects of body-weight support during full-effort sprints and overspeed sprints on kinematic stride parameters and especially ground contact time in 19 Austrian male elite sprinters. Methods A kite with a lifting effect combined with a towing system to erase drag was utilized. Subjects performed flying 20m-sprints under three conditions: (1) free sprint; (2) body-weight supported sprint – normal speed (BWS-NS); and (3) body-weight supported sprint – overspeed (BWS-OS). Sprint cycle characteristics were recorded during the high-speed phase by an optical acquisition system. One-way analyses of variance for repeated measures were used to determine differences between sprinting conditions and partial Eta-squared was used to determine effect-size (ES). Results Compared to the free sprint, running velocity, step length, and step frequency remained unchanged during BWS-NS, while ground contact time decreased (-5.80%,  $p < 0.001$ ,  $ES = 0.85$ ) and air time increased (+5.79%,  $p < 0.001$ ,  $ES = 0.79$ ). Throughout BWS-OS ground contact time (-7.66%,  $p < 0.001$ ,  $ES = 0.85$ ) was reduced, whereas running velocity (+2.72%,  $p < 0.001$ ,  $ES = 0.91$ ), air time (+4.92%,  $p < 0.001$ ,  $ES = 0.72$ ), step length (+1.98%,  $p < 0.001$ ,  $ES = 0.58$ ) and step frequency (+1.05%;  $p < 0.01$ ,  $ES = 0.39$ ) increased. Compared to BWS-NS, BWS-OS caused an increase in running velocity (+3.33%,  $p < 0.001$ ,  $ES = 0.94$ ), step length (+1.92%,  $p < 0.001$ ,  $ES = 0.62$ ), and step frequency (+1.37%,  $p < 0.01$ ,  $ES = 0.39$ ), while ground contact time was diminished (-1.97%,  $p < 0.001$ ,  $ES = 0.48$ ). Discussion In summary, sprinting with a body-weight supporting kite appeared to be a highly specific method to reduce ground contact times in well trained sprinters. The additional application of an overspeed condition led to a further reduction of ground contact time. Therefore, we recommend body-weight supported sprinting as an additional tool in sprint training. References Mann R (2010) The mechanics of sprinting & hurdling. The European Sprints and Hurdles Conference. UK-Athletics, London, p. 230 Mero A, Komi PV, Gregor RJ (1992) Biomechanics of sprint running. A review. Sports Med 13: 376-392 Weyand PG, Sternlight DB, Bellizzi MJ, Wright S (2000) Faster top running speeds are achieved with greater ground forces not more rapid leg movements. J Appl Physiol 89: 1991-1999

## **MINIMIZING VELOCITY FLUCTUATIONS IN ROWING IMPROVES PERFORMANCE IN CREW ROWING; BREATHING NEW LIFE INTO AN OLD IDEA**

Hofmijster, M.J., De Brouwer, A.J., De Poel, H.J.  
*Vrije Universiteit Amsterdam*

Introduction Competitive rowing performance is defined as the time to cover a certain race distance, usually 2000m. The power equation can be used to investigate rowing performance. It shows that power dissipation can be divided into useful power (i.e. power needed to overcome resistance) and wasted power, namely power lost during the push off and power lost to speed fluctuations (e.g. Hofmijster et al. 2007). From this perspective, a rowing crew can increase performance by either maximizing power output or by minimizing power losses. In the 1920's of the previous century, an interesting strategy was attempted to minimize speed fluctuation losses in an eight. By having pairs of the crew row in 90 degree antiphase, a more continuous boat run was achieved and checking of the boat was minimized. Nevertheless, the strategy was not successful and subsequently abandoned for being "too difficult". We reinvestigated this idea of "syncopated rowing" using a less complicated strategy where we had pairs of rowers perform in phase and in 180 degree antiphase on a set of coupled free floating ergometers. Ergometer motion was resisted using a linear damper to introduce power losses to velocity fluctuations (see also Hofmijster et al. 2008). We hypothesized that velocity fluctuations would be much smaller for antiphase rowing, resulting in higher efficiency. We also hypothesized that power output might be negatively influenced for the antiphase situation as antiphase rowing might be more difficult to execute. Methods Nine pairs of rowers performed a 2 minute in phase and a 2 minute antiphase maximum effort trial at 36 strokes/min. Kinematics of ergometers and both rowers were recorded as well as pulling forces on both handles. Useful power was defined as the power dissipated in both flywheels combined. Wasted power was defined as the power dissipated by the linear damper. Crew coordination accuracy was determined as the average absolute deviation from the intended phase difference between the rowers. Results All nine pairs easily managed to row in antiphase coordination, while one of the pairs showed a transition from antiphase to inphase coordination during the maximum effort trial. Although for antiphase rowing the interpersonal coordination was indeed less accurate, power production was not affected. Importantly, in antiphase rowing the decreased power loss to velocity fluctuations resulted in more useful power being transferred to the ergometer flywheels, hence in better performance. Conclusion The results imply that antiphase coordination indeed improves rowing performance, even without any experience with the antiphase technique, thereby encouraging further study exploration of (on-water) antiphase crew rowing. References Hofmijster, M.J., E.H. Landman, R.M. Smith, and A.J. van Soest. (2007). J Sports Sci. 25:403-411 Hofmijster, M.J., A. van Soest, and J. de Koning. (2008). Med Sci Sports Exerc. 40:1101-1110

## **A COMPARISON OF ELLIPTICAL ZONE AND 3D SCANNING CALCULATING METHODS OF ESTIMATING SWIMMER'S BODY SEGMENT VOLUMES**

Machtsiras, G., Sanders, R.  
*The University of Edinburgh*

A COMPARISON OF ELLIPTICAL ZONE AND 3D SCANNING CALCULATING METHODS OF ESTIMATING SWIMMER'S BODY SEGMENT VOLUMES Machtsiras, G. 1, 2, & Sanders, R. 1 1:UoE (Edinburgh, UK), 2:ENU (Edinburgh, UK) Introduction In swimming, anthropometric data are combined with three-dimensional motion analysis techniques to compute the centre of mass (CM) location of the body segments and whole body (WBCM). Kinematics and kinetics of the body motion can then be derived. For this reason high accuracy is necessary to identify the location of the WBCM precisely. The 'e-Zone' software developed by Deffeyes and Sanders (2005) is a modified version of the elliptical zone method (Jensen, 1978) enabling the identification of the location of the segment CMs and subsequently the WBCM. The body is divided into segments and each segment is modelled as a series of elliptical cylinders whose volume is computed and summed to make the volume of the whole body (WB). The aim of the current study is to assess the accuracy of the e-Zone software by comparing directly the volume of each body segment measured by 3D scanning. Method A national level swimmer volunteered to participate in the study. The volume of the head, neck, thorax, abdomen, right upper limb and right lower limb segment was measured when standing in

the anatomical position with the use of the e-Zone software and also with the use of 3D body scanning techniques. Symmetry in the sagittal plane was assumed and only the right upper and lower limbs were measured in both cases. A front and side view photograph was taken simultaneously for the requirement of the e-Zone method and the radii of each elliptical cylinder was measured from the photographs with manual digitizing. The digitizing process was repeated five times to establish reliability. In parallel, a 3D laser scanner (Hamamatsu®) was employed to create an accurate 3D representation of the swimmer's body. The model was then edited and segmented with the use of Rhinoceros® software whereas the segment volumes were measured with the use of the Magics® software. Results The volume of the WB was computed to be 74230.90 cm<sup>3</sup> with the eZone method and 76613.90 cm<sup>3</sup> with the 3D scanning technique. The head and neck volume was overvalued by 3.7% whereas the core, the right upper and lower limb were undervalued by 3%, 2.7% and 4.5% respectively. Discussion The findings of this study demonstrate that the volume of the full body was undervalued. These findings suggest that the estimates of segment mass and the location of the WBCM could have been affected. Further investigation of the accuracy of the e-Zone method with a greater number of participants and of both genders is necessary to draw a safe conclusion. Also, the effect of the WB volume measurement error in the location on the WBCM should be investigated. References Deffeyes J & Sanders R, (2005). In, Wang Q (Ed.): Proceedings of the XVII International Symposium on Biomechanics in Sports. Beijing, China. Pp. 749-752. Jensen, R.K. (1978). Journal of Biomechanics, 11, 349-358.

### SPRINT RUNNING MECHANICS: A CASE STUDY OF A WORLD-CLASS ATHLETE

Morin, J.B., Bourdin, M., Edouard, P., Peyrot, N., Samozino, P.

*Laboratoire de Physiologie de l'Exercice*

SPRINT RUNNING MECHANICS: A CASE STUDY OF A WORLD-CLASS ATHLETE Morin, JB.1, Bourdin, M.2, Edouard, P.1, Peyrot, N.3, Samozino, P.4 1: LPE, University of Lyon (Saint Etienne, France), 2: LBMC, University of Lyon (Lyon, France), 3: DIMPS, University of La Réunion (Le Toupon, France), 4: LPE, University of Savoy (Le Bourget du Lac, France) Introduction To date very few experimental data have been obtained directly on world-class sprinters. The recent validation of a sprint instrumented treadmill (Morin et al., 2010) allowed us to introduce the concept of effectiveness of force application throughout sprint acceleration and to show its relationship with 100-m performance in non-specialists (Morin et al., 2011). We tested here our recent hypothesis that the forward orientation of the resultant force onto the ground was better related to sprint performance than its magnitude, in a population including a sub-10 s individual. Methods The biomechanics and field 100-m performance of a world-class sprinter (WCS, 2011 best times of 9.92 s and 19.80 s on the 100-m and 200-m, respectively) were tested and compared to those of three national-level sprinters (NLS), and nine physical education students (PE). Subjects performed 6-s sprints on an instrumented treadmill during which horizontal, vertical and resultant ground reaction forces (GRF), and belt velocity were continuously recorded and used to compute linear force-velocity relationships. An index of the force orientation effectiveness (DRF) was also computed as the slope of the linear relationship between the decrease in the ratio of contact-averaged horizontal-to-resultant GRF and the increase in velocity (Morin et al. 2011). A 100-m field sprint was also performed with performances were recorded with a radar. Results WCS differed by more than 2 SD from the NLS and 2 to 4 SD from the PE for the slope of his force-velocity relationship (~25 % more oriented towards velocity muscular qualities), his ability to orient the resultant GRF forward during acceleration (~43 % better DRF) and his step frequency (~5 % higher, resulting only from a lower contact time). Contrastingly, he did not differ from NLS and some of the PE for the magnitude of resultant force produced. Discussion The main mechanical determinants characterizing this WCS were (i) a "velocity-oriented" force-velocity profile, likely explained by (ii) a higher ability to apply the resultant GRF vector with a forward orientation over the acceleration. Despite similar resultant force capabilities compared to NLS and PE, the WCS showed a better forward orientation of the resultant force onto the ground during acceleration, which confirmed our recent hypothesis that what matters to acceleration and sprint performance is more the orientation of the resultant force than its magnitude. References Morin JB, Samozino P, Bonnefoy R, Edouard P, Belli A. (2010) J Biomech, 43, 1970-1975. Morin JB, Edouard P, Samozino P. (2011). Med Sci Sports Exer, 43, 1680-1688.

### STRONG POSITIVE CORRELATIONS WERE FOUND BETWEEN MUSCLE ACTIVATION AND BREASTSTROKE SPEED MEASURED WITH 3D AUTOMATIC TRACKING

Olstad, B.H., Zinner, C., Cabri, J., Haakonsen, D., Kjendlie, P.L.

*1: NSSS (Oslo, Norway), 2: GSU (Cologne, Germany), 3: VUC (Toensberg, Norway)*

Introduction A limited number of studies have investigated the muscle activation during breaststroke swimming through the use of surface electromyography (sEMG). No previous studies have investigated kinematic variables in human swimming using motion capture (mo-cap) 3D with automatic tracking (AT). The aim of this study was therefore to investigate the relationship between muscle activation in eight different muscles and swimming velocity at five different efforts. Methods Four swimmers (one male, world championship medalist and three females, one Olympic medalist, one national medalist and one national finalist) performed one trial of 20m breaststroke at the speeds of 60%, 70%, 80%, 90% and 100% of maximum effort. During each trial the velocity of the swimmers right trochanter major and the muscle activation in biceps brachii, triceps brachii, trapezius (pars descendens), pectoralis major (pars clavicularis), rectus femoris, biceps femoris, tibialis anterior and gastrocnemius were recorded over three stroke cycles. Each stroke cycle started when the heels were fully pulled up, flexed and ready to kick. 3D images with AT were recorded from ten underwater mo-cap cameras (Oqus Underwater, Qualisys, Gothenburg, Sweden). The cameras recorded spherical markers (diameter of 19mm) fixed to the swimmers suit using cyan LED light. The muscle activity was recorded using waterproof electrodes and active sensors from (Plux Ltda, Lisbon, Portugal) and recorded according to (Olstad et al., 2011). Results Pearson's correlations was used to assess the relationship between the average velocity of trochanter major (representing hip speed) at the five different velocities with the average sEMG during the three stroke cycles. Strong positive and significant relationships were found for tibialis anterior  $r=.756$  ( $p<0.001$ ), biceps femoris  $r=-.666$  ( $p<0.001$ ), pectoralis major (pars clavicularis)  $r=.666$  ( $p<0.001$ ), biceps brachii  $r=.641$  ( $p<0.002$ ), triceps brachii  $r=-.622$  ( $p<0.01$ ). Positive but insignificant relationship was found for rectus femoris  $r=.448$ . Moderate positive and insignificant relationships was found in gastrocnemius  $r=.311$ . In trapezius (pars descendens) weak and insignificant relationship was found,  $r=-.028$ . Discussion The study showed a strong and significant relationship between muscle activation in five different muscles and average swimming velocity over five different speeds. It showed that velocity can be tracked using 3D AT and therefore opens up new possibilities for conducting kinematic analysis in swimming with 3D AT combined with measuring muscle activity through the use of sEMG. References Olstad, B. H., Cabri, J., Zinner, C., Nunes, N., & Kjendlie, P. L. (2011). SEMG measurements on land and in water prior to and after 60-90 minutes of submersion (swimming) are highly reliable. Portuguese Journal of Sport Sciences, 11 (Suppl. 2), 763-765.

16:05 - 17:35

## Oral presentations

### OP-PM38 Health and Fitness: Obese population

#### COMPARATIVE STUDY OF ENERGY EXPENDITURE MEASURED BY DIFFERENT DEVICES IN A CIRCUIT RESISTANCE TRAINING

Furukawa, M., Peinado, A.B., Benito, P.J., Zapico, A.G.

*Universidad Politécnica de Madrid*

COMPARATIVE STUDY OF ENERGY EXPENDITURE MEASURED BY DIFFERENT DEVICES IN A CIRCUIT RESISTANCE TRAINING Furukawa, M1; Peinado, AB1; Benito, PJ1; Zapico, AG2 1: Universidad Politécnica de Madrid, Spain; 2: Universidad Complutense de Madrid, Spain. INTRODUCTION Physical Activity (PA) is recommended by major health and sports medicine organizations to maintain good health[1]. The use of monitors of PA to measure energy expenditure (EE), such as accelerometers (AC), is a common practice in PA research studies because it is practical, relatively inexpensive and an easy-to-use method to estimate EE. However, the accuracy of the real EE measured by AC has been questioned. The aim of this study was to compare the accuracy of different devices of EE during a circuit resistance training (CRT). METHODS Six overweight subjects (body mass index  $27.02 \pm 2.75$  kg/m<sup>2</sup>) participated in this study. Each subject had to perform three sets of 15 maximum repetitions in a combined circuit training (strength and aerobic exercises) at 70% of their maximum weight load (strength exercises) and at 70% of their maximum heart rate (aerobic exercises). EE was measured by indirect calorimetry with the portable system Oxycon Mobile (OM) and with two ACs: Sense Wear Armband (SWA) 2-axis accelerometer and the MTI Actigraph single axis accelerometer (AG). The differences between the EE measurements were evaluated with an ANOVA. The significance level was set at 0.05. RESULTS The measured EE was  $364.83 \pm 95.96$  kcal for OM,  $337.40 \pm 98.52$  kcal for SWA and  $212.17 \pm 60.22$  kcal for AG. An underestimation of EE in kcal was found when we compared AG vs OM ( $p < 0.05$ ). Differences between SWA vs OM and SWA vs AG were not found ( $p > 0.05$ ). OM showed  $4.5 \pm 0.7$  METs, SWA  $3.2 \pm 0.7$  METs and AG  $3.3 \pm 0.21$  METs. Differences in METs were found comparing OM vs SWA and AG ( $p < 0.01$ ). There was no difference between SWA vs AG ( $p > 0.05$ ). CONCLUSION Our study found that AG underestimates EE during CRT. However, some studies such as Schmidt et al[2] and Strath et al [3] have reported overestimation. Drenowatz[4] reported that SWA does not accurately estimate EE at intensities above ten METs. However, futures studies are needed to improve the accuracy of SWA and AG. REFERENCES 1. Garber, C.E., et al., *Med Sci Sports Exerc*, 2011. 43(7): p. 1334-59. 2. Schmidt, M.D., et al., *Med Sci Sports Exerc*, 2003. 35(9): p. 1605-11. 3. Strath, S.J., D.R. Bassett, Jr., and A.M. Swartz, *Int J Sports Med*, 2003. 24(4): p. 298-303. 4. Drenowatz, C. and J.C. Eisenmann, *Eur J Appl Physiol*, 2011. 111(5): p. 883-7.

#### SCALING THE PEAK OXYGEN UPTAKE RESPONSES TO AEROBIC TRAINING IN OBESE MALES AGED 10-16 YEARS

Carvalho, H.M.1, Coelho e Silva, M.J.1, Milano, G.E.2, Titski, A.K.2, Radominski, R.B.2, Leite, N.2

*1 University of Coimbra; ; 2 Federal University of Paraná Brazil*

Introduction A disproportionate enlargement with bigger individuals is obvious, both in shape and composition and in particular in obese children and adolescents. There is a great interest on physical activity interventions for health related benefits. The available information about size relationships with peak oxygen uptake (VO<sub>2</sub>max) in obese adolescents is limited as well as their trend of change in response to training exposure. Hence, the aim of this study was to examine the peak oxygen uptake responses to aerobic training in obese males aged 10-16 years from an allometric perspective. Methods Thirty obese adolescent males ( $12.5 \pm 1.7$  yrs) were measured in the pre- and post 12 weeks of multidisciplinary training program. Stage of pubic hair development was assessed at clinically. Body mass (BM) was measured and fat-free mass (FFM) was estimated by bioelectrical impedance (Biodynamics®). VO<sub>2</sub>max was assessed (Balke protocol) on treadmill using a calibrated breath-by-breath monitoring system (Parvo Medics, True Max 2400, Utah, USA). The training program consisted on physical exercise sessions, nutritional intervention and three educational meetings. Nonlinear allometric modeling was used to partition variation in body size on VO<sub>2</sub>max in beginning and after 12-week training program. Proportional allometric model incorporating the chronological age within an exponential term in addition to the body size components to accommodate both mass (or BM or FFM), age when modeling VO<sub>2</sub>max was also used. We also investigated the effect of maturity status, but it was not significant in all the proportional allometric models. Results Values of VO<sub>2</sub>max significantly increase with training program [pre-training:  $2.41$  (0.67) L/min; post-training:  $2.65$  (0.65) L/min,  $p < 0.01$ , ES =0.38]. The estimates for size exponents (95% CI) from the separate allometric models for VO<sub>2</sub>max before vs after training program were, respectively: BM  $1.01$  (0.67–1.36) vs  $0.82$  (0.48–1.15), FFM  $1.11$  (0.84–1.37) vs  $1.05$  (0.81–1.28). Estimates for size exponents (95% CI) from the separate proportional allometric models for VO<sub>2</sub>max before and after training program were, respectively: BM  $0.62$  (0.21–1.03) and age  $0.07$  (0.02–0.12) vs  $0.48$  (0.13–0.83) and  $0.07$  (0.03–0.11), FFM  $0.87$  (0.48–1.27) and age  $0.04$  ( $p > 0.05$ ) vs  $0.88$  (0.47–1.21) and  $0.03$  ( $p > 0.05$ ). Discussion/Conclusion The results showed a change in the VO<sub>2</sub>max–BM relationship as response to a 12-week training program. The relationships of VO<sub>2</sub>max with BM and FFM in obese adolescent were differently affected by the responses to training. VO<sub>2</sub>max–body size relationships in response to training in adolescent obese males do not appear to be influenced by inter-individual variability in maturity status.

#### VERIFICATION OF THE SENSEWEAR® PRO ARMBAND TO ESTIMATE ENERGY EXPENDITURE OF LOW-INTENSITY, DAILY ROUTINE ACTIVITIES BY DIFFERENT BODYWEIGHT GROUPS

Eckert, K., Lange, M., Hermsdorf, M., Wagner, P.

*University of Leipzig*

Introduction Assessing low-intensity physical activity (PA) accurately is a major challenge in sport science. Each of the current methods of assessing PA and energy expenditure (EE) has limitations. Spirometry is regarded as a very precise measure of EE for physical activity (Jakicic et al., 2004), but this technique is not feasible for studies in the field. The aim of our investigation was therefore to evaluate, how accurate the SenseWear Pro Armband (multisensory device) (SW) measures low-intensity, daily routine activities depending on BMI (WHO classification) compared to portable spirometry MetaMax® 3b (Cortex, Germany) (MM) by normal, overweight and obese participants. Methods We were able to include 47 participants to our study (♀=31, ♂=16). Mean age was 70,5 (standard deviation sd=4,9) and mean



BMI 27,42 (sd=3,3). All participants were asked to perform the following activities under standardized conditions: sitting, walking (3,2 km/h), vacuuming, cycling (50 watt) and stair stepping for three minutes each with a resting time of six minutes in between. Data were taken by SW and MM to measure EE for each activity. T-tests, ANOVA and Pearson correlations were used for calculation. Results Our findings show that the measurements of four out of five activities with the SW are significant lower than those with the MM. Only sitting reached higher results. Looking at different BMI groups (BMI: <25, n=13; ≥25 to <30, n=21; ≥30, n=13), it can be observed that these differences become taller with increasing BMI. It is also noticeable that especially the activities cycling ( $p<.001$ ,  $t=15,88$ ) and vacuuming ( $p<.001$ ,  $t=5,67$ ) have been quantified clearly different between the measurement devices. Overall, interclass correlations for sitting, walking and vacuuming ( $p<.001$ ) proved to be moderate with correlation coefficients between  $r=.648$  to  $.741$ . Discussion This study supports existing literature that body mass strongly impacts EE during a given PA (LeCheminant et al., 2009). For further studies in this field, it would be important to investigate whether the SW can recognize and define more specifically the transition from resting levels to light activities. References Jakicic JM, Marcus M, Gallagher KI, Randall C, Thomas E, Goss FL & Robertson RJ (2004). Evaluation of the SenseWear Pro Armband™ to assess energy expenditure during exercise. *Med Sci Sports Exercise*, 36:897-904. LeCheminant JD, Heden T, Smith J, Covington NK (2009). Comparison of energy expenditure, economy, and pedometer counts between normal weight and overweight or obese women during a walking and jogging activity. *Eur J Appl Physiol*, 106:675-682.

### **HORMONAL, ANTHROPOMETRIC AND BIOCHEMICAL CHANGES IN OBESE SUBJECT SUBMITTED AT RESISTANCE TRAINING PROTOCOL: A HEALTH PROMOTION MODEL**

Pimenta, L.D.1, Neiva, C.1,2,3, Guimaraes, B.R.1, Verardi, C.E.L.2, Furukawa, M.3, Zaia, J.E.1

1: UNIFRAN (Franca, Brasil), 2: UNESP (Bauru, Brasil), 3: UPM (Madrid, España)

Introduction Obesity can currently be defined in a simplified way. That is an illness characterised by excessive storage of fat, as a consequence of positive energetic balance. Thus, it causes health issues with significant losses in both quality of life and life expectancy of obese individuals. Endocrine-metabolic, biochemical and anthropometric alterations are ordinarily observed in obese women. Therefore, evidence allows us to affirm that excessive weight plays an important role in relation to the appearance of degenerative diseases, which are increasingly detected in women. Physical exercise causes alteration in the rhythms or levels of secretions of certain hormones, such as Growth Hormone (GH), Triiodothyronine (T3), and insulin, and they, in turn, are directly involved in controlling and treating obesity. As a result, resistance exercise protocols and weight training exercise have shown effective results in obese individuals not only with the increase of bone mass, strength and muscle mass, but also in the loss of fat mass. Thus, the aim of this research was to study the effects of a strength training protocol on obese women's hormonal, biochemical and anthropometric variables and their impact on these individuals' health promotion. Methods Seventeen obese women from 24 to 56 years of age submitted themselves to the resistance muscular training oriented protocol in the percentage of 15RM, performed in circuit form, for 8 weeks in three weekly sessions lasting 50 minutes each. Additionally, pre- and post-applications of training were carried out on the selected women, as well as anthropometric, hormonal, and biochemical evaluations. Results After 8 weeks of training, results showed the efficiency of the training protocol in reducing TG values, and in significantly improving ( $p<0,01$ ) the levels of this biochemical variable on the investigated group. With reference to T3, the results after applying the protocol also showed a statistically different reduction ( $p<0,05$ ) regarding the values of this hormone, which can be explained by negative regulation of their blood concentrations, regarding an improvement of its performance and significant raising of its metabolic rate. When it comes down to the other investigated variables (GH, insulin, IMC and RCQ), the protocol did not show any significant alterations. Discussion The regular practice of the physical training protocol can contribute to reducing TG rates on obese adult women, which can produce favourable metabolic alterations observed by variation of tri-iodine ironia blood centralisation, even if anthropometric alterations are not noticed. This result is an important indicative of promotion of these individuals' health.

### **PHYSICAL ACTIVITY PATTERNS OF OBESE CHILDREN AND THEIR PARENTS**

Sartor, F., de Groot, K., Boughorbel, S., Breebaart, J., van Mil, E.

*Philips Research*

Introduction Child Obesity is a worldwide spread epidemic, in 2010 it was estimated that 43 million children are overweight and obese and 92 million are at risk of overweight (de Onis 2010). The etiology of child obesity is multifactorial, however the environmental component is of paramount importance (unlimited food availability & low physical activity). Parents should and can provide a healthy environment that minimizes exposure to temptations (Golan 2011), and help to promote healthy behaviors, such as healthy eating, and regular physical activity. The aim of this study was to monitor objectively physical activity in obese children undergoing a lifestyle change coaching program, and their parents to see whether these are correlated. A secondary aim was to monitor the adherence to wear an unobtrusive physical activity monitor. Methods Eighty-three participants took part in this study (46 females and 37 males), which consisted of 28 families, 32 obese children (16 boys and 16 girls) and 46 parents (25 mothers and 21 fathers). Those families took part in a lifestyle coaching program, provided by the local Hospital. One physical activity monitor (TracmorD, Philips) was given to each participant. The observation period lasted 3 months. Wearing time was analyzed only if the activity counts were above 500 counts/min. The activity data were considered for correlation analysis only if they were above 1000 counts/min. PAL conversion was done using Bonomi's et al. formula (2010). Results The total wearing time for children was 16.1% (including day and night), whereas total wearing time for mothers, fathers and coaches was 15.0%, 16.0%, 24.0% respectively. Children had an average PAL of  $1.70 \pm 0.18$ , mothers of  $1.55 \pm 0.13$ , fathers of  $1.51 \pm 0.11$  and coaches of  $1.58 \pm 0.12$ . The Pearson's correlation between obese children PAL and their parents' PAL was  $r = 0.271$ ,  $t(19) = 1.226$ ,  $p$ -value = 0.235. Discussion We observed that physical activity of obese children was not correlated with the physical activity of their parents. Wearing time over 3 months observation period in the obese children and in their parents was rather low. The higher PAL in children than in their parents could be due to their anthropometric differences. However, children's PAL in this study was similar to non-obese children's PAL (Ekelund et al 2004). References de Onis et al., Global prevalence and trends of overweight and obesity among preschool children. *Am J Clin Nutr* 2010, 92:1257-64 Golan, Good-Enough Parenting, Self-Regulation, and the Management of Weight-Related Problems. *Global Perspectives on Child Obesity* 2011, 43-55 Bonomi et al., Estimation of free-living energy expenditure using a novel activity monitor designed to minimize obtrusiveness. *Obesity* 2010; 18(9): 1845-51 Ekelund et al., Body movement and physical activity energy expenditure in children and adolescents: how to adjust for difference in body size and age. *Am J Clin Nutr* 2004; 79:851-6

16:05 - 17:35

## Oral presentations

## OP-PM39 Neuromuscular Physiology 2

**THE CONTRIBUTION OF MUSCLE HYPERTROPHY TO INTER-INDIVIDUAL VARIABILITY IN THE STRENGTH RESPONSES TO ELBOW FLEXOR RESISTANCE TRAINING**

Erskine, R.M.1, Fletcher, G.2, Folland, J.P.2

*(1) Manchester Metropolitan University, UK; (2) Loughborough University, UK.*

**Introduction** Although maximum force generation is proportional to muscle size, there is surprisingly little evidence to suggest that training-induced gains in human muscle strength are related to hypertrophy. Therefore, we aimed to determine the contribution of muscle hypertrophy to the inter-individual changes in isometric and isoinertial strength in response to 12-wk elbow flexor resistance training (RT). **Methods** Thirty-three previously untrained, healthy men (18-30 yr) completed 3-wk elbow flexor RT, followed by 6-wk no training, and then 12-wk RT. The initial 3-wk RT provided extensive familiarisation and facilitated neural adaptations that might confound muscular responses to the subsequent 12-wk RT, which was performed 3 x per wk with unilateral and bilateral preacher curls [2-3 sets of each exercise; 8-10 repetition maximum (RM)]. The following assessments were made pre and post 12-wk RT: muscle strength [isometric maximum voluntary force (MVF) at an elbow joint angle of 120° (180° = full extension) and unilateral preacher curl 1-RM]; total agonist muscle volume (Vm) and sum of maximum anatomical cross-sectional areas of agonist muscles ( $\Sigma$ ACSAmax), both assessed with 1.5T MRI; agonist muscle fascicle pennation angle, measured with ultrasound; muscle activation [EMG at MVF and during the 1-RM normalised to Mmax (agonists) or maximum EMG during maximum isometric elbow extension (antagonists) or during maximum isometric bench press (stabilisers)]. **Results** Following 12-wk RT, there were increases in Vm ( $15.9 \pm 6.0\%$ ,  $P < 0.0005$ ),  $\Sigma$ ACSAmax ( $15.9 \pm 5.8\%$ ,  $P < 0.0005$ ) and pennation angle ( $16.2 \pm 7.5\%$ ,  $P < 0.0005$ ), and the relative gains in pennation angle correlated with % increases in both Vm ( $R^2 = 0.184$ ,  $P = 0.013$ ) and  $\Sigma$ ACSAmax ( $R^2 = 0.215$ ,  $P = 0.007$ ). MVF and 1-RM increased by  $13.2 \pm 9.1\%$  ( $P < 0.0005$ ) and  $41.6 \pm 19.9\%$  ( $P < 0.0005$ ), respectively, and these strength gains correlated with the % increase in Vm (MVF,  $R^2 = 0.28$ ,  $P = 0.002$ ; 1-RM,  $R^2 = 0.23$ ,  $P = 0.005$ ). However, strength gains were unrelated to changes in pennation angle ( $R^2 \leq 0.04$ ;  $P \geq 0.25$ ). Furthermore, there were no changes in normalised agonist EMG ( $P \geq 0.167$ ) or stabiliser EMG ( $P \geq 0.058$ ) when measured at MVF or during 1-RM. **Conclusion** We have shown for the first time that, following 12-wk elbow flexor RT in young men, muscle hypertrophy explains ~28% and ~23% of the inter-individual variability in isometric and isoinertial strength changes, respectively. This provides clear evidence that the individual hypertrophic response does influence the functional adaptations that occur with RT. **Acknowledgement** This study was sponsored by GlaxoSmithKline Nutritional Healthcare UK.

**DYNAMIC OUTPUT OF TWO TYPES OF VERTICAL JUMPS PERFORMED WITH POSITIVE AND NEGATIVE LOADING**

Suzovic, D.1, Pasic, M.1, Markovic, G.2, Jaric, S.3

*1Faculty of Sport and Physical Education, Belgrade, 2Faculty of Kinesiology, University of Zagreb, 3Department of Health, Nutrition, and Exercise Sciences, University of Delaware, Newark, DE*

**Introduction** The aim of this study was to evaluate the effects of positive and negative external loading on mechanics of the two types of vertical jumps (Markovic, Jaric, 2007). We hypothesized that the muscular mechanical output could be higher under no-load conditions than in the presence of either positive or negative external loads (Jaric & Markovic 2009; Leontijevic et al. 2012), as well as that the output would be lower for the counter movement jump performed without (CMJ) than with the arm swing (CMJWA). **Methods** Thirteen physically active physical education students (age: 21.2 (1.3) yr, body mass: 79.5 (10.8) kg, height: 1.84 (0.06) m; mean (SD)) performed CMJ and CMJWA on a force plate while a pulley system exerted a constant vertical force upon the body simulating either increase or decrease of body weight (BW) within the range from 0.6BW to 1.4BW. **Results** Both the mean (Pavg;  $P < 0.03$ ) and peak power output (Ppeak;  $P < 0.03$ ) calculated from the ground reaction force and the velocity of the center of mass revealed a significant main effect of load (Pavg;  $P < 0.001$ ) and (Ppeak;  $P < 0.001$ ) with the maxima in the vicinity of 1.0BW (i.e., no loading applied), as well as a higher output in CMJWA than in CMJ ( $P < 0.01$ ), and no interaction. **Discussion** The findings observed from two different vertical jumps consistently revealed the data in line with our previous studies (Jaric & Markovic 2009; Markovic & Jaric 2007). These findings not only provide additional support for the 'maximum dynamic output hypothesis' (Jaric & Markovic 2009), but could also be of importance for optimizing the athletic training procedures aimed towards maximizing the muscle power output. **References** Leontijevic B., Pazin N., Bozic P., Kukolj M., Ugarkovic D., Jaric S. (2012). Effects of loading on maximum vertical jumps: Selective effects of weight and inertia. *J Electromyogr Kinesiol.* 22 (2), 286-293. Jaric S., Markovic G. (2009). Leg?muscles?design: the?maximum?dynamic?output?hypothesis. *Med Sci Sports Exerc.* 41(4), 780-787. Markovic G., Jaric S. (2007). Positive and negative loading mechanical output in maximum vertical jumping. *Med Sci Sports Exerc.* 39(10), 1757-1764.

**ANTAGONIST FORCES ARE UNDERESTIMATED WHEN ASSESSED USING EMG-TORQUE RELATIONSHIP**

Simoneau, E.M., Longo, S., Seynnes, O.R., Narici, M.V.

*Université de Valenciennes*

**Introduction** Antagonist force production cannot be calculated directly in vivo and is usually estimated by using the relationship between surface EMG activity and exerted torque of the antagonist muscles, while they act as agonists (Maganaris et al., 1998; Mademli et al., 2004; Kellis et al., 1997). An implicit assumption of this method is that during an isometric contraction, the relationship between the level of EMG activity and the mechanical output is the same when a muscle is acting either as an agonist or as an antagonist. If this were the case, one would expect changes in EMG to match changes in architecture (Hodges et al., 2003) in both conditions. Therefore, the aim of this study was to investigate whether the behaviour of Gastrocnemius Medialis muscle (GM) - as assessed by its architecture - would be identical during isometric agonist and antagonist contractions at equal level of EMG activity. **Methods** Torque, architecture (pennation angle and fiber length) and EMG activity of GM were obtained while 8 young healthy males performed ramp isometric contractions in dorsi-flexion (DF) and plantar-flexion (PF) up to maximal voluntary contractions (MVC). **Results** At a given EMG activity, GM fiber length was significantly shorter while performing a sub-maximal PF contraction than during DF MVC (-18%;  $p < 0.001$ ). Similarly, pennation angle during sub-maximal PF was significantly larger than during DF MVC (+28 %;  $p = 0.014$ ). **Discussion** At a given level of GM EMG activity,

architectural parameters were significantly different when the muscle acted as agonist or antagonist: fiber length was longer, and pennation angle was smaller during antagonist than during agonist isometric contractions. These findings indicate that GM elicits a higher mechanical output while acting as an antagonist when EMG activity is matched. This means that estimation of antagonistic force using the common method based on the EMG/net torque relationship yields underestimated values. References Hodges PW, Pempel LH, Herbert RD, Gandevia SC. (2003). *Muscle Nerve*;27(6):682-692 Kellis E, Baltzopoulos V. (1997). *Eur J Appl Physiol Occup Physiol*;76(3):253-259 Mademli L, Arampatzis A, Morey-Klapsing G, Brüggemann GP. (2004). *J Electromyogr Kinesiol*;14(5):591-597 Maganaris CN, Baltzopoulos V, Sargeant AJ. (1998). *Exp Physiol*;83(6):843-855

### **ANKLE DESTABILISATION DEVICE FOR INJURY PREVENTION OR REHABILITATION IN SPORTS.**

Paizis, C.I, Fautrelle, L.2, Guinet, S.1, Lheraud, C.1, Ballay, Y.2, Babault, N.1

*University of Burgundy*

Introduction Numerous epidemiological studies demonstrated that lateral ankle sprain (LAS) seemed to be a recurrent problem in athletes (Hootman et al. 2007). Further to LAS, residual symptoms could arise and about 70% of the athletes who suffer acute LAS develop chronic ankle instability (Herel 2002). At the muscular level, the evolver muscles strength appeared as an essential factor in order to ensure ankle stability (Wilkerson et al. 1997). In this study, we proposed to investigate the modulation of the EMG activities of 6 ankle muscles (on the right and left leg) in response to an ankle destabilisation device (ADD) when walking, in normal or constrained conditions, and jumping. We hypothesized that such device should significantly modify the amplitude parameters of the EMG pattern of the ankle muscles, especially in the peroneal muscles. In such case, such ADD would then be use in ankle injury prevention or rehabilitation to improve the functional stability of the ankle joint. Methods Twelve healthy sport sciences students without previous history of neuromuscular disease or acute LAS volunteered for the experiment. Subjects were required to normally walk, walk along a straight line or realize horizontal jumps, with or without the ADD. The ADD was a device mounted under the heel of the shoes which induces subtalar joint destabilization. Kinematics and surface electrical activities were recorded on the both sides of the subjects in six muscles (twelve as a whole), namely the tibialis anterior, the peroneus longus, the peroneus brevis, the gastrocnemius lateralis, the gastrocnemius medialis and the soleus. For each muscle, the EMG activities recorded during the experimental conditions were normalized by the EMG activities recorded during a maximal voluntary isometric contraction. Results Our electromyographic investigations on these twelve ankle muscles showed a significant effect of the ADD when subjects have to realize horizontal jumps. Indeed in this condition, our statistical analyses clearly demonstrated a significant increase (17%,  $P < 0.05$ ) of the amplitude of the EMG activities in the left and right peroneus brevis and longus. Discussion Our finding evidenced that horizontal jumps with ADD generated a significant increase in electromyographic activity of both peroneus and are therefore a valuable resource in the functional strength training and sensory- motor rehabilitation and prevention of the ankle. References Hootman JM, Dick R, Agel R. (2007). *J Athl Train*, 42(2): 311-9. Herel J, (2002). *J Athl Train*, 37(4): 364-375 Wilkerson GB, Pinerola JJ, Caturano RW. (1997). *J Orthop Sports Phys Ther*, Aug;26(2):78-86.

### **BAREFOOT TRAINING IMPROVES PHYSICAL PERFORMANCE IN NETBALL PLAYERS**

Venter, R., De Villiers, J.E.

*Stellenbosch University*

BAREFOOT TRAINING IMPROVES PHYSICAL PERFORMANCE IN NETBALL PLAYERS Venter, R., De Villiers, JE. Stellenbosch University (Stellenbosch, South Africa) Introduction Recent research on barefoot running has focused mainly on lower-limb and spatio-temporal kinematics, its influence on kinetics of running, as well as running economy. Little is known about the effect of barefoot training on physical performance in team athletes. The aim of this study was to determine the effect of barefoot training on speed, agility, power and single-leg stability in netball players. Methods Twenty women netball players (age:  $20 \pm 2$  years) were randomly assigned to a barefoot ( $n=10$ ) and a shod group ( $n=10$ ). Both groups performed the same drills during 20 training sessions over a period of eight weeks. Time spent training barefoot gradually increased to 40 minutes in the final session. Speed, agility, vertical jump height and single-leg stability were measured pre- and post-intervention. Results Players in the barefoot group showed significant improvements in agility to the left ( $P < 0.05$ ;  $ES=0.74$ ) and the right ( $P < 0.05$ ;  $ES=0.42$ ). A large practical significant difference was found between barefoot and shod players for 10-m speed ( $ES=1.01$ ) and 20-m speed ( $ES=0.80$ ). The barefoot group showed significant improvements in single-leg stability for the right leg in the anterior/posterior plane ( $P=0.01$ ;  $ES=0.22$ ), the medial/lateral plane ( $P=0.04$ ;  $ES=0.27$ ), as well as overall stability ( $P=0.01$ ;  $ES=0.25$ ). A small practical significant difference was found for the left leg in the medial/lateral plane ( $ES=0.24$ ) and overall stability ( $ES=0.17$ ). No significant differences were found between the two groups with regard to vertical jump height. Discussion Barefoot training improved speed, agility and single-leg stability in netball players. The novelty of this study makes it difficult to compare our results with previous research. Higher step frequencies and reduced contact time during barefoot running in habitually shod runners have been reported previously (Braunstein et al., 2010; Divert et al., 2008; Smith et al., 2010). It has also been suggested that barefoot training could strengthen small muscles crossing the ankle joint (Nigg, 2009) and improve proprioceptive ability (Jenkins et al., 2011). Although we did not analyse kinematic data or assess muscle strength in this study, the abovementioned aspects associated with barefoot training could have played a role in the improved performance of the barefoot group. Future longitudinal studies could determine the effect of barefoot training on prevention of ankle injuries in netball players. References Braunstein B, Arampatzis A, Eysel P, Brüggemann, GP. (2010). *J Biom*, 43, 2120-2125. Divert C, Mornieux G, Freychat P, Baly L, Mayer F, Belli A. (2008). *Int J Sports Med*, 29, 512-518. Jenkins DW, Cauthon DJ. (2011). *J Am Pod Med Ass*, 101(3), 231-246. Nigg B. (2009). *Footwear Sci*, 1(2), 73-79.

17:45 - 19:15

## Invited symposia

## IS-PM09 Mechanism in Sarcopenia

**SARCOPENIA: MECHANISMS AND FUNCTIONAL SIGNIFICANCE**

Narici, M.V.

*University of Nottingham*

Sarcopenia, the age-related loss of muscle mass, has a prevalence of 20% in individuals aged 60- to 70-years, approaching 50% in those over 75 years. Between the 2nd and 7th decades, about 20% of muscle mass is lost during the normal ageing process. The associated decrease in muscle strength and power actually exceeds that of muscle size, indicating a deterioration of muscle quality (1). Decreased single fibre specific tension, changes in muscle architecture, alterations in tendon mechanical properties and in neural drive, contribute this phenomenon. Sarcopenia has a multifactorial origin, involving neuropathic processes leading to loss of motor units, oxidative stress leading to cellular damage, mitochondrial dysfunction and apoptosis, hormonal alterations impacting upon protein turnover, immunological changes involving inflammation-mediated cytokines release, activating proteolytic pathways and cellular apoptosis, and lifestyle changes (e.g. nutrition, physical activity, stress) leading to stable gene expression alterations (epigenetics) (1). A reduction in muscle regenerative capacity also contributes to sarcopenia (2). Basal protein synthesis and breakdown show little changes in old age, however, blunting of the anabolic response to feeding and exercise, particularly in older women, and of the anti-proteolytic effect of insulin are observed (3,4). Further understanding of the mechanisms of sarcopenia also requires disentangling of the effects of ageing alone from those of disuse and disease. Regular resistive exercise is by far the most effective intervention for combating sarcopenia. Evidence exists that it may also afford protection against the loss of motor units, as suggested by observations on master athletes (5). These benefits afforded by chronic exercise involve not only maintenance of muscle mass through the anabolic action of muscular exercise but likely also through a reduction of inflammation (6). Among the various pharmacological treatments for preventing sarcopenia, the use of anti-myostatin antibodies (7), of  $\beta$ -hydroxy- $\beta$ -methylbutyrate (HMB) (8) and of Omega-3 polyunsaturated fatty acids (9) seem particularly worthy of attention. References 1) Narici MV, Maffulli N. *Br Med Bull.* 91, 2010. 2) Kadi F, Charifi N, Denis C et al. *Muscle Nerve* 29, 2004. 3) Cuthbertson DJ, Babraj J, Smith K et al. *Am J Physiol Endocrinol Metab* 290, 2006. 4) Wilkes EA, Selby AL, Atherton PJ et al. *Am J Clin Nutr* 90, 2009. 5) Power, G. A., B. H. Dalton, D. G. Behm, A. A. Vandervoort, T. J. Doherty, And C. L. Rice. *Med. Sci. Sports Exerc.*, 42, 2010. 6) Nicklas BJ, Brinkley TE. *Exerc Sport Sci Rev.* 2009;37(4): 165–70. 7) Siriett V, Salerno MS, Berry C, Nicholas G, Bower R, Kambadur R, Sharma M. *Mol Ther.* 15, 2007. 8) Hill DS, Hossain T, Phillips BE, Rankin D, Rathmacher JA, Loughna PL, Williams JP, Smith K, Szewczyk NJ & Atherton PJ. Poster 7-11, Proc. 6th Cachexia Conference, 2011, Milan. 9) Smith GI, Atherton P, Reeds DN, Mohammed BS, Rankin D, Rennie MJ, Mittendorfer B. *Clin Sci (Lond).* 121, 2011.

**LOSS OF SKELETAL AND CARDIAC MUSCLE REGENERATIVE CAPACITY WITH OLD AGE**

Ellison, G.M.

*Liverpool John Moores University*

Organ ageing is characterised by a decline in the ability of its tissue-specific stem cells to repair damage and regenerate functional tissue. This decline in regenerative capacity involves both intrinsic molecular changes in the stem cells themselves and/or alterations in their aged environment. Proliferation of mammalian cells, including human, is dependent on having functional telomeres. Adult somatic stem cells, like embryonic stem cells, are self-renewing. Most express telomerase which restores telomere length after each cell replication and prevents 'replicative senescence'. However, haematopoietic stem cells have a finite lifespan and develop a senescent phenotype (Beerman et al. 2010, *Curr Opin Immunol.* 22:500). Telomere shortening in the absence of telomerase activity is one of the major causes of loss of proliferation in mammalian cells (Bodnar et al. 1998, *Science.* 279:349). Telomere attrition occurs with age and as a consequence of oxidative stress and it is proposed to be a cause of replicative cell aging. Progressive loss of telomere sequences like in telomerase knockout mice, *Terc*<sup>-/-</sup>, eventually leads to loss of organism viability after 3-6 generations (Herrera et al. 1999, *EMBO J.* 18:2950). We have found that in 22 month old mice, c-kit positive endogenous cardiac stem cells (eCSCs), are susceptible to the physiological aging process, characterized by impaired proliferation, p16INK4a expression, telomere shortening, 'permanent' withdrawal from the cell cycle (putatively senescent) and increased apoptosis. The senescence of eCSCs with age results in the development of cardiac dysfunction and failure. Interestingly, this progression is altered favourably in IGF-1 transgenic mice (Torella et al. 2004, *Circ Res* 94:514). Here, I will present our recent data on the molecular pathways and mechanisms regulating cardiac and skeletal muscle-derived stem cell fate and regeneration, and how these are affected by ageing. Specifically, I will show that it is possible to rejuvenate the 'aged' stem cell population by stimulating their growth with extrinsic cues or reverting their phenotype into self-renewing and therefore overcome the loss of the tissue-regenerative potential with age. It will be a better understanding of the biology of the processes regulating stem cell fate which will pen-ultimately lead to developing realistic and clinically applicable strategies, utilising the proper stimulation of these cells and leading to meaningful and functional cardiac and skeletal muscle regeneration.

**ROLE OF REACTIVE OXYGEN SPECIES AND INFLAMMATION IN SARCOPENIA**

Jackson, M.J., Vasilaki, A., Kayani, A., Pearson, T., Sakellariou, G., McArdle, A.

*University of Liverpool*

Chronic loss of skeletal muscle mass and function is a major contributor to frailty and weakness in the elderly. The major cause of age-related loss of muscle mass is a decrease in the number of skeletal muscle fibres associated with atrophy and weakness of the remaining fibres. The fundamental causes of loss of tissue function with increasing age are the subject of considerable research activity, but remain unclear. A large number of studies have reported a dysregulation of reactive oxygen species (ROS) homeostasis during ageing that may potentially lead to increased oxidative damage to tissues and/or to defective redox signalling. Skeletal muscle tissue from aged organisms contains increased amounts of oxidative damage, but whether this is the cause of age-related deficits in muscle or a consequence of ageing has been the subject of controversy. Studies from our group have examined the changes in ROS generation that occur

with ageing in man and experimental models and have also utilised a transgenic approach to modify ROS generation in model organisms. Data from these experiments support the hypothesis that aberrant ROS regulation plays a role in the deficits in skeletal muscle and motor neurons that occur during ageing, but also indicate this does not simply occur through increased oxidative damage to tissues. This research is supported by the Medical Research Council, Biotechnology and Biological Sciences Research Council and United States National Institute on Aging.

## 17:45 - 19:15

### Oral presentations

#### OP-SH08 Sport Statistics & Analysis

##### PACING STRATEGY AND PERFORMANCE DURING THE WORLD CHAMPIONSHIP MARATHON RACE

Renfree, A., St Clair Gibson, A.

*University of Worcester*

**PACING STRATEGY AND PERFORMANCE DURING THE WORLD CHAMPIONSHIP MARATHON RACE** Renfree, A.1, St Clair Gibson A.2 1: University of Worcester UK, 2: Northumbria University UK Introduction Optimal pacing is fundamental to successful endurance performance. Although there appears to be a common strategy characteristic of elite performance in distance running events (Tucker et al 2006), previous research has focused on strategies employed by successful or winning athletes. The present study analysed pacing strategies of successful and less successful athletes during a championship race. Methods Final and intermediate 5 km times of finishers (n=60) in the 2009 IAAF Women's Marathon Championship race were accessed via the championship website along with individual personal best (PB) times. Times were converted to mean speeds (m/s). Competitors were split into four groups with Groups 1,2,3, and 4 comprising the first, second, third, and fourth 25% of finishers. Mean speed maintained in PB performances and intermediate segments of the race were calculated for all groups. Relative speed (% of PB speed) was also calculated for intermediate segments. One way ANOVA was used to identify differences in performance times, and two way ANOVA followed by the Bonferroni post-hoc test was used to identify differences between groups in intermediate segments. Results Mean PB speed decreased from Group 1 to 4; other than between Groups 3 and 4, all differences were statistically significant ( $P < 0.05$ ). Speed maintained in the race was  $98.5 \pm 1.8\%$ ,  $97.4 \pm 3.2\%$ ,  $95.0 \pm 3.1\%$  and  $92.4 \pm 4.4\%$  of PB speed for Groups 1-4 respectively. Group 1 was fastest in all segments and displayed less variability in speed. Differences in speed between groups increased as the race progressed. Group 1 ran at a lower relative speed than other groups for the first two 5 km segments, but a higher relative speed from 35km onwards. Statistically significant differences ( $P < 0.01$ ) in the percentage of PB speed maintained were observed between Groups 1 and 4, and 2 and 4 in all segments after 20 km, and Groups 3 and 4 from 20-25 km and 30-35 km. Discussion Group 1 athletes displayed strategies that resulted in superior relative performances. It appears that Group 2, 3, and 4 athletes selected unsustainable initial speeds that resulted in losses of speed later in the race. Although it is only possible to speculate as to the mechanisms underpinning selection of initial work rates, it may be that psychological factors specific to a major competitive event influenced decision making by athletes. These poor decisions resulted in performances inferior to those that may have been expected based on PB times. Further research is warranted to examine the decision making process leading to selection of pacing strategies in competitive events. Reference Tucker R, Lambert M, Noakes T. (2006) An analysis of pacing strategies during mens world-record performances in track athletics. *Int J Sports Physiol Perform*, 1(3), 233-245

##### CHARACTERISTICS OF A SUCCESSFUL PROFESSIONAL ROAD CYCLING SPRINTER: A PERFORMANCE ANALYSIS CASE STUDY

Menaspà, P.1,2,3, Abbiss, C.1, Martin, D.T.1,2,3

*1: Edith Cowan University (Perth, Australia), 2: AIS Physiology (Canberra, Australia), 3: Cycling Australia (Adelaide, Australia)*

**Introduction** Many stages during grand cycling tours (GT; Giro d'Italia, Tour de France and Vuelta a Espana) are designed specifically for sprinters. Of the 79 GT stages won by sprinters within 2008-2011, 5 sprinters won 54 stages and 19 sprinters won remaining 25 stages. The primary aim of this investigation is to describe the sprint performances of a successful professional road cyclist in order to explore performance analysis methodology used for evaluating road sprints. We focused on comparing winning sprints to less successful efforts. **Methods** A the time of this study the subject was the highest international ranked professional male road sprint cyclist (age, 26; height, 175 cm; weight, 69 kg). Performances of this athlete during 2008-2011 GT stages were identified using public access web sites. Stages won by sprinters were classified into those in which he won (W) or lost (L) the sprint, or was dropped (D) from the front bunch prior to the sprint. In addition, video footage of 16 stages have been analyzed for sprint duration, position in the bunch at 60, 30, 10 s remaining and the number of lead-out team members (at 30s) to determine tactical differences between W and L. The total elevation gain (TEG) of 22 stages has been determined to examine its relationship with W, L and D. A descriptive analysis of head-to-head performances against the 2nd-5th most successful professional sprinters has also been conducted. **Results** Over 4 years, the cyclist started 52 GT stages (out of 79 won by sprinters) with 30 W (58%), 15 L (29%), 6 D (12%) and one crash. Video analysis of the sprints showed that sprint duration was similar between W and L sprints ( $10.9 \pm 1.8$  and  $10.0 \pm 3.6$  s, respectively). The position in the bunch was lower for W compared to L at 10s from the finish ( $1.8 \pm 0.4$  and  $4.7 \pm 3.3$ , respectively) but not at =20s. The number of team members was not significantly different between W ( $1.1 \pm 0.6$ ) and L ( $0.6 \pm 0.8$ ). TEG was significantly higher when the rider was dropped ( $1313 \pm 395$  m) compared to W and L sprints ( $478 \pm 266$  and  $524 \pm 324$  m, respectively). The cyclist's ability to reach the finish line in the first bunch (77%) was lower when compared with other successful sprinters (89%). However, the subject won over 60% of stages in which he was in contention to sprint, while his competitors won less than 15%. **Discussion** This study presents novel methodology for the analysis of the road cycling sprint performance. The detailed descriptive information describes performances of one of the most successful sprinters in cycling history. This cyclist demonstrates the ability to win professional road sprints with or without a team lead out, when the GT stage is performed over low elevation gain.

## VARIATION OF PHYSICAL ACTIVITY DURING CONGESTED AND NON-CONGESTED PERIODS IN TOP-CLASS EUROPEAN TEAM SEASON 2011-12.

Djaoui, L., Dellal, A., Pialoux, V., Hautier, C.  
*Université Claude Bernard Lyon 1*

Variation of physical activity during congested and non-congested periods in top-class European team season 2011-12. Djaoui L. (1), Dellal A. (2), Pialoux V. (1), Hautier C (1). (1) Sport Science University of Claude Bernard, Lyon, France; (2) Olympique Lyonnais FC (soccer) Introduction In modern elite soccer, the ability to recover from consecutive official match-play is considered as a key factor, especially during a congested period. However, to the best of our knowledge, no study has investigated how consecutive match-play influences the physical activity. Therefore, the aim of the present study was to examine the variation of physical activity of elite soccer players within a prolonged period of fixture congestion and non-congestion period (from August to December) in competitive season. Methods 16 international players ( $24.3 \pm 3.2$  years;  $178.1 \pm 4.2$  cm;  $76.9 \pm 4.3$  kg), classified into 6 positional roles were examined during French First League and Cup ( $n=10$ ) and UEFA Champion's League ( $n=4$ ) matches, in season 2011-2012 (central defenders: CD,  $n=3$ ; full-backs: FB,  $n=2$ ; central defensive midfielders: CDM,  $n=3$ ; wide midfielders: WM,  $n=3$ ; central attacking midfielders: CAM,  $n=2$ ; forwards: FW,  $n=3$ ). The total distance covered at light ( $<12$  km.h<sup>-1</sup>), moderate (18 to 21 km.h<sup>-1</sup>), high (21 to 23 km.h<sup>-1</sup>), very high (23 to 25 km.h<sup>-1</sup>), over high (25 to 27 km.h<sup>-1</sup>), and sprinting ( $>27$  km.h<sup>-1</sup>) intensity running were analyzed using a semi-automatic match analysis system (Amisco©). Results No differences between congested and non-congested period for the total distance covered in all the speed thresholds superior at 18 km.h<sup>-1</sup> were observed, whereas at light-intensity running, CD and CDM covered lower distance when playing 1 match/week (vs. 2 matches/week,  $p<0.05$ ). Moreover, no physical seasonal variation was found across all matches of the different periods analyzed from August to December. However, lower coefficient of variation were found concerning the overall distance and at light intensity (4.9-7.3%) in comparison with the others speed thresholds all across the playing positions. Furthermore, differences ( $p<0.001$ ) were found among positions for overall distance covered (CDM=CAM > others), sprinting (FB > CD=CDM=CAM and WM=FW > CDM), over high (FB > CD=CDM & WM=CAM > CDM), very high (FB=WM=FW > CD=CDM), high (FB=WM=CAM=FW > CD=CDM), moderate (CAM > FB=CD=WM > CD) and light (CD=CDM > FB=WM=FW) intensities. Discussion The present study reveals that the recovery time between two matches (72 to 96 hours) should not affect the physical performance during a prolonged period of fixture congestion in top-class soccer players. It could be suggested that post-match strategies (alternating legs' hot and cold water immersion, massage, diet and drink supplementation), and training including recovery and prevention session between matches, allow to reduce the apparition of fatigue and thus, to maintain sufficiently a high-level of physical performance within congested period.

## DIFFERENCES BETWEEN COMPETITION AND RECREATIONAL GAME PLAY IN SOCCER

Laura, T., Hermann, T., Bürgi, R., Heinzmann, P., Murer, K.  
*ETH Zurich*

Introduction The amount of recreational game play in childhood, in addition to official competition matches, relates positively with a child's chances of a successful career (Ford et al., 2009). It is, however, unclear whether this relationship is due to recreational play improving children's soccer skills by simply increasing the time spent on game play or by training different aspects of the game compared to competition game (CG) play. This study compares qualitative and quantitative aspects of recreational game (RG) and CG play. The analysis is on physical and tactical parameters. Methods 34 boys and one girl ( $10.3 \pm 1.3$  years) from different junior teams were assessed during one CG and one RG. The games were about 60 minutes in duration. The RG took place on hard surface (1280 m<sup>2</sup>), the CG on grass fields (1650 to 3332 m<sup>2</sup>). The number of players ranged from 6 to 9 per team. These numbers were different depending on the age based category. The physical parameters total distance covered, speed distribution (Castagna et al. 2009) and maximal velocity were extracted from GPS tracking devices (BT-Q1300S, Qstarz International Co., Taiwan) carried in an armband by all players. The tactical parameter number of one-on-one situations was extracted from videos of the games. Dependent t tests and Wilcoxon signed ranks tests were used to detect differences between RG and CG play. The significance level was set to 0.05. Results Significant differences between RG and CG play were detected in the conditional parameters. In RG the percentage of total distance walking (CG = 20.3% < RG = 23.7%) and jogging (CG=  $42.7 \pm 7.9\%$  < RG =  $46.6 \pm 4.6\%$ ) was higher, medium intensity running (CG=  $21.7 \pm 6.5\%$  > RG =  $17.6 \pm 4.8\%$ ) and high-intensity running (CG =  $9.3 \pm 3.6\%$  > RG =  $7.4 \pm 3\%$ ) was lower. Top speed differed significantly between CG and RG only during back checking (23.4 km/h and 21.3 km/h, respectively). No differences between games were found for the total distance covered. Finally, the total number of one on one situations was significantly lower in CG (CG =  $6.2 \pm 5$  < RG =  $14.7 \pm 8.5$ ). Discussion It seems that intensity during RG is lower than in CG. This can be explained by the fact that during RG children can chose the intensity they want. The freedom and relative insignificance of RG seems to trigger creativity and a willingness to initiate more offensive one-on-one actions. Relative to CG play, defensive work is slightly neglected. It thus seems that RG play more specifically targets the offense and one-on-one situations than CG play does. References Ford PR, Ward P, et al. (2009). High Ability Studies 20(1), 65-75. Castagna C, Impellizzeri F, et al. (2009). The Journal of Strength & Conditioning Research 23(7), 1954-1959.

## VARIABILITY AND PREDICTABILITY OF PERFORMANCE TIMES OF ELITE CROSS-COUNTRY SKIERS

Spencer, M., Losnegard, T., Hallén, J., Hopkins, W.G.  
*Norwegian School of Sports Sciences*

VARIABILITY AND PREDICTABILITY OF PERFORMANCE TIMES OF ELITE CROSS-COUNTRY SKIERS Spencer, M. 1, Losnegard, T. 1, Hallén, J. 1, Hopkins, W.G. 2 1: Norwegian Research Centre for Training and Performance, Norwegian School of Sports Sciences, Oslo, Norway, 2: Sport Performance Research Institute NZ, AUT University, Auckland, New Zealand Introduction The variability in performance of elite athletes between competitions provides useful information for research on factors affecting medal-winning performance (Hopkins et al., 1999). The aim of this study was to estimate the variability of performance of cross-country skiers in international competitions. Methods Official race times and course information were downloaded from fis-ski.com for individual-start races in World Cup, World Championship and Olympic competitions from 2001 to 2010. The eight events were classic and free versions of women's distance (10 km), men's distance (15 km), and men's and women's sprint qualification (prolog), each with a total of 410-569 athletes competing in 1-44 races at 15-25 venues. In analyses restricted to the top 10 from each race there were 55-107 athletes in 1-28 races. A linear mixed model of log-transformed race times for each event provided estimates of within-athlete race-to-race variability (the residual, expressed as a coefficient of variation, CV) after adjustment for fixed effects of snow conditions (6 levels), altitude (2 levels), and race length (simple numeric), with random effects (expressed as CV) representing differences in performance time arising from race terrain, athlete ability, and chang-

es in-athlete ability between seasons. Predictability of performance was expressed as an intraclass correlation representing the mean correlation between pairs of races within a season. Results Within-athlete race-to-race variability in performance time was similar for men and women in the various events for all athletes (CV of 1.5-1.8%), but for top-10 athletes men were a little less variable (0.68-0.73%) than women (0.88-1.0%). Observed effects of differences in snow conditions and altitude on mean performance time were substantial (up to ~2%) but mostly unclear, owing to extremely large effects of terrain (CV of 4-10% in top-10 analyses). Predictability of performance was extremely high (correlations of 0.90-0.96) for all athletes but only poor-moderate (0.09-0.46) for top-10 athletes. Discussion The race-to-race variability of the best skiers is similar to that of elite runners (Hopkins, 2005) and is therefore likely a consequence of irreducible variability in physiological power output, with little contribution from variability in pacing, skill, or environmental effects. Estimates of the smallest worthwhile performance enhancement (0.3x within-athlete variability) will assist researchers investigating factors affecting performance of elite skiers. References Hopkins WG, Hawley JA, Burke LM. (1999). *Med Sci Sports Exerc*, 31: 472-485. Hopkins WG. (2005). *Sports Science*, 9: 17-20.

## ACCELEROMETER-DERIVED PHYSICAL ACTIVITY IN PRESCHOOLERS: A G-FORCE HISTOGRAM ANALYSIS

Laukkanen, A., Havu, M., Pesola, A., Sääkslahti, A., Finni, T.

*University of Jyväskylä*

ACCELEROMETER-DERIVED PHYSICAL ACTIVITY IN PRESCHOOLERS: A G-FORCE HISTOGRAM ANALYSIS Laukkanen, A.1, Havu, M.1, Pesola, A.1, Sääkslahti, A.2, Finni, T.1. 1: Department of Biology of Physical Activity, University of Jyväskylä, Finland, 2: Department of Sport Sciences, University of Jyväskylä, Finland Introduction Accelerometers have been seen as gold-standard objective tool for monitoring children's habitual physical activity. To become biologically meaningful, the activity levels have generally been estimated on the basis of cut-off points. However, there is a lack of general agreement on how to choose the cut-off points (Bornstein et al., 2011). The aim of this study was to describe habitual physical activity of preschool-aged children both by means of an acceleration histogram and the cut-off points (van Cauwenberghe et al., 2010). Methods The subjects were 4- to 6-year-old children attending all-day day-care in kindergarten (n = 17; 10 boys; mean age 5.5 ± 0.6 years). Physical activity was measured over 6 days (at least 1 weekend day) using triaxial Gulf Coast Data Concepts X6-1a accelerometers with a dynamic range of ±6g. The devices were carried in an elastic belt that was firmly worn on the subjects' waist (Finni et al. 2011). The direction of the acceleration was ignored. Magnitudes were band-pass filtered (0.25 Hz ... 11 Hz), and values below 0.05g were filtered out. Physical activity counts were calculated by summing over 15-second epochs and multiplying by a device-specific factor that was derived from simultaneous recordings with the X6-1a and ActiGraph GT3X. Results Physical activity was monitored for an average of 4.7 days (12.2 ± 2.5 hours/d). The average time children spent at acceleration level under 0.05g, between 0.05-2g and over 2g each day were 658.0 ± 133.3 (89.6%), 48.1 ± 12.1 min (6.6%) and 28.1 ± 12.2 min (3.8%), respectively. Mean total activity was 664 ± 295 counts per minute. Children participated on average 36.7 ± 14.6 minutes per day in light physical activity and 52.7 ± 35.4 minutes per day in moderate-to-vigorous physical activity. Discussion To our knowledge this is the first time to describe preschool-aged children's physical activity by g-force histogram using accelerometers. The g-force histogram conserves valuable raw data gathered and is thus promising tool for assessing both the amount and quality of preschool-aged children's physical activity. In further research, g-force histogram could be useful for assessing, for instance, physical activities' dose-response rate relating to children's bone and motor skill development. Further study is also needed to map behavioural meanings into g-force histogram values. References Bornstein DB, Beets MW, Byun W, McIver K. (2010). *J Sci Med Sport*, 14, 504-511. Finni T, Saakselahti A, Laukkanen A, Pesola A, Sipilä S. (2011). *BMC Public Health*, 11: 944. van Cauwenberghe E, Labarque V, Trost SG, De Bourdeaudhuij I, Cardon G. (2010). *Int J of Pediatr Obes*, 6 (2-2), 582-589.

17:45 - 19:15

## Oral presentations

### OP-PM40 Rehabilitation 2

#### IS THE INITIAL PERFORMANCE LEVEL RELATED TO EXERCISE RESPONSE IN ALLOGENIC STEM CELL TRANSPLANT PATIENTS?

Wiskemann, J.1,2, Jäger, D.2, Bohus, M.3, Nies, R.1, Huber, G.4, Dreger, P.5, Ulrich, C.M.1

1: NCT/DKFZ (Heidelberg, Germany), 2: NCT/University Clinic (Heidelberg, Germany), 3: CIMH (Mannheim, Germany), 4: ISSS (Heidelberg, Germany), 5: University Clinic (Heidelberg, Germany)

Introduction Before, during and after allogeneic hematopoietic stem cell transplantation (allo-HSCT) patients experience considerable physical, psychological and psychosocial distress. Besides GVHD and infections, particularly reduced physical performance and functioning as well as high levels of fatigue affect patient's quality of life negatively. Our recently published study in this field shows that a partly self-administered exercise program is beneficial for several treatment-related side-effects (Wiskemann et al., 2011). In this analysis we investigate the individual training response of the exercisers group depending on their baseline fitness level. Methods We analyzed physical performance data of 40 exercise intervention (EX) participants from a randomized-controlled trial. Patients trained in a home-based setting prior to hospital admission, during inpatient treatment and 6-8 weeks period after discharge (partly self-administered with an intervention manual and DVD). Physical performance was assessed via 6-minute walk test (6MWT) and handheld dynamometry (HHD). In order to analyze individual training response patients in the EX were categorized as 'fit' (>80% of their predicted fitness scores) or 'unfit' (<80% of their predicted fitness scores). Results Patients in the 'unfit' group declined about 1,7% in maximal voluntary isometric strength in knee extensor muscles over the entire study period whereas the 'fit' group lost 31,1% in average (p<0.05). Comparable differences between the "unfit" (improvement or maintenance) and "fit" (maintenance or loss) were observed for all other measured muscle groups. Similarly, the 6MWT distance showed a significantly greater improvement for the 'unfit' vs. the 'fit' group (+13,4% vs. -3,7%, p<0.05). Discussion The effect of exercise training on physical fitness in allo-HSCT patients differs by their performance level at baseline. Oncologists and exercise therapists should be aware of the importance of exercise in initially unfit patients in improving performance during allo-HSCT. References Wiskemann J, Dreger P, Schwerdtfeger R, Bondong A, Huber G, Kleindienst N, Ulrich CM, Bohus M (2011).

Effects of a partly self-administered exercise program before, during, and after allogeneic stem cell transplantation. *Blood*, 117(9):2604-2613.

### **SPORTS CLIMBING ONCE A WEEK IMPROVES BALANCE, FATIGUE AND COGNITIVE FUNCTION IN MULTIPLE SCLEROSIS**

Kern, C.1, Tusker, F.2, Bischoff, C.3, Oberhoffer, R.1

*Technical University of Munich*

Purpose MS affects mainly young adults, still capable of working. Even though immunomodulating drugs slow down disease progression, the loss of functional capacity severely handicaps patients with MS. Although exercise reduces secondary complications in patients with MS, Motl (2005) has shown that MS patients are less physically active than non-disabled subjects. Sports Climbing (SC) is new in therapy of neurological patients and intrinsically highly motivating. Thereby, multidimensional skills in SC allow targeting various symptoms of patients with MS individually. This study aimed to investigate if SC once a week improves balance, fatigue and cognitive function in patients with MS. Patients and Methods We report on 27 MS-patients randomized into SC-group (n=12) and control-group (cg) (n=15) with an Expanded Disability Status Scale (EDSS) 1-6.5. The SC-program was performed over 20 sessions of two hours within 6 months on consecutive Saturdays. Criteria for exclusion are 'attendance less 18 sessions' or 'relapse during intervention'. Each session was adjusted individually and documented. Controlled top rope climbing and safety-standards in the SC-program were ensured. Data were collected for cognitive function (PASAT=Paced Auditory Serial Addition Test), dynamic balance (MFT S3Check [Multifunktionale Trainingsgeräte GmbH]), steady balance (COP=Center of Pressure [Kistler force platform]) and fatigue (WEIMuS=Würzburger Erschöpfungsinventar). Results EDSS decreased in SC-group (n=10) from 5.5 [IQR 2.8; 6.5] to 4.3 [2.6; 6.5], p=0.068 whereas we had no changes in cg (n=14) 4.0 [pre 2.5; 6.0; post 2.4; 6.0], p=0.157. Significant improvements were found in all mental and physical tests in the SC-group from pre- to post-test. WEIMuS totally decreased in SC-group from 36.0 [25.75; 46.50] to 17.5 [1.75; 32.50], p=0.011 whereas results in cg increased from 26.0 [5.75; 45.25] to 27.0 [15.25; 34.25], p=0.550. The PASAT ascended significantly in SC-group from 44.0 [27;50] to 50.5 [38.5;57.25], p=0.028; slightly in control-group from 46.0 [38;51] to 49.0 [42.5; 55.5], p=0.270. Steady and dynamic balance improved in SC-group; S3Check (n=7) revealed (pre / post) for stability index 5.8 [5.3; 6.4] / 5.6 [4.5; 6.6], p=0.046 and sensomotoric index 5.1 [4.4;6.3] / 4.6 [4.0;5.0], p= 0.051 vs cg stability index 5.0 [4.8;6.5] / 5.5 [4.5;6.4], p=0.752 and sensomotoric index 4.6 [3.7;5.6] / 4.3 [3.7;5.3], p=0.612. Conclusions SC-intervention improves or stabilizes mental as well as physical functioning in MS-patients. Regular sport participation, such as SC should be recommended to patients with MS.

### **EFFECT OF AEROBIC INTERVAL TRAINING ON PHYSICAL AND METABOLIC FITNESS IN OVERWEIGHT/OBESE ADOLESCENTS WITH INTELLECTUAL DISABILITY.**

Elmahgoub, S., Cambier, D., Gysel, T., Rombaut, L., de Wandele, I., Roman de Mettelinge, T., Calders, P.

*Arteveldehogeschool / Universiteit Gent*

INTRODUCTION: Aerobic interval training has the potency to improve physical fitness in adolescents with overweight/obesity without intellectual disability (Ingul CB 2011). Data concerning the effect on metabolic fitness are not available. In overweight/obese adolescents with intellectual disability no data are available. Therefore, the purpose of this study is to evaluate the effect of aerobic interval training on metabolic and physical fitness in adolescents with intellectual disabilities and overweight/obesity compared to endurance training and no training. METHODS: This study is a controlled trial with patients receiving either aerobic interval training (AET), endurance (END) or no training (C). 30 adolescents with intellectual disabilities (mean age: 17 (3,4), mean BMI-percentiles: 91 (4), mean IQ: 54 (8,3)) were recruited from two schools for special education (BUSO Ravelijn and BUSO De Varen, Brugge, Belgium). Subjects received either aerobic interval training (4 blocks of 10 minutes; alternating 2 minutes 80% peak heart rate (3x), 2 minutes 50% peak heart rate (2x); n=10) or endurance training (4 blocks of 10 minutes, continuous heart rate at 70% peak heart rate; n=10) twice a week for 40 minutes per session for 20 weeks or no training (n=10). After 10 weeks, intensity was increased to 90% of peak heart rate and 60% of peak heart rate in the interval group and to 80% of peak heart rate in the continuous group. Groups were matched for age, sex and intellectual disability. Before and after the training period body composition (length, weight and BMI), physical fitness (aerobic capacity, muscle strength), blood pressure (resting systolic and diastolic) and lipid profile (triglycerides, HDL, LDL and total cholesterol) were evaluated. RESULTS: Compared to no training, aerobic interval training has significant positive effects on peak VO<sub>2</sub>, ventilatory threshold (VO<sub>2</sub> and power output), muscle fatigue and six minute walk test. Compared to endurance training, aerobic interval training resulted in a significant better evolution of ventilatory threshold VO<sub>2</sub> (mean differences: +10% versus +4%), ventilatory threshold power output (+15% versus +5%), muscle fatigue (+5 sec versus 0 seconds), 6 minute walk test (+109m versus +68m). PeakVO<sub>2</sub> increased in both groups significantly with 5%. There was no significant effect on metabolic fitness in all groups. CONCLUSION: This study revealed a tendency towards more beneficial effects concerning physical fitness of aerobic interval training in overweight/obese adolescents with intellectual disability compared to endurance training. Concerning metabolic fitness no positive effects could be revealed. Reference: Ingul CB, Tjønnhaug AE, Stølen TO, Stølen A, Wisloff U. Impaired cardiac function among obese adolescents: effect of aerobic interval training. *Arch Pediatr Adolesc Med*. 2010 Sep;164(9):852-9

### **UNEXPECTED DISTURBANCE PROGRAM IN REHABILITATION OF HIGH PERFORMANCE ATHLETES.**

Teichmann, J.

*National Sport Institute of Malaysia*

Unexpected disturbance program (UDP) in rehabilitation of high performance athletes. Jörg Teichmann<sup>1</sup>, Dr Ramlan Bin Abd. Aziz<sup>1</sup>, Edin Suwarganda<sup>1</sup> Msc., Prof.Dr.Dietmar Schmidbleicher<sup>2</sup> and Dr Barry Wilson<sup>1</sup> <sup>1</sup>National Sports Institute of Malaysia, <sup>2</sup>Goethe-University Frankfurt-Germany Athletes recovering from anterior cruciate ligament (ACL) injury reached 75-85% of their pre injury level of performance (Haas et al., 2004). Exercises in proprioception training with voluntary corrective movements are widely accepted in post-surgical rehabilitation for ACL reconstruction of athletes. The UDP promotes exercises in response to so-called involuntary short to mid latency disturbances (Taube et al., 2006). A pre - post study design was used to investigate the effectiveness of UDP in the last 6 weeks of rehabilitation of 15 Malaysian national athletes. Tests included 20 m sprint, 1 RM single leg press, standing long jump, sway test and a psychological questionnaire. The rehabilitation consisted of two parts, general training and specific training. A total of 7 sessions per week of 90 minutes with 3 sessions allocated for 5-6 UDP exercises. Conditioning tests were measured with timing system (Brower), measure tape and observation on the outdoor track or in-house gym. Sway was measured as the centre of pressure movement in AP and ML directions, at 100 Hz for a period of 10-15 seconds, on a tri-axial force plate. Sway conditions were semi-randomized in a 3x3x3 design with



varying intrinsic, extrinsic conditions and each trial was repeated three times. The non-injured leg served as a control for the injured leg. Two-tailed paired t-tests were used for limited a-priori comparisons to examine differences. Significance level was set at  $p < 0.05$ . Significant improvements in average time by 3.6% (ES=0.42), strength by 21.6% (ES=1.49), distance jumped by 5.2% (ES=0.36) and ML sway (ES=0.96) were noted. Additionally athletes reported improved perceived confidence in their abilities. All athletes improved in each conditioning tests except for the long jump of two athletes. The ML sway decreased with 9 out of the 15 athletes for the injured limb. Group mean sway showed an overall increase for both the injured and non-injured limb. However, the injured limb increased significantly less in ML sway than the non-injured limb. The increase in sway due to the UDP was unexpected but may be due to athletes' increased ability to correct imbalances with active torque. The prevention training with UDP resulted in improved conditioning and seems to decrease ML sway. Continued research is needed to further confirm these observations. References: Haas, C.T., Turbanski, S. & Schmidtbleicher, D. (2004). Präventive und rehabilitative Aspekte im alpine Skirennlauf. Kongressband Sportärzttewocke in Zell am See. Taube, W., Schubert, M., Gruber, M., Beck, S., Faist, M., & Gollhefer, A. (2006). Direct corticospinal pathways contribute to neuromuscular control of perturbed stance. *Journal of Applied Physiology*, 101(2), 420-429.

## EXERCISE ADHERENCE AFTER AEROBIC INTERVAL TRAINING IN PATIENTS WITH CORONARY ARTERY DISEASE

Aamot, I., Karlsen, T., Dalen, H., Stoylen, A.

*Norwegian University of science and technology*

Introduction: Aerobic interval training (AIT) is shown to be superior in increasing aerobic capacity compared to moderate continuous training in coronary artery disease (CAD) patients (1). However, exercise adherence to high-intensity exercise is reported to be low (2). The aim of this study was therefore to assess exercise adherence one year after an AIT cardiac rehabilitation (CR) program. Methods: 47 CAD patients (41 men/6 women, mean age 58±8 years, body mass index 27±3) referred to CR due to myocardial infarction (n=30), acute coronary syndrome (n= 2) or coronary artery bypass graft (n=15) completed 12 weeks of AIT, twice a week. Exercise intensity was 85-95% of peak heart rate during the 4x4 minute intervals. They were encouraged to continue exercise after CR completion, and then the participants returned to retests 12 months later. Primary outcome measure was peak oxygen uptake (VO<sub>2</sub>peak). Secondary outcome measures were self-reported physical activity (PA) using International Physical Activity Questionnaire (IPAQ) short version last seven days and health-related quality of life with MacNew. All tests were performed at baseline (BL), after 12 weeks of AIT and after 15 months, analyzed with Repeated measures ANOVA with Bonferroni corrections for multiple analysis. Results: VO<sub>2</sub>peak at BL was 34.7±6.8 ml•kg<sup>-1</sup>•min<sup>-1</sup>, after 12 weeks of AIT 38.3±7.2 ml•kg<sup>-1</sup>•min<sup>-1</sup> (mean difference (md) 3.6, CI 2.7-4.5,  $p < 0.001$ ), and after 15 months 36.0±7.0 ml•kg<sup>-1</sup>•min<sup>-1</sup> (md from BL 1.3, CI 0.14-2.4,  $p = 0.023$ , md from 12 w 2.4, CI 1.2-3.5,  $p < 0.001$ ). Self-reported MET-minutes • week<sup>-1</sup> were 2109±1584, 2331±1794 and 2318±1712, for BL, 12 weeks and 15 months, respectively (differences non-significant). MacNew Global scores were 6.0±0.5 at BL, 6.2±0.5 at 12weeks (md 0.3, CI 0.09-0.45,  $p = 0.001$ ) and 6.2±0.6 at 15 months (md from BL 0.2, CI -0.1-0.5,  $p = 0.31$ , from 12 weeks 0.08, CI -0.4-0.2,  $p = 1$ ). Discussion: our results indicate that exercise adherence after AIT in CR is not optimal, though VO<sub>2</sub>peak at 15 months still were significantly above BL levels. In a study from Moholdt et al (2011) adherence to exercise after CR were higher after AIT than exercise at lower intensity (3). Exercise intensity per se is probably not the reason for decline in exercise participation. Thus, AIT is an optional exercise mode in cardiac rehabilitation. However, CAD patients seem to be in need of additional attention for a prolonged time to stay into exercise habits after CR completion. 1. Rognmo O, Heiland E, Helgerud J et al. *Eur J Prev Rehab* 2004 Jun;11(3):216-22. 2. Perri MG, Anton SG, Durning PE et al. *Health Psychol* 2002 Sep;21(5):452-8 3. Moholdt T, Aamot IL, Granøien I et al. *Int J Cardiol*. 2011 Nov 3;152(3):388-90

17:45 - 19:15

## Oral presentations

### OP-PM41 Biochemistry

#### IMMUNE RESPONSE EFFECTS OF A SWIMMING SESSION REMAIN FOR MORE THAN 24 HOURS

Morgado, J.I, Monteiro, C.P.I, Matias, C.2, Alves, F.1, Seixas, M.T.3, Alvim, M.3, Bourbon, M.3, Laires, M.J.4

1,2,4 - Faculty Human Kinetics, Technical University of Lisbon, Portugal; 3 - Unidade Laboratorial Integrada, Dpt Promoção da Saúde e Doenças Crônicas, Instituto Nacional de Saúde Dr Ricardo Jorge

Introduction The effect of exercise over the immune response along the recovery period has revealed inconsistent findings especially in swimming training. The purpose of this study was to evaluate the immune systemic response to a high intensity swim training session during a 24h recovery period. Methods A group of 36 Portuguese male swimmers (16 ± 0.4 yrs; 186 ± 12 cm; 65 ± 1.3 Kg) performed a selected swim training session with a high intensity main set at the end of the first macrocycle of the season. Blood samples were collected before (Pre), immediately after (Post), 2 h after (Post2h) and 24 h after (Post24h) the swimming session, by standard procedures for assessment of Haemogram and Leukogram (automated counter Beckman Coulter LH 750) and Lymphocytes subpopulations (FACS Calibur Becton, Dickinson and Company) including CD3+, CD4+, CD8+, CD16+ and CD19+. ANOVA for repeated measures with Bonferroni post-hoc test or Friedman test with pairwise comparisons were used for the assessment of exercise effects. Statistical significance was considered at  $p < 0.05$ . Results At Post, significantly lower values of haemoglobin, monocytes, eosinophils, total lymphocytes and all the subpopulations evaluated were observed. Platelets, neutrophils and CD4+/CD8+ ratio were elevated at Post but leukocytes did not change significantly. At Post2h, monocytes and platelets had return to Pre values; haemoglobin, eosinophils, continued to decrease; total lymphocytes, CD3+, CD4+, CD8+ and CD16+ maintained lower values; CD19+ increased significantly regarding Post but remained below Pre; neutrophils continued to rise, CD4+/CD8+ ratio maintained higher values and leukocytes increased. At Post24h, neutrophils, eosinophils, CD8+, CD16+ and CD4+/CD8+ ratio recovered to Pre levels; total lymphocytes, CD3+ and CD4+ augmented comparing to Pos2h but stayed above Pre; CD19+ remained lower than Pre while leukocytes and monocytes decreased to values below Pre. Discussion A demanding swimming session seems to provoke a significant acute depression of the Immune System suggesting that a 24h period is insufficient to attain total recovery. These findings support the idea that exercise induces immune suppression and increases susceptibility to infections after high intensity training sessions.

### SYSTEMIC CHANGES AFTER 4 MONTHS OF SWIMMING TRAINING

Monteiro, C.P.1, Morgado, J.1, Matias, C.2, Alves, F.1, Seixas, M.T.3, Alvim, M.3, Bourbon, M.3, Laires, M.J.4

1,2,4 - Faculty Human Kinetics, Technical University of Lisbon, Portugal; 3 - Unidade Laboratorial Integrada, Dpt Promoção da Saúde e Doenças Crônicas, Instituto Nacional de Saúde Dr Ricardo Jorge

**Introduction** In endurance sports such as Swimming the implementation of cycles of high training volume in order to optimize aerobic and movement economy adaptations can lead to transient imbalances between training loads and recovery contributing to the onset of fatigue and eventually illness in well trained athletes. An immunodepression state characterized by substrate depletion, hormonal and immune functions disturbances is usually the response to hard training periods. The purpose of this study was to evaluate the effects of a 4-month swim training macrocycle of preparation for the Winter Swimming National Championships over the resting systemic immunity. **Methods** Systemic immunity was assessed in 35 Portuguese male swimmers ( $15.8 \pm 0.32$  yrs;  $187 \pm 14.6$  cm;  $63.8 \pm 1.4$  kg) at the beginning of the training season (M1) and at the end of the winter National Championships (M2). This macrocycle was characterized by an aerobic training predominance and the progressive increase of training volumes and intensities in the first 3 months and for the maintenance of high intensities and progressive decrease of volumes in the last month. At the National Championships swimmers have accomplished at least one personal best time in the races they were enrolled in. Blood samples were collected by standard procedures for assessment of haemogram and leukogram (automated counter Beckman Coulter LH 750) and lymphocytes subpopulations (FACS Calibur Becton, Dickinson and Company) including CD3+, CD4+, CD8+, CD16+ and CD19+. Paired samples t test or Wilcoxon test was used to compare M1 and M2 resting values of each variable. The level of significance was set at  $p < 0.05$ . **Results** At M2 we observed significant higher resting levels of haemoglobin, haematocrit, red blood cells, and neutrophils. Contrarily, total lymphocytes (%) were significantly diminished. **Discussion** During this training cycle it was observed a stimulation of innate immunity (represented essentially by neutrophils) and a decline in the adaptive immunity (represented by total lymphocytes) that may be associated with the higher performance levels observed after a swimming winter macrocycle. These alterations may reflect the cumulative effects of aerobic training predominance suggesting that training load volume may be determinant for systemic change.

### HAEMATOLOGICAL CHANGES IN RECREATIONAL ENDURANCE RUNNERS DURING A MULTI-STAGE ULTRA-MARATHON CONDUCTED IN HOT AMBIENT CONDITIONS.

Gill, S.K.1, Teixeira, A.4, Rama, L.4, Morse, T.3, Cresswell, S.3, Godson, N.3, Scheer, V.6, Valero, E.6, Costa, R.J.S.1,2

Coventry University, UK; Coimbra University, Portugal; University of Heidelberg, Germany; Vinalopo Hospital, Elche, Spain.

**Introduction:** Endurance running in the heat has previously been linked with disturbances to haematological parameters. The aim was to monitor haematological responses in ultra endurance runners (UER) during a multi-stage ultra-marathon (MSUM) competition in hot ambient conditions ( $T_{max} 36.8 \pm 3.6^\circ\text{C}$ , RH 35%) conducted over five consecutive days (5 stages) totalling 230km. **Methods:** On each of the 5 stage days, whole blood samples were collected by antecubital venepuncture without venostasis pre-stage and immediately post-stage (UER  $n = 21$ ; Control (CON)  $n = 6$ ). Full blood counts, Hct, and Hb were analysed using an automated cell counter. Haematological indices were corrected for changes plasma volume. Data were analysed using a repeated measures ANOVA with post hoc HSD. **Results:** Pre-stage resting plasma volume in UER increased by Stage 3, and remained elevated thereafter ( $p < 0.01$  vs. pre-Stage 1;  $p < 0.05$  vs. CON). Leukocytosis was observed post-stage on all stages ( $p < 0.01$  vs. pre). Resting pre-stage leukocyte counts were higher on Stages 2, 3 and 5 compared with Stage 1 ( $p < 0.05$ ). Lymphocyte counts decreased post-stage on Stage 1 ( $p < 0.01$  vs. pre), but increased post-stage on Stages 2 and 3 ( $p < 0.05$  vs. pre). Post-stage lymphocyte counts were higher on Stages 2 to 4 compared with Stage 1 ( $p < 0.01$ ). Monocyte counts increased post-stage on Stages 1 to 3 ( $p < 0.01$  vs. pre). Resting pre-stage monocyte counts were higher on Stage 5, while post-stage monocyte counts were lower on Stages 4 and 5, compared with Stage 1 ( $p < 0.01$ ). Granulocyte counts increased post-stage on all stages ( $p < 0.01$  vs. pre). Resting pre-stage granulocyte counts were higher all other stages, while post-stage granulocyte counts were lower on Stage 5, compared with Stage 1 ( $p < 0.01$ ). UER presented higher monocyte and MCHC counts pre-Stage 5, and lower granulocyte counts pre-Stage 1 compared with CON ( $p < 0.05$ ). **Conclusion:** Extreme exertional-heat stress may contribute in transient haematological changes observed during MSUM, regardless of acute stress induced adaptations. Despite these changes, illness symptoms in UER was low ( $n=1$ ). Notably, haematological responses are influenced by nutritional and hydration status, it is therefore plausible that sufficient food and fluid intake throughout competition may have attenuated any further disturbances in these haematological parameters.

### EFFECTS OF PROGRESSIVE RESISTANCE EXERCISE INTENSITY ON OXIDATIVE STRESS IN RESISTANCE EXERCISE TRAINED AND UNTRAINED MEN

Cakır-Atabek, H., Özdemir, F., Colak, R., Sevil, G.

Physical Education and Sport 3: Physical Education and Sports School, Ardahan University, Ardahan, Turkey

**Introduction** Acute resistance exercise induce oxidative stress responses are conflicting and the relation between oxidative stress and some exercise components, e.g. "intensity" – "volume", is not clear. Therefore the purposes of this study were (a) to determine time-dependent effects of progressive intensity of resistance exercise (RE) on oxidative stress markers, (b) to determine time-dependent effects of progressive intensity of RE on oxidative stress markers in RE trained and untrained men, (c) to search possible threshold intensity required to evoke oxidative stress. **Methods** RE trained (RET gr:  $n=8$ , experience:  $5,31 \pm 3,40$  years, 1RM:  $137,4 \pm 19,9$  kg) and untrained (UT gr:  $n=8$ , 1RM:  $110,5 \pm 17,67$  kg) young men volunteered to participate to this study. To elicit blood oxidative stress all subjects performed the leg extension RE test at 5 different but progressive intensities: 1) 1x17 reps at 50% of 1RM; 2) 1x14 reps at 60% of 1RM; 3) 1x12 reps at 70% of 1RM; 4) 2x5 reps at 80% of 1RM; 5) 3x3 reps at 90% of 1RM, with 5 min rest between intensities and 90 sec rest between sets. The RE intensities were standardized for total volume. Blood samples were drawn before (PRE), immediately post each intensities (T50%, T60%, T70%, T80% and T90%) and after (30 min post = T30min, 60 min post = T60min and 24 h post = T24h) the RE in order to analyze LHP, AOPP, PCO, 8-OHdG, total GSH and SOD. **Results** In response to progressive intensity of RE; LHP significantly increased during the test and then significantly decreased in recovery period in both groups, the T24h LHP level was lower than PRE LHP level. During the test AOPP level decreased and later increased. In recovery period the T30min AOPP level was significantly lower than PRE and T24h AOPP level. PCO and SOD significantly increased in both groups however 8-OHdG and GSH were not affected by the RE intensity. The results indicated that there were no significant training status (group) x RE intensity (time) interaction for examined variables. **Discussion** Most of the studies used only one or two oxidative stress biomarker that makes it difficult to explain effects of RE on oxidative stress precisely (Dixon et al., 2006; Hoffman et al., 2007). On the other hand different RE intensities may affect biomarkers in contrast (Hudson et al, 2008).

Results suggest that for standardized exercise volume RE-intensity increased oxidative stress responses both in RE trained and untrained young men. References Dixon CB, Robertson RJ, Goss FL, et al. (2006). *J Strength Cond Res*, 20(3), 693-8. Hoffman JR, Im J, Kang J, et al. (2007). *J Strength Cond Res*, 21(1), 118-122. Hudson MB, Hosick PA, McCaulley GO, et al. (2008). *Med Sci Sports Exerc*, 40(3), 542-8

### DOES AEROBIC TRAINING COUNTERACT CANCER-INDUCED SKELETAL MUSCLE WASTING?

Campos-Ferraz, P.L., Alves, C.R.R., Carnevali Jr, L.C., Lira, F.S., Rosa, F.O., Almeida, N.R., Brum, P.C., Seelaender, M., Gualano, B., Lancha Jr, A.H.

*University of Sao Paulo*

**Introduction:** It is currently unclear whether aerobic training can mitigate the skeletal muscle wasting in cancer-induced cachexia. The present study aimed to examine the impact of moderate-intensity aerobic training on skeletal muscle mass and oxidative stress in Walker 256 tumor-bearing rats. **Methods:** Male adults Wistar rats were randomly allocated into three groups: 1) control (CON; n=5), 2) Walker 256 (W; n=7) and 3) Walker 256 + aerobic training (WT; n=10). The WT group was submitted to 8 weeks of aerobic training 5 days a week; 60 min per session at 60 % of VO<sub>2</sub> max). After 6 weeks of aerobic training, WT and W groups were inoculated with Walker-256 tumor cells (2.10<sup>7</sup> for each rat). Subsequently, WT group were submitted to 2 additional weeks of aerobic training. All animals were killed by decapitation and gastrocnemius were isolated, weighed, and deep frozen for further analyses of lipid hydroperoxidation. Data are expressed as mean ± standard deviation. **Results:** Gastrocnemius weight was significantly higher in the CON compared to W and WT groups ( $p < 0.05$ ), but no significant differences were observed between the W and WT groups ( $p > 0.05$ ) (CON =  $2.03 \pm 0.37$  vs. W =  $1.46 \pm 0.33$  vs. WT =  $1.56 \pm 0.18$  g). Additionally, lipid hydroperoxidation were comparable in the W and WT groups (CON =  $22.9 \pm 6.3$  vs. W =  $32.2 \pm 27.2$  vs. WT =  $33.8 \pm 6.3$  nmol-mg<sup>-1</sup>;  $p > 0.05$ ). **Discussion:** Gastrocnemius mass was reduced in the W group, suggesting that Walker 256 tumour-bearing rats were in a cachexia process and skeletal muscle wasting. Lipid hydroperoxidation remained unchanged in both W and WT groups. Aerobic training did not affect either the skeletal muscle mass or the oxidative stress marker. **Conclusion:** These data suggest that therapeutic moderate-intensity aerobic training has no effect on muscle mass in an aggressive experimental model of cancer-induced cachexia. Further experiments are warranted to confirm these preliminary data, testing different types and intensities of exercises in a broad spectrum of cachexia stages. **References:** Dimeo FC, Tilmann MHM, Bertz H et al. Aerobic exercise in rehabilitation of cancer patients after high-dose chemotherapy and autologous peripheral stem cell transplantation. *Cancer*.1997; (79)9: 1717-22. Glass DJ. Signaling pathways perturbing muscle mass. *Curr Op Clin Nut Metab Care*.2010;13: 225-9.

## 17:45 - 19:15

### Oral presentations

#### OP-PM42 Training and Testing 5

### CRITICAL POWER DOES NOT CORRESPOND TO MAXIMAL LACTATE STEADY STATE

Groves, E.M., Sasso, J.P., Aylwin, A.J.M., Neil, R., Smith, D.J.

*University of Calgary*

**Introduction** Critical power (CP) is often considered to be the threshold of aerobic energy production and the highest power output at which ventilatory and metabolic variables attain a steady state. However, the original study inaccurately defines steady state, which leads to a misinterpretation of maximal lactate steady state (MLSS) and its subsequent association with CP (Poole et al. 1988). The purpose of this research was to compare MLSS, defined as the highest power output where blood lactate (Bla) slope is 0mM/min, and CP. **Methods** Seventeen male subjects (29+/-5.8yrs, 74+/-7.8Kg, 178+/-4.9cm) participated in one incremental exercise test and 6 constant load rides of varying power outputs on an electronically braked cycle ergometer on separate days. Three rides were to exhaustion (ranging 3 to 15min) to determine CP and 3 rides were used to establish MLSS zero (MLSSz). Blood lactate was collected every 5min and the resulting slope was plotted against power output to determine MLSSz (Neupert et al. 2006). Subjects were blinded to all power outputs, elapsed time and times to exhaustion. **Results** Maximal oxygen consumption and power output were 48.3+/-3.5ml/Kg/min and 355+/-39W, respectively. Critical power (245+/-40W) was significantly higher than MLSSz (212+/-32W)  $p < 0.001$ . Interpolating to the maximum power output possible within the traditional 1mM change in Bla (i.e. a slope of 0.05 mM/min) resulted in an MLSS at 221+/-33W, which remained significantly lower than CP ( $p < 0.001$ ). Conversely, extrapolating the MLSSz model to CP resulted in a mean Bla slope of 0.185+/-0.072mM/min or an increase of 3.7mM over 20min at CP. **Discussion** The current results show that in active individuals, CP does not correspond to MLSSz or the broader traditional definition of MLSS. It is also in agreement with McLellan & Cheung (1992) who showed a significant difference between CP and the individual anaerobic threshold. This refutes the often-quoted paradigm that CP and MLSS represent the same physical intensity (Poole et al. 1988). The power-duration relationship provides a theoretical framework for understanding the physiology of exercise tolerance and is an accurate tool for predicting performance (Morton 2006). However, it is only a parametric model, and as shown here, CP does not represent the MLSS intensity it commonly purports to. **References** McLellan, T. M. and Cheung, K. S. (1992). *Med Sci Sports Exerc*, 24(5), 543-550. Morton, R. H. (2006). *Eur J Appl Physiol*, 96(4), 339-354. Neupert, E., Smith, D. J. and Norris, S. R. (2006). 11th Annual Congress of the ECSS, Lausanne, Switzerland. Poole, D. C., Ward, S. A., Gardner, G. W. and Whipp, B. J. (1988). *Ergonomics*, 31(9), 1265-1279.

### THE EFFECT OF DOMESTIC TRAVEL ON PERFORMANCE DURING AND RECOVERY FOLLOWING COMPETITIVE FOOTBALL MATCHES.

Duffield, R.

*Charles Sturt University*

THE EFFECT OF DOMESTIC TRAVEL ON PERFORMANCE DURING AND RECOVERY FOLLOWING COMPETITIVE FOOTBALL MATCHES. Duffield R.1, Fowler P.1, Vaile J.2 1. School of Human Movement Studies, Charles Sturt University, AUSTRALIA. 2. Performance Recovery Centre, Australian Institute of Sport, AUSTRALIA. **Introduction** Travel is a necessary demand for professional footballers, although there is little evidence

on the effect of domestic in-season travel on player performance and recovery. The aim of this study was to investigate the effect of domestic travel on the physiological, perceptual and performance responses to home v away matches in professional (Australian) football players. Methods Six male, football players from a professional A-League Club were recruited for this study. Following familiarisation, data was collected from 3 pairs of home and away games (n=6) involving the same three opposition teams (travel time = 5–8h). Data collection occurred on the 2 days prior, match day and 2 days following each match. Measures included urine specific gravity (USG) for hydration status, actimetry measures of sleep quantity and quality and subjective perceptions of sleep quality, fatigue, stress and muscle soreness. Match performance was determined from the result (win/draw/loss) and goal difference (goals for - goals against). Physical match load was determined via Global Positioning Satellite measures of movement demands, whilst technical performance was assessed from video coding of match technical outcomes (passes, tackles, possessions etc). Effect size analyses (Cohen's d) were used to determine the magnitude of effect of home v away matches on performance and recovery. Results Reduced match performance was evident during away matches with increased losses and goals conceded ( $1.2 \pm 2.2 \pm 0.8$  goals;  $d > 1.0$ ). Further, technical performance was reduced during away matches with fewer passes completed and increased turnovers, corners conceded and opposition attempts on goal ( $d > 1.2$ ). Physical performance during away matches resulted in an increased mean speed compared to home matches ( $119 \pm 8$  v  $111 \pm 6$  m.min<sup>-1</sup>;  $d = 1.6$ ), with trivial effects ( $d < 0.3$ ) for playing duration ( $81 \pm 9$  v  $84 \pm 7$  min) or high-intensity running distance. Pre-match USG did not differ ( $d < 0.3$ ), but was higher 2 days following away matches ( $d = 0.80$ ), while sleep duration was lower 2 days following away matches ( $465 \pm 88$  v  $384 \pm 82$  min;  $d = 1.3$ ). Subjective sleep quality, stress and muscle soreness did not differ between conditions ( $d < 0.3$ ), although perceived fatigue was increased 2 days following away matches ( $d = 0.9$ ). Conclusion Away matches resulted in inferior match outcomes, likely due to reduced technical performance alongside increased physical match loads; although, the domestic travel seems to have minimal physiological or perceptual effect to explain such outcomes. Following away matches, altered sleep patterns, hydration status and increased perceptions of fatigue were evident, suggesting an exacerbated post-match recovery, which may be of importance for ensuing weekly preparation cycles.

### HIGH INTENSITY INTERVALS WITH INCOMPLETE RECOVERY: COMPARING CYCLING TEAM PURSUIT RACE STRATEGIES

Bartram, J.2, Martin, D.T.2, West, N.2,3, Stephens, J.1, Michaels, S., Halson, S.L.1

1: AIS Performance Recovery (Canberra, Australia), 2: AIS Physiology (Canberra, Australia), 3: Griffith University (Gold Coast, Australia)

Introduction For aerodynamic reasons, a team pursuit cyclist riding at 60km.h<sup>-1</sup> will produce ~600W in the lead position but ~400W when drafting (Broker et al., 1999). The purpose of this study was to simulate two team pursuit race strategies varying the rate of positional changes. Strategies were simulated such that total time as the lead rider was consistent (1min), but with varied compositions (4x15s versus 3x20s). Methods Male competitive cyclists (n=31; 20.0±1.6yr, 70.2±7.0kg, 355±35W MAP; mean±SD) completed 37d of structured training. Training included daily rides of 2-8 h and cycle ergometer (Wattbike) sessions 3 d.wk<sup>-1</sup>. Included within an extensive ergometer session were two pursuit-specific interval sets (4x15s, 45s rec at ~250W; 3x20s, 60s rec at ~250W) simulating 1 or 1.5 lap changes in lead position. Both team pursuit interval sets resulted in 1min of high intensity work and 3min of incomplete recovery. Reliability of high intensity power produced during interval sets over one wk was calculated as typical error (TE). A priori planned contrasts (paired t-test) was used to compare each cyclist's best efforts of the two approaches, provided that corresponding incomplete recovery powers were comparable (±5W). Influence of within group cyclist ability was also explored by establishing two sub samples (Low, High) based on the magnitude of power increase from incomplete recovery to effort. Results TE for 1min of high intensity power for both interval sets was ~7% (37W). Best interval power for 1min of total work was similar for 1 and 1.5 lap strategies (577±116W vs 588±108W), a difference (mean±90% CI) of 1.4±1.6% (p=.14). Differences were similar for both sub samples (Low 1.9±2.2%, p=.14; high 0.9±2.7%, p=.56). Based on our testing conditions and a minimum worthwhile difference of 2% these differences could be considered "trivial" and "unclear". Discussion Cycling power during a simulated pursuit does not appear to be compromised by performing 3x20s efforts compared to 4x15s efforts with incomplete recovery. This finding was observed regardless of the magnitude of power production by the cyclists involved. Reducing interval number from 4 to 3 while increasing interval duration from 15-20s can be accomplished without a large decrement in work capacity within the conditions employed in this study. Further research with more reliable performance measures is required to evaluate the ~1.4% greater power produced during the 3x20s intervals. References Broker JP, Kyle CR, and Burke ER. Racing cyclist power requirements in the 4000m individual and team pursuits. *Med Sci Sports Exerc.* 1999. 31:1677-85.

### EFFECTS OF LIGHT EXERCISE ADDED TO CONTRAST-WATER IMMERSION ON RECOVERY AFTER AN EXHAUSTIVE INTERMITTENT EXERCISE.

DELEY, G., DENUZILLER, J., BABAULT, N.

*Faculty of Sport Sciences*

Effects of light exercise added to contrast-water immersion on recovery after an exhaustive intermittent exercise. G. DELEY, J. DENUZILLER, N. BABAULT Centre d'Expertise de la Performance Gilles Cometti, Dijon, France Introduction For athletes, the development of strategies that would optimize recovery and speed performance restoration is essential. Among them, contrast water immersion (CWI) is one of the most popular (Hing et al. 2008). Due to temperature changes, this technique is supposed to increase blood flow and enhance the removal of metabolic by-products, consequently speeding recovery (Vaile et al. 2008, Hing et al. 2008). However, it has been suggested that vaso-pumping induced by CWI might be insufficient to induce significant effects on blood flow (Wilcock et al. 2006). We hypothesized that adding light pedalling during water immersion might maximize the effects of recovery. The aim of the present experiment was therefore to investigate the efficacy of CWI associated with light pedalling to recover from an exercise inducing a great metabolic fatigue. Methods Thirty-three young healthy male subjects physically active participated in this study. They were randomly assigned to one of the three experimental groups: (i) passive contrast water immersion (CONTRAST), (ii) contrast water immersion with light pedaling (ACTIVE), and (iii) passive rest at room temperature (PASSIVE). Recovery was applied during 30 minutes after a fatiguing exercise composed of four Wingate Anaerobic Test (WANt) separated by 30 seconds of passive rest. Counter-movement jump, blood lactate concentration as well as peak power and mean power developed during a WANt were recorded before and immediately after the fatiguing exercise. Measurements were repeated after the 30-minute recovery intervention and after an additional 30-minute period of passive rest. Results After 30 minutes of the CONTRAST intervention, jump height was back to Pre values, whereas values were still depressed after 60 minutes in the other groups (P<0.05). Conversely, lactates were back to their initial values after 30 minutes of ACTIVE recovery (P<0.05), whereas 60 minutes and more were necessary for the PASSIVE and CONTRAST conditions. Performances to WanT were back to their initial values after 30 minutes of recovery, whatever the intervention. Discussion The present results are in favor of the utilization of CWI after an exhaustive exercise (as compared with passive). Surprisingly, we found that despite a greater clearance of blood lactate when light pedalling was added during CWI, jump performances returned faster to normal after passive immersion. These results suggest that the intervention to

be chosen depends on the aim of recovery (lactates elimination or subsequent performance). References Vaile J, Halson S, Gill N, Dawson B (2008) *Int J Sports Med* 29:539–544 Hing WA, White SG, Bouaaphone A, Lee P (2008) *Phys Ther Sport* 9:148–161 Wilcock IM, Cronin JB, Hing WA (2006) *Sports Med* 36:747–765

### EFFECTS OF DOSE RESPONSE LOAD SQUAT JUMP TRAINING ON MUSCLE STRENGTH, STRUCTURE AND PERFORMANCE

Coratella, G., Annicchiarico, M., Trepin, M., Impellizzeri, F.M., Schena, F.

*University of Verona*

Introduction Squat jump training is a common method to improve athletic performance. The load that maximize power is around 30% of maximal dynamic strength, i.e. body weight only.(Cormie 2007) However, also weighted jump training has been proved effective to enhance jump or sprint(Mc Bride 2002) Few studies measured changes in muscle mass and architecture to better understand physiological mechanisms those lead to a better field performance. Aim or the study is to evaluate a dose response effect of weighted or un-weighted squat jump training on muscle strength, mass structure, jump and sprint ability. Methods Forty eight healthy students were randomly assigned to body weight only (BW), 25% body mass weighted squat jump training (WJ) and control group (CON).Isokinetic quadriceps strength(MVC), lower limbs total lean mass (DEXA), architectural adjustments (ultrasound), Squat jump (SJ), 30m dash, 20+20m shuttle and ability T test were assessed before and after 8 weeks of 60 maximal jumps, twice a week. All the dependent variables were analyzed after log transformation with ANCOVA using the baseline values as covariate and factor "group" as independent variable. Results No differences appeared in CON. Compared to baseline, BW improved MVC (23%,16 to 30,p<0,001), lean mass (2%,1 to 4 p<0,05), fascicle length (11%,7 to 16, p<0,001), SJ (10%,6 to 15, p<0,001), 20+20m(-3%,-5 to -1 p<0,05). Compared to baseline, WJ improved MVC(22%,15 to 29,p<0,001), lean mass(5%,3 to 7, p<0,001) fascicle length (5% 0 to 9,p<0,05), SJ(5%,0 to 10,p<0,05), 20+20m(-3%,-6 to -1,p<0,01), 30m(-3% -1 to -5,p<0,01). All parameters were significantly different from CON. BW had significant alterations in muscle architecture compared to WJ, while the latter improved 30m dash and T Test running test more than BW. Discussion Jump training improved task related quadriceps strength, also by an increment of lower limbs lean mass, that caused a power transfer in jumping and shuttle test. Greater velocity contractions in BW caused different architectural alterations(Blazevich 2003). Higher changing direction agility and sprint power could be related to increased strength expression in WJ. Blazevich AJ, Gill ND, Bronks R, Newton RU: Training-specific muscle architecture adaptation after 5-wk training in athletes. *Med Sci Sports Exerc.* 2003 Dec;35(12):2013-22. Cormie P, Mc Caulley GO, Mc Bride JM: Power Versus Strength–Power Jump Squat Training: Influence on the Load–Power Relationship. *Med. Sci. Sports Exerc.*,39(6), pp. 996–1003, 2007. Mc Bride JM, Mc Bride T, Davie A, Newton RU: The effect of heavy- vs. light-load jump squats on the development of strength, power, and speed. *J Strength Cond Res.* 2002 Feb;16(1):75-82

### EFFECTS OF PULSED ELECTROMAGNETIC FIELD THERAPY ON SYMPTOMS ASSOCIATED WITH ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE

Banyard, H., Nosaka, K.

*Edith Cowan University*

EFFECTS OF PULSED ELECTROMAGNETIC FIELD THERAPY ON SYMPTOMS ASSOCIATED WITH ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE Banyard, H. 1, Nosaka, K. 1 1:Edith Cowan University (AUSTRALIA) Introduction Pulsed electromagnetic field therapy (PEMFT) sends magnetic waves to deep tissues to reduce pain and enhance injury recovery (1). It is expected that PEMFT is effective for alleviating symptoms associated with eccentric exercise-induced muscle damage (EIMD). One study (2) reported that 20-min PEMFT for 5 consecutive days after exhaustive eccentric contractions of the elbow flexors with a dumbbell significantly attenuated muscle soreness compared with a sham treatment. However other symptoms of muscle damage such as decreases in muscle strength, and blood markers (e.g., plasma creatine kinase activity: CK) were not examined in the study. The present study investigated the effects of PEMFT on several indirect muscle damage markers to test the hypothesis that PEMFT would be effective for EIMD. Methods Four men and seven women (24.1 ± 5.1 y) performed two bouts of 60 maximal isokinetic (30°·s<sup>-1</sup>) eccentric contractions of the elbow flexors on each arm separated by 4 weeks. In each eccentric contraction, the elbow joint was forcibly extended from a flexed (90°) to a fully extended position (0°). At immediately after and 1-4 days following the exercise, the exercised arm received either PEMFT or sham treatment by a device (E-cell®). The duration of the treatment was 30 min, but one with an active device and the other with a sham device that did not generate electromagnetic pulses. The arm dominance and the order of treatment conditions were randomised and counterbalanced amongst the subjects, and the study was conducted in a double-blinded manner. Dependent variables included maximal voluntary isometric contraction strength (MVC), range of motion (ROM), muscle soreness by a visual analogue scale (100 mm) and CK. Changes in the variables for 7 days following the exercise from baseline were compared between PEMFT and sham treatment conditions by a two-way repeated measures ANOVA. The changes in the variable from pre to post treatment were also analysed by a two-way repeated measures ANOVA. Results All variables changed significantly (P<0.05) following eccentric exercise such that MVC decreased to 55.3 ± 2.6% immediately post exercise and did not recover at 7 days post-exercise (85.2 ± 2.9% of baseline), moderate muscle soreness was induced (peak: 29.7 ± 4.4 mm), and CK increased (peak: 1705 ± 462 IU/L). However, changes in MVC, ROM, muscle soreness and plasma CK activity over time were not significantly different between conditions. No significant changes in variables were evident from pre to post treatment for any days for neither condition. Discussion The results did not support the hypothesis that the PEMFT could alleviate muscle soreness and enhance recovery from EIMD. References 1) Foley-Nolan et al. (1990) *Orthopedics*, 13,445-51 2) Spodaryk K. (2002) *Medicina Sportiva*, 6,19-25

17:45 - 19:15

## Invited symposia

## IS-SH08 Life-Style Sports and Youth Development

**DETTE ER MEKKA! LIFESTYLE SPORTS AND YOUTH'S LEISURE-SPORT LIFESTYLES IN NORWAY**

Green, K.

*University of Chester*

Based on quantitative data from the Norwegian Statistisk Sentralbyrå (Statistics Norway) study of Mosjon, Friluftsliv and Aktivlivstill (Vaage, 2009), this paper explores Norwegian youths' engagement with conventional and lifestyle sports via an examination of recent trends. Norway boasts some of the highest levels of sports participation and adults as well as young people. Indeed, young Norwegians are the quintessential sporting omnivores. Nevertheless, among the age group where regular participation peaks in Norway, 16-19-year-olds, the popularity of games declined while participation in lifestyle sports continued to increase over the decade 1997-2007 (Vaage, 2009). It seems that the particular mix of conventional and lifestyle sports that Norwegian youngsters favour has shifted within a generation, with lifestyle activities far more prominent in 2007 than they had been even a decade earlier. One particular area of sporting participation strongly associated with Norwegian culture – friluftsliv (outdoor life) – has undergone particularly marked changes in participatory terms among young people. The changes in participation in outdoor sports in general and friluftsliv in particular appear to represent a shift among Norwegian youth to sports and physical activities that offer alternative forms as well as types of participation to conventional sports. In conclusion, the paper will draw upon these findings in order to tentatively hypothesize developments in youth leisure-sport. Vaage, O.F. (2009). Mosjon, Friluftsliv og Kulturaktiviteter. Resultater fra Levekarsundersøkelsene fra 1997-2007. Rapport 2009/15. Oslo-Kongsvinger: Statistisk Sentralbyrå.

**LIFESTYLE SPORT, PUBLIC POLICY AND YOUTH ENGAGEMENT**

Wheaton, B.

*University of Brighton Trevin Towers*

Images of 'lifestyle sport' participants (e.g. parkour, skateboarding, and surfing) have focused on their reckless, hedonistic and anti-social behaviour (c.f. Wheaton 2004; Wheaton 2010). In this paper I consider a recent discursive shift, whereby lifestyle sports are being repositioned by civic authorities, educationalists and policy makers as tools of youth engagement. The paper will discuss the emergence of these non-traditional, informally-organised sports as tools for policy makers (e.g. Bradley 2010), and the potential role they can make in terms of encouraging youth engagement, physical health and wellbeing. My main case study will be the emergence and development of parkour (Gilchrist and Wheaton 2011), and its use in public policy debates and initiatives around youth, physical activity, and risk in England. I explore the potential of parkour to engage communities, particularly those traditionally excluded from mainstream sport and physical education provision, discussing how the perceived success of parkour in these different contexts is related to the culture and ethos of the activity which is, anti-competitive, more inclusive and less rule-bound than most traditional sports; and to its ability to provide managed risk-taking. The paper will therefore contribute to on-going debates about the (in)ability of traditional sports to meet government targets for sport and physical activity participation, and the need to put lifestyle sport on the policy radar (Tomlinson et al. 2005). Bradley, G. L. (2010). Skate Parks as a Context for Adolescent Development. *Journal of Adolescent Research*, 25, 288-323. Gilchrist, P., & Wheaton, B. (2011). Lifestyle sport, public policy and youth engagement: Examining the emergence of parkour. *International Journal of Sport Policy & Politics*, 3, 109 - 131 Tomlinson, A., Ravenscroft, N., Wheaton, B., & Gilchrist, P. (2005). Lifestyle Sport and national sport policy: An agenda for research. Report to Sport England. Wheaton, B. (2004). Introduction: Mapping the lifestyle sport-scape. In B. Wheaton (Ed.), *Understanding Lifestyle sports: Consumption, identity and difference*. London: Routledge. Wheaton, B. (2010). Introducing the consumption and representation of lifestyle sports. *Sport in Society: Cultures, Commerce, Media, Politics*, 13, 1057-1081.

**WHAT'S IN IT FOR ME? LIFESTYLE SPORT AND POSITIVE YOUTH DEVELOPMENT**

Säfvenbom, R.

*Norwegian School of Sport Sciences*

As an extension of relational developmental systems theories on human development (Overton, 2010), theories on Positive Youth Development (PYD) have grown during the last decade (Lerner, et al., 2011). PYD-theory is concerned about outcome variables indicating thriving adolescents, yet first of all emphasizes the developmental process in terms of developmental regulation across ontogeny, integrated actions, relative plasticity, and thus optimism. According to the theory, the potential for plasticity at both individual and contextual levels constitutes a fundamental strength of all human's development (Silbereisen & Lerner, 2007). Based on in-depth interviews with three young lifestyle activity practitioners (longboarding, tricking and skydiving) and their experiences from both organized, traditional sports promoted by local sports clubs and more-or-less self-organized lifestyle activities, lifestyle activity contexts are discussed as developmental assets for youth. According to the adolescents' reflections on the magnitude of relative plasticity in traditional sports versus lifestyle sports, it is argued that traditional sports and lifestyle sports reveal adolescents' potentials differently, and that traditional sports often conceal more than they reveal about human potential. The paper claims that (1) if policy makers are concerned with improving life chances (e.g. lifetime activity alignment) of diverse youth, youth has to be viewed as resources to be developed and not as problems to be managed (Silbereisen & Lerner 2007: 7) and (2) if we really want to see more happy adolescents involved in movement activities, contexts based on non-traditional, new, explorative, lifestyle activities should be supported and funded at the same level as traditional sports (Säfvenbom et al., in rev). References Overton, W. F. (2010). Life-span development: Concepts and issues. In Lerner, R.M. (Ed.), *The Handbook of Lifespan Development*. Vol 1: Cognition, Biology and Methods. NJ: John Wiley & Sons. Lerner, R.M., Lerner, J.V. & Benson, J.B. (2011). Positive Youth Development. *Advances in Child Development and Behavior*, 31. MA: Academic Press, 1-444 Silbereisen, R.K. & Lerner, R.M. (2007). Approaches to Positive Youth Development: A view of the issues. In Silbereisen, R.K. & Lerner, R.M. (Eds), *Approaches to Positive Youth Development*. London, UK: Sage Publications Ltd., 3- 31 Säfvenbom, R., Agens, J. & Lerner, R.M. (In rev). Physical activity and youth. The need for a human development perspective.

17:45 - 19:15

## Invited symposia

### IS-BN06 Biomechanics and Injury Prevention in Elite Sports (\*)

#### GENDER SPECIFIC JOINT LOADS IN SOCCER

Gehring, D., Gollhofer, A.

*University of Freiburg*

Female soccer players have by far higher incidence rates to suffer from anterior cruciate ligament (ACL) injury than males (Agel et al., 2005). Due to recent findings about the complex shoe-surface interaction in soccer, the aim of this presentation is to review the current state of ACL injury research with a specific focus on the female soccer player and the equipment used. Based on the phenomenon of the increased ACL injury rates in women, much effort was made to evaluate the underlying etiology. Recent research suggests systematic differences in joint specific loading and whole body biomechanics between genders. Factors like increased knee abduction angles and moments, differences in activation patterns of flexor and extensor muscles, alterations in trunk control and anatomical specifications are suggested to result in increased ACL load during soccer specific movements in women (Hewett et al., 2006a). Various injury prevention programs were developed based on these recent findings about the gender specific knee joint loading. Neuromuscular training programs, comprising muscle strengthening, balance training or technique feedback, were shown to reduce the number of ACL injuries effectively (Hewett et al., 2006b). Beside these interventions, which aim to improve intrinsic factors of the athlete, modifications of the athlete's equipment may additionally have an effect on the injury outcome. In this context a very special feature is the cleated soccer shoe, which provides the traction needed on natural or artificial grass (Sterzing et al., 2010). However, the traction provided in the complex shoe-surface interaction seems to be a crucial factor for ACL loading, as systematic modifications in shoe traction were shown to result in systematic modifications in knee joint loading (Stefanyshyn et al., 2010). In light of these findings, consequences for cleat construction and gender-specific soccer shoe design will be discussed. In particular, it will be shown that alterations in the weight of the soccer shoe can influence knee joint abduction moments especially in female soccer players. References Agel J, Arendt E, Bershadsky B. (2005). *Am J Sports Med*, 33, 524-530. Hewett TE, Myer GD, Ford KR. (2006a). *Am J Sports Med*, 34, 299-311. Hewett TE, Ford KR, Myer GD. (2006b). *Am J Sports Med*, 34, 490-498. Stefanyshyn DJ, Lee JS, Park SK. (2010). *Footwear Sci*, 2, 13-20. Sterzing T, Müller C, Milani TL. (2010). *Footwear Sci*, 2, 37-49

#### CHARACTERISTIC EMG PATTERNS IN ELITE X/C ATHLETES WITH A HISTORY OF ANTERIOR COMPARTMENT PAIN - IMPLICATIONS FOR EARLY DIAGNOSIS AND FOR INJURY PREVENTION STRATEGIES

Federolf, P.A.

*Norwegian School of Sport Sciences*

Pain syndromes are common signs of overuse injuries in running, cross country skiing and related sports. The nature and characteristics of many chronic injuries have been described in detail, however, strategies for their prevention remain largely unknown. Important first steps for the development of effective prevention strategies would be an early identification of athletes that may be at risk of developing overuse injuries or the identification of movements that may contribute to their development. The physiological changes that lead to the development of a chronic injury may be accompanied by adaptations in the neuromuscular control of an athlete's movement. Detecting such adaptations in surface electromyographic (sEMG) signals may therefore offer one avenue to the development of effective prevention strategies. The wavelet transformation of the EMG signal, as proposed by von Tscharnner (2000), presents a promising technique for the detection of changes in muscle activation patterns that may be indicative of neuromuscular adaptation processes. In a recent study we investigated a group of young elite cross country skiers with a high incidence rate of chronic anterior compartment syndrome (CACS). The objective was to determine if the muscle activation patterns of athletes with a history of anterior compartment pain (symptomatic group) differ from pain free athletes in the same group (reference group). A first observation of this study was that the EMG power spectrum of the affected muscle (tibialis anterior) differed between athletes in the symptomatic and in the reference group (mono-modal versus bi-modal frequency spectrum). It has been suggested that such spectral differences might indicate differences in fibre type recruitment (Wakeling et al., 2002; von Tscharnner, Goepfert, 2006). A second observation of this study was that the differences were most obvious in the gliding phase, when the subjects were supported only by the instrumented leg while the contralateral leg and the arms were in a swing phase. This suggests that the neuromuscular control of balance may play a role in anterior compartment pain and potentially in the development of CACS. Both of these results may prove to be clinically useful in the future. The first result might help develop an early indicator of athletes that are at risk of developing CACS. The second result might help to better understand what movements are critical for the development of CACS. This might help establishing prevention programs, for example, specific balance training exercises. References: von Tscharnner V. (2000). *J Electromyogr Kines*. 10, 433-45. von Tscharnner V, Goepfert, B. (2006). *J Electromyogr Kines*. 16: 188-97. Wakeling JM., et al. (2002). *J Exp Biol*. 205: 359-69.

#### BIOMECHANICS AND INJURY PREVENTION IN ELITE ALPINE SKIING

Kröll, J., Spörri, J., Gilgien, M., Chardonens, J., Müller, E.

*University of Salzburg*

BIOMECHANICS AND INJURY PREVENTION IN ELITE ALPINE SKIING Kröll, J.1, Spörri, J.1, Gilgien, M.2, Chardonens, J.3, Müller, E.1 1: IFFB-US (Salzburg, Austria), 2: NSSS (Oslo, Norway), 3: EPFL (Lausanne, Switzerland) Introduction Data obtained by the International Ski Federation (FIS) Injury Surveillance System illustrated an alarmingly high injury risk for elite alpine ski racing (Florense et al, 2009). One of the main contributors to the injury situation seems to be the ski-plate-binding-boot system (Bere et.al. 2011, Spörri et al. 2010). Therefore the FIS launched a scientific project which should serve as a base for a new regimentation. The current presentation illustrates the process from a "qualitative interview survey" via "experimental prototype studies" to the "support of decision making units with scientific results" for giant slalom. Methods Based on existing knowledge (Bere et.al. 2011, Spörri et al. 2011) together with FIS and ski manufacturers a definition process for prototypes occurred. Limiting factors for the definition were technical (by ski manufacturers) so as controllability possibili-

ties (by FIS). The three prototypes (GS30, GS35, GS40) differed compared to the actually used equipment (GS27) in radius (>30m, >35m, >40m), minimum with (<65mm) and length (>195). Active and recently retired World Cup racers have tested the prototypes among several experimental conditions. During the biomechanical experiments athlete's kinetics (pressure insoles), kinematics (video based 3D reconstruction, GNSS, Time) and qualitative judgment in terms of safety aspects were captured. Results and Discussion The biomechanical analysis depicted no differences between GS27 and GS30. Comparing GS35 and GS40 with GS27 with respect to the occurring forces, differences in the order of 2% and 3.8% were found. Those numbers go in line with the findings for turn speed and run times. The force distribution among the turn alters in the way that towards turn end the forces seem to substantially decrease with GS40, which is with respect to specific ski racing injury mechanisms (Bere et al. 2011) of importance. The qualitative judgment of the not quantitative measurable parameters (e.g. aggressiveness of the Ski) for the prototypes with the substantially increased radius revealed a remarkable difference towards more safety. Consequently only radical changes will lead to substantial improvement in terms of safety. References Bere, T., Florenes, T. W., Krosshaug, T., Koga, H., Nordsletten, L., Irving, C., Bahr, R. (2011). Mechanisms of anterior cruciate ligament injury in World Cup alpine skiing: a systematic video analysis of 20 cases. *Am J Sports Med*, 39(7), 1421-1429. Florenes, T. W., Bere, T., Nordsletten, L., Heir, S., Bahr, R., (2009). Injuries among male and female World Cup alpine skiers. *Br J Sports Med* 43, 973-978. Spörri, J., Kröll, J., Blake, O., Amesberger, G., & Müller, E. (2010). A qualitative approach to determine key injury risk factors in alpine ski racing FIS. Online: <http://www.fis-ski.com/uk/medical/fis-injury-surveillance-.html>

**17:45 - 19:15**

## Oral presentations

### OP-SH09 Psychology

#### THE OBSERVATION OF A SOCIAL INTERACTION SPECIFICALLY MODULATE HUMAN CORTICOSPINAL SYSTEM

Ippolito, D., Bucchioni, G., Cavallo, A., Matron, G., Castiello, U.

*University of Padova, University of Torino*

THE OBSERVATION OF A SOCIAL INTERACTION SPECIFICALLY MODULATE HUMAN CORTICOSPINAL SYSTEM Ippolito, D.1, Bucchioni, G.2, Cavallo, A.3, Marton, G.1, Castiello, U.2 1: DSB-UNIPD (Padova, Italy), 2: DPG-UNIPD (Padova, Italy), 3: DPT-UNITO (Torino, Italy) Introduction It is well known that when we observe another individual acting, we resonate with her action, as revealed by an enhancement of motor evoked potentials (MEPs) in muscles corresponding to those involved in the observed action (Fadiga et al. 1995). What remains unclear is if the viewer's motor facilitation varies depending on context. In the present study, we investigated whether facilitation of the corticospinal system (CS) during the observation of an action differs depending on the presence of a social interaction. Methods 23 right-handed volunteers were tested. All participants were free from any contraindication to transcranial magnetic stimulation (TMS) (Rossi et al. 2009). Two types of video representing individual action (i.e., throwing a ball) or social interaction (i.e., throwing a ball to a partner) were utilized as experimental stimuli. SpTMS and MEP recording were used to investigate CS excitability during the stimuli observation. TMS coil was placed over the left primary motor cortex corresponding to the area where the flexor carpi ulnaris, FCU and the abductor digiti minimi, ADM are cortically represented. MEPs from the right FCU and the right ADM muscles were acquired for each condition. Results The repeated measure ANOVA on normalized MEP amplitudes yielded a statistically significant main effect of type of action for both the FCU ( $P < 0.05$ ) and ADM ( $P < 0.01$ ) muscles. Post hoc comparisons indicated MEP amplitude for both the FCU ( $P < 0.05$ ) and ADM ( $P < 0.01$ ) muscles were greater for the social than for the individual condition. Discussion The results of the present study show that during the observation of an action performed in a social context, the mean amplitude of MEPs recorded from the FCU and ADM muscles was significantly greater than those recorded when observing the same action performed in a context which did not entail a social interaction. These findings are consistent with previous studies. For example Oberman et al. (2007) have demonstrated that the observation/execution matching system is sensitive to the degree of social interaction of the observed action. Moreover, activation of action observation system is stronger during observation of actions performed by an interacting partner than for the actions performed alone (Kourtis et al. 2011). Along these lines, our findings show that the human CS is modulated by the social nature of observed actions. References Fadiga L, Fogassi L, Pavesi G, Rizzolatti G (1995) *J Neurophysiol* 73,2608–2611 Kourtis D, Sebanz N, Knoblich G (2010) *Biol Lett* 6,758–761 Oberman LM, Pineda JA, Ramachandran VS (2007) *Soc Cognitive Affective Neurosci*, 2,62–66 Rossi S, Hallett M, Rossini PM, Pascual-Leone A (2009) *Clin Neurophysiol*,120,2008–2039

#### VALIDATION OF A FIVE-ITEM NEIGHBORHOOD ENVIRONMENT SCALE: EVIDENCE FROM GREECE

Theodoropoulou, E., Karteroliotis, K.

*National and Kapodistrian University of Athens*

Introduction Recent studies have indicated that neighborhood environment has a positive impact on physical activity (Ishii et al., 2010). Despite its important role, there are not validated and reliable scales to assess perceived neighborhood environment in Greece. Therefore, the aims of the current study were to examine the factorial validity and reliability of the Greek version of a neighborhood environment scale, which presented satisfactory validity (Ishii et al., 2010). Methods Participants were 340 volunteers that attended the physical education classes at the University of Athens. To test the factorial validity, two samples were used. The first sample (N=150) were 77 men and 73 women (24.28±6.32 yrs), whereas the second sample consisted of 86 men and 64 women (22.85±5.64 yrs). An Exploratory Factor Analysis (EFA) was conducted with the first sample. The extraction method employed was principal axis factor followed by promax rotation (Russell, 2002). A Confirmatory Factor Analysis (CFA) (maximum likelihood method) was performed with the second sample to confirm the goodness of fit of the model found in EFA. The CFA was conducted using the AMOS 16.0 statistical software (Arbuckle, 2007). Assessment of model fit was based on  $\chi^2$ ,  $\chi^2/df$ , CFI, GFI, IFI, TLI and RMSEA indices (Kline, 2005). To test the internal consistency, the Cronbach's alpha ( $\alpha$ ) coefficient was used. To examine the test-retest reliability, 40 students, 21 men and 19 women (28.78±5.647 yrs), completed this scale twice with an interval of 15 days between the two assessments. Results The Kaiser-Meyer-Olkin (0.778) and the Bartlett Test of Sphericity ( $\chi^2=318.18$ ,  $df=10$ ,  $p=0.00$ ) were satisfactory. EFA yielded one factor accounted for 60.96% of the variance of the model (item factor loadings=0.52-0.86,  $\alpha=0.84$ ). Similarly, CFA showed that this model presented a good fit ( $\chi^2=3.441$ ,  $df=4$ ,  $p=0.487$ ,  $\chi^2/df=0.860$ , CFI=0.990, GFI=1.000, IFI=1.002, TLI=1.004, RMSEA=0.000, item factor loadings=0.66-0.81,  $\alpha=0.86$ ). The test-retest reliability



coefficient was 0.87. Discussion The results revealed that the neighborhood environment scale was a valid and reliable instrument. The aforementioned findings show that this scale is a useful tool for studies focusing on environmental factors, which may act as facilitators or barriers to physical activity. Additional research is needed to further the knowledge about its validity and reliability using other samples of Greek adults. References Ar buckle JL. (2007). Amos 16 user's guide. Amos Development Corporation, USA. Ishii K, Shibata A, Oka K. (2010). *Int J Behav Nutr Phys Act*, 7(61). Kline RB. (2005). Principles and practice of structural equation modeling. The Guilford press, USA. Russell DW. (2002). *Pers Soc Psychol Bull*, 28(12), 1629-1646.

### THE ROLE OF SELF-IDENTITY AS A COMPONENT OF THE THEORY OF PLANNED BEHAVIOR IN PREDICTING PHYSICAL ACTIVITY

Ries, F., Hein, V., Pihu, M.

*University of Seville - Faculty of Educational Sciences*

Among the variables proposed as useful additions to the structure of the Theory of Planned Behavior (TPB; Ajzen, 1991), there is evidence for the predictive usefulness of a measure of self-identity. The main purpose of this study was to test the hypothesis that self-identity is an independent predictor of physical activity (PA) intention and behavior in adolescents. School students (N = 397) from Estonia and Spain completed an initial questionnaire assessing the TPB constructs of attitude, subjective norms, and perceived behavioral control, as well as self-identity and intrinsic motivation in a leisure-time PA context. Four weeks later, participants completed a follow-up questionnaire that assessed self-reported PA during the previous four weeks. Several structural equation models were constructed. Self-identity had a direct effect on PA intention ( $\beta = .33$ ,  $p < .01$ ) and behavior ( $\beta = .31$ ,  $p < .01$ ). The hypothesized model accounted 67% of the variance of intention and 45% of PA behavior. To confirm the hypothesis that intention mediated the effect of self-identity on PA behavior the direct path from self-identity was fixed to zero. The effect of intention on PA behavior ( $\beta = .61$ ,  $p < .01$ ) increased indicating that partial mediation occurred. Overall, the results provide support for an extended version of the TPB incorporating self-identity.

### A MULTIDIMENSIONAL MEASURE OF CHILDREN'S WELL- AND ILL-BEING: INITIAL VALIDATION OF A NEW PSYCHOMETRIC TOOL.

Bracey, S., Qusted, E., Duda, J.L.

*University of Birmingham*

A MULTIDIMENSIONAL MEASURE OF CHILDREN'S WELL- AND ILL-BEING: INITIAL VALIDATION OF A NEW PSYCHOMETRIC TOOL. Bracey, S.J., Qusted, E., Duda, J.L. School of Sport and Exercise Sciences, University of Birmingham (Birmingham, UK) Introduction: Indices of subjective well-being and life satisfaction, commonly utilized to measure well-being in youngsters, were developed with adult populations. Moreover, existing measures of well-being tend to assess only positive indicators of functioning, not potential facets of experienced ill-being. Well- and ill-being are posited as independent albeit often inversely related constructs (Ryff et al., 2006). Addressing these gaps in the literature, a multidimensional measure of children's well- and ill-being was developed. Items were developed from children's qualitatively assessed conceptualizations of well-/ill-being as well as a consideration of item content contained within existing measures of emotional and physical health of children (Bracey et al., 2011). Extending this line of work, the present study tested the psychometric properties of the new multi-dimensional questionnaire. Method: Children (N=704) aged 7-11 years old (M = 9.33, SD = 1.16) comprising 387 males and 302 females (15 participants did not report gender) completed the 70-item questionnaire tapping multiple indicators of well- and ill-being. The questionnaire asked children to rate their well-/ill-being over the past month (e.g., 'I was full of energy...'; 'I felt like crying...') using a 5-point Likert scale (1 = never to 5 = always). Exploratory factor analysis with principal axis factoring (PAF) were conducted. Confirmatory factor analysis (CFA) will be conducted with an independent dataset. Factors were extracted with PAF and direct oblimin rotation. Results: A 43 item hierarchical structure with 6 second order dimensions (i.e., depression/anxiety, lethargy, physical ill-being, vitality, serenity, secure/inspired) was revealed. Cronbach's Alphas for all dimensions were acceptable to good: DEP/ANX .89; LET .73; PIB .76; VIT .85; SER .72; SEC/INS .61. Discussion: These findings support the perspective that children's well- and ill-being is multidimensional. Future work is required to confirm the factor structure and to examine the psychometric properties of the measure with different aged children. References: Bracey, S. J., Qusted, E., & Duda, J. L. (2011). *Sport & Exercise Psychology Review*, 7(2), 18-22. Ryff, C. D., Love, G. D., Urry, H. L., Muller, D., Rosenkranz, M. A., Friedman, E. M., Davidson, R. J., & Singer, B. H. (2006). Psychological well-being and ill-being: Do they have distinct or mirrored biological correlates? *Psychotherapy & Psychosomatics*, 75, 85-95.

17:45 - 19:15

## Oral presentations

### OP-PM43 Health and Fitness: Youth population

#### INTERACTION OF SEDENTARY ACTIVITY, SPORTS PARTICIPATION, AND PHYSICAL FITNESS WITH BODY COMPOSITION IN CHILDREN

Drenowatz, C.1, Kettner, S.1, Kobel, S.1, Fischbach, N.1, Steinacker, J.M.1

*Ulm University*

1: Ulm University Medical Centre (Ulm, Germany) Introduction The increasing prevalence of childhood overweight and obesity warrants further research on the interaction of various behavioural and physiologic aspects. While the effect of single components contributing to weight gain have been addressed only limited research is available on the combined association of sports participation, physical fitness, and time spent watching TV with body composition; thus the purpose of this study. Methods Baseline data from a large school-based intervention in southern Germany funded by the Baden-Württemberg Stiftung was used. 1594 children (809 male; 785 female), 7.1±0.6 years of age with no reported chronic disease were included in the analysis. Height and weight was measured by trained technicians and BMI was calculated and converted to BMI percentiles (BMIPCT) to determine normal weight, overweight and obesity. Sports participation and time spent watching TV was assessed via parent questionnaire and fitness was determined based on the results of the DKT

fitness test (Graf et al. 2004). 2-way ANCOVA, controlling for age and sex, using tertiles for fitness and sports participation groups (high, medium, low) as well as 2 groups for TV time (up to 60 min/day; more than 60 min/day) were used to examine combined effects on BMIPCT. Continuous scores for sports participation, fitness, and TV time were also used in one-way ANCOVA to determine differences between normal weight, overweight and obese subjects. Results Prevalence of overweight and obesity was 8.5% and 5.4%, respectively. There was no difference between boys and girls in BMIPCT. No interaction effects of fitness, sports participation or sedentary behaviour on BMIPCT occurred but significant main effects were observed for fitness and TV time. Higher TV time and lower fitness scores were associated with higher body weight. Similar results occurred when examining the different weight categories. Only TV time and fitness differed significantly between normal weight, overweight, and obese subjects, while no difference was seen for sports participation. Discussion Time spent watching TV and physical fitness independently influence body weight, while no effect of sports participation on body composition in children was shown. The lack of significance may be due to subjective assessment but could also be a reflection of lower sports participation in children in relation to their habitual physical activity. Overall, more research using objective measurements is needed to examine the combined association of various behavioural and physiological components contributing to weight gain in children. References: Graf C et al. (2004). Physical activity, leisure habits and obesity in first-grade children. *Eur J Cardiovasc Prev Rehabil* 11: 284–290.

### ASSOCIATIONS BETWEEN WEIGHT STATUS AND MOTOR COORDINATION DURING CHILDHOOD

Lopes, V.P., Stodden, D.F., Rodrigues, L.P.

*Polytechnic Institute of Braganca*

Introduction Ordinarily the relationship between obesity, physical activity (PA) and motor coordination (MC) is analyzed having in mind that low levels of PA cause obesity and low MC. But MC was found to be predictor of both PA (Lopes et al. 2011) and adiposity (Lopes et al. 2011). The purpose of this study is to analyze the association between MC and weight status. Methods Participants were 6,625 children (boys n = 3,344; girls n = 3,281), aged 6 - 10 years. Body mass index (BMI) was calculated from height and weight. MC was evaluated using the body coordination test (KTK). A factorial ANOVA was conducted using BMI as dependent variable. A binary logistic regression using two weight status categories as the dependent variable was performed. The odds ratios were calculated for weight status and MC tertiles separately in boys and girls, controlling for age. Results BMI significantly increases across age groups (F (5, 6224) = 50.59; p < 0,001). Children with higher MC showed lower BMI levels (F (10, 6224) = 4.53; p < 0.001). The differences in BMI among MC tertile groups became larger across age (F (10, 6224) = 4.53; p < 0.001). Girls in the first and second tertiles of MC distribution had respectively 3.47 and 1.63 more chances of being overweight/obese than girls in the third tertile. Boys in the first and second MC tertiles had respectively 3.90 and 2.08 more chances of being overweight/obese than boys in the first tertile. Discussion The findings show that children with lower MC had higher BMI than children with higher MC, and this difference became larger across age. The risk of being overweight/obese is higher in children with lower MC. We suggest that the relationship between MC, BMI and PA changes with age. At very young ages, till 4 - 5 years, the levels of PA are extremely important to MC and skills development and to weight control (Bürgi et al. 2011). During subsequent years and until puberty, children's weight status across time may be indirectly affected (from the direct result of PA and fitness levels) via the development of MC throughout childhood. Children who continue to develop higher levels of MC throughout childhood will be able to successfully engage in more movement opportunities promoting a healthy weight status (Stodden, Goodway et al. 2008). References Bürgi, F., U. Meyer, et al. (2011). *Int J Obes* 35(7): 937-944. Lopes, V. P., J. A. R. Maia, et al. (2011). *European Journal of Sport Science*: 1-8. Lopes, V. P., L. P. Rodrigues, et al. (2011). *Scandinavian Journal of Medicine & Science in Sports* 21: 663–669. Stodden, D. F., J. D. Goodway, et al. (2008). *Quest* 60: 290–306.

### REDUCED MOTOR SKILLS IN KINDERGARTEN CHILDREN WITH CONGENITAL HEART DISEASE IN COMPARISON WITH HEALTHY CHILDREN

Engelhardt, A.1,2, Hess, J.2, Hager, A.2

*Technische Universität München*

Objective: Motor competence is of major importance for the interactions of individuals with their environment. School children with congenital heart disease are known to have limitations even with minor defects. Data from kindergarten children are missing. This study was to compare the motor development of kindergarten children aged 4-6 years with congenital heart disease with healthy peers of the same age. Patients and methods: Motor development was investigated in 62 children (19 female, 43 male) with various forms of CHD and compared to 39 healthy children (22 female, 17 male). All subjects performed the motor development test (MOT 4-6), answered the Kiddy-KINDL® quality of life questionnaire (as well as the parents) and wore an accelerometer to capture daily activity for seven consecutive days. Results: The median [quartile1; quartile 3] motor quotient (MQ) in the CHD group (104 [96;113]) was significantly lower than in the control group (111 [104;116]; Mann-Whitney-U test p=0.005). Quality of life did not differ significantly (p=0.774, parents' questionnaire p=0.066), nor the minutes in moderate and vigorous physical activity (p=0.093). No correlation between the MQ and the other variables could be shown. Conclusion: Kindergarten children with CHD have a reduced motor ability in comparison with healthy children. This reduction seems not to be related to physical activity or quality of life.

### SALIVARY IGA AND UPPER RESPIRATORY SYMPTOMS IN PORTUGUESE YOUNG SOCCER PLAYERS

Rama, L., Leitao, R., Rosado, F., Teixeira, A.M.

*Faculty of Sport Sciences and Physical Education of Coimbra*

Introduction: In sportive adult population, intense training or competition can induce immune alterations, namely, a decrease of salivary IgA (sIgA), predisposing to upper respiratory symptoms (URS) occurrence (Gleeson, M., 2004). Fewer studies were conducted with children involved in sport participation, looking for mucosal immune response. In young gymnasts, the sIgA at rest seems to be not affected (Filaire, Bonis, & Lac, 2004). It is generally accepted that sport activity at youth, brings benefits to the health, related to the immune function, as it develops at that time (Bartlett, et al., 1998). Most studies shown that more active children had lower illness episodes (Cieslak, Frost, & Klentrou, 2003) The aim of this study was to compare de sIgA response in U-10 soccer players with a control group of teammates which are not involved in physical activity. Methods: 12 young soccer players (U-10 level), training twice a week, and 11 controls, that were not involved in regular physical activity (less than 1 hour/ week), participate in this study held during the first 15 weeks of the training season. Anthropometric measurements and the maturation status were controlled. The Salivary IgA concentration was calculated through ELISA assays (Salimetrics, UK). During the study the URS episodes were recorded. Descriptive, independent t-test and repeated

measures statistics were used to analyze data. Significance was placed at  $p < 0.05$ . Results: When compared, the athletes show always significant higher sIgA values than non-athletes ( $p < 0.05$ ). However no variation of sIgA values was found within each group during the study period. The occurrences of URS shown by the controls was slightly higher than that of the athletes Conclusion: Young soccer players show higher sIgA values than less active counterparts. Although not significantly different, non-athletes tend to be more affected by URS than athletes. The weekly training schemas of this U-10 soccer player's don't affect the sIgA concentration. REFERENCES: Bartlett, J. A., Schleifer, S. J., Demetrikopoulos, M. K., Delaney, B. R., Shiflett, S. C., & Keller, S. E. (1998). Immune function in healthy adolescents. *Clinical and Vaccine Immunology*, 5(1), 105. Cieslak, T. J., Frost, G., & Klentrou, P. (2003). Effects of physical activity, body fat, and salivary cortisol on mucosal immunity in children. *Journal of Applied Physiology*, 95(6), 2315-2320. Filaire, E., Bonis, J., & Lac, G. (2004). Relationships between physiological and psychological stress and salivary immunoglobulin A among young female gymnasts. *Percept Mot Skills*, 99(2), 605-617. Gleeson, M. (2004). Immune function and exercise. *European Journal of Sport Science*, 4(3), 52 - 66.

### INDIVIDUAL, SOCIAL, AND ENVIRONMENTAL FACTORS ASSOCIATED WITH WALKING TO AND FROM SCHOOL IN PORTUGAL.

Rodrigues, L.P., Teixeira, S.

*Instituto Politécnico de Viana do Castelo*

In the present days, children are often restricted in their mobility and autonomy, resulting in a more inactive and less healthier life style. Traffic danger and social safety concerns are pointed as causes for these restrictions. Among them, commuting to and from school has become a usual behavior, setting apart the more healthier and autonomous walking to and from school. In fact, studies show that children are progressively more being driven by car and that the age for autonomous journeys is increasing in western countries. Because walking to school can encourage children's autonomy and physical activity, there is the need to better understand the reality in order to promote changes. The aim of this study was to understand how children commute to school and back home, and what characteristics or settings can predict a healthier behavior. Methods Four hundred eighty nine students (247 boys, 242 girls) from two northern Portuguese school clusters (Viana do Castelo (urban) and Ponte de Lima (rural)), ranging from the 4th to the 9th grade, and living up to a one kilometer from school were inquired about their weekly (five days) commuting to school (to and from school). Their results were analyzed using a binary logistic regression, with sex, school year, school cycle, socioeconomic status, urban/rural gradient, and living distance, as independent predictors of the active behavior (walking to school). Results Results show that 47% of the children walked to school, while 62% walked back home. Significant relationships were found between active commuting and sex, school year, school cycle, socioeconomic status, and living distance. Using a binary logistic regression a significant odds ratio (OR) was found for belonging to an older school year (OR from 4.2 to 11.8); being economically disadvantaged (OR from 2.3 to 4.2); living less than 500 m from school (OR from 2.4 to 2.9); living in the more urbanized city of Viana do Castelo (OR=1.4); and being a girl (OR=1.3), as compared to their counterparts. Discussion Although traffic danger and safety concerns are usually pointed as the two main causes for walking to school restrictions, our data showed that girls, and children living in a urbanized area with an increased traffic flow, have a higher chance of walking to school by themselves (particularly in the morning). It looks like that parent's perceptions do not entirely match with their behaviors, when it comes to allow (or encourage) their children to walk to school. More studies are needed to better understand this complex behavior if we want children to become more autonomous and active on their daily route to and from school.

### MOTOR COMPETENCE IN CONTEMPORARY KINDERGARTEN CHILDREN IS GOOD, BUT REDUCED IN THOSE BEING OVERWEIGHT

Engelhardt, A., Müller, J., Schinzel, M., Hager, A., Oberhoffer, R.

*Institute of Preventive Pediatrics*

Objective: Perceptual and motor experiences determine not only the physical and motor development of children; they also affect the emotional, psychosocial and cognitive development of children. Since contemporary studies report on a diminished physical activity and a rising prevalence of overweight and obesity, this study aimed to evaluate the motor competence of kindergarten children and to determine the relation of obesity. Patients and methods: We studied 90 healthy kindergarten children (53 girls) aged  $5.5 \pm 0.6$  years with a median Body Mass Index Standard Deviation Score (BMI-SDS) of  $0.3 \pm 1.2$ . All children performed the MOT 4-6 from Zimmer designed to assess motor competence by 18 different exercise tasks. Task points were summed up to a score that is transformed to a motor ability index (MQ) according to the corresponding age-dependent reference value for boys and girls. Results: In general, current kindergarten children present a similar motor competence compared to the reference values from 1987 (MQnow: 98.6 vs. MQref: 100;  $p = .393$ ). MQ significantly decreased with higher BMI-SDS ( $r = -.503$ ,  $p < .001$ ). This difference also became especially obvious when comparing the 20 overweight children (BMI-SDS  $> 1$ ) with the normal weight subjects (MQnormal: 102 vs. MQoverweight: 87,  $p = .001$ ) Conclusions: Motor competence of kindergarten children is rather good. Overweight seems to be a risk factor for impaired motor competence.

17:45 - 19:15

## Oral presentations

### OP-PM44 Exercise Physiology 3

#### IMPROVEMENT OF IMMUNE RESPONSE TO VACCINATION IN ELDERLY PEOPLE AFTER PHYSICAL EXERCISE

Vaisberg, M.

*Federal University of São Paulo*

Introduction: Aging is a multifactorial phenomenon that also affects the immune system, leading to a higher susceptibility to infections and other diseases. Vaccination against influenza is a powerful strategy to protect this population against pulmonary diseases. However the efficacy of the vaccine is lowered by aging. Elderly people also show increase in the production of autoantibodies which actually is considered a natural antibody that acts as a protective mechanism. According to the literature regular moderate exercise is able to

attenuate some aspects of immunosenescence. The aim of this study was to evaluate the presence of autoantibodies, and the relation of these antibodies to the response of serum IgM and IgG specific to the influenza vaccine, comparing a group of sedentary people to a physically active group. Methods: The study population consisted of 78 elderly people aged between 60 and 85 years (mean age  $69,7 \pm 6,97$  years) living in the city of São Paulo. The volunteers recruited to the study kept to their usual routine and were divided in two groups: sedentary [SE,  $n=34$  (mean age  $70,4 \pm 6,9$  years)] and physically active [PA,  $n=44$  (mean age  $69,2 \pm 6,35$  years)] that performed a routine of physical activity (4-days a week - 1 hour each exercise session), at least for 12 months. The training program was constituted in aerobic exercises (60-70% of  $VO_2$  maximum) associated with resistance exercises. All volunteers received the same sample of influenza virus vaccine and none of the participants had liver, renal, inflammatory, cognitive, autoimmune or neoplastic diseases. Serum was collected at two different times: before and 30 days after the vaccination to determine the levels of immunoglobulin G produced in response to vaccine of influenza virus by ELISA. Anti-nuclear antibodies (ANAs) were determined by indirect immunofluorescence assay. Results: The results showed that the number of individuals' ANAs positive in the physical activity (PA) group was higher [ $n=20$  (45,45%)] than in the sedentary group [ $n=13$  (32,35%)], however no statistical difference was observed. Before the vaccination the serum IgG levels did not showed difference between the subgroups [SE,  $P=0.07(0.02-0.15)$  and  $N=0.17(0.10-0.38)$ ; PA,  $P=0.18(0.06-0.31)$  and  $N=0.22(0.13-0.37)$ ]. After the vaccination, in a comparison between the negative and positive individuals of SE and PA groups, only a significant statistical difference was observed in IgG levels of positive individuals of PA group [ $0.46(0.30-0.58)$ ] in relation to concentration observed in the positive individuals of SE group [ $0.15(0.10-0.40)$ ]. Discussion: We were able to demonstrate that a regular moderate physical activity increased the presence of autoantibodies and that this increase is correlated to an improvement in the immune response of elderly people as can be viewed by the higher levels of IgG antibodies against the virus of the influenza vaccine.

### EXERCISE-INDUCED FATIGUE AND HYPOGLYCAEMIA IMPAIR EYE MOVEMENTS BUT NOT VISUAL PERCEPTION

Gant, N., Duncan, S., Kuhn, G., Thompson, B.

*The University of Auckland*

Purpose Lowered substrate availability and exercise-induced fatigue are known to impair motor performance. It is currently unclear, however, whether the human visual system is also susceptible to this type of functional impairment. The aim of this study was to assess the extent to which the neural control of eye movements and cortical processing of visual information are susceptible to exercise-induced fatigue and hypoglycemia. This study examined visual performance after prolonged exercise and energy depletion. Methods Within a double-blind, randomized, cross-over design, 9 male cyclists (mean age 30.5 y and  $VO_{2max}$  61 ml/kg) consumed either placebo (fatigue + hypoglycemia condition) or carbohydrate (fatigue alone condition) solutions every 15 min during a 180 min cycling protocol. Exercise was performed after a 14h overnight fast at an intensity equivalent to 60%  $VO_{2max}$ . Visual acuity, binocular function, global motion perception and saccadic eye moments, were assessed using an established social attention eye movement paradigm, which was employed before and after the exercise protocol. Eye movements were recorded using an infra-red eye-tracker. Heart rate and perceived exertion were recorded throughout the protocol and venous blood samples were collected at routine intervals for assessment of plasma glucose and serum insulin. Results Fatigue alone or fatigue and hypoglycemia did not reduce visual acuity, binocular visual function, global motion perception or the effects of social attention on the latency of eye movements. There was, however, a significant reduction in the velocity ( $F(1,8) = 18.4, p = 0.003$ ) and accuracy ( $F(1,8) = 34.7, p < 0.001$ ) of saccadic eye movements for both the fatigue alone and fatigue + hypoglycemia conditions. Conclusion Neural processing of visual information is robust to exercise-induced fatigue and hypoglycemia, however ocular motor control is susceptible to the effects of prolonged and depleting exercise. Exercise-induced perturbations in homeostasis may impair the function of cortical areas governing ocular-motor control, whereas brain regions associated with sensory processing appear resistant to exertional and metabolic fatigue.

### EXERCISE-INDUCED BRONCHOCONSTRICTION IS VAGALLY MEDIATED AND CORRELATES WITH LUNG CLEARANCE INDEX IN ELITE SWIMMERS

Luke-Zeitoun, M., Wildman-Tobriner, B., Ghio, E., Hatamiya, N., Luke, A., Nielson, D., Lazarus, S., Gold, W.

*University of California San Francisco, San Francisco, California, United States of America*

Introduction: There is a high prevalence of exercise-induced bronchoconstriction (EIB) in elite swimmers. Elite athletes frequently report respiratory symptoms associated with exercise, but the diagnosis of asthma is often difficult to make because of the variability and poor specificity of the symptoms. Vagal activity has been shown to be increased in high level athletes and is known to promote bronchoconstriction. The lung clearance index (LCI) is a simple and sensitive measure of lung physiology, which has been used to detect early airway dysfunction in patients with asthma. The goal of this study was to determine the direct effects of vagal tone on airway responsiveness in elite swimmers and to evaluate the relationship of LCI to bronchial response to exercise challenge. Methods: Bronchial response to exercise was measured in 19 elite swimmers on 2 different occasions. To provoke EIB, the athletes exercised for 8 minutes on a cycle ergometer at 90% of their maximal heart rate while breathing dry air. In one of the visits, the athletes received intravenous saline (placebo). In the other visit, they received intravenous atropine (0.04 mg/kg), given in divided doses (0.01 mg/kg every 30 seconds) between minutes 8 and 10 of exercise to selectively achieve parasympathetic blockade by the end of the exercise challenge. Specific airway conductance (SGAW) was measured by body plethysmography before and 3, 6, 10, 15, 20 and 30 minutes after the exercise challenge. LCI was measured at rest using the multiple breath washout technique. Results: Post-exercise SGAW showed changes over time ( $p < 0.05$ ), differences among the 2 experimental conditions ( $p < 0.05$ ) and a condition x time interaction ( $p < 0.05$ ) in both asthmatics and non-asthmatics. Post-exercise bronchial response was significantly higher during the placebo trial than the atropine trial. 10 athletes met criteria for exercise-induced bronchoconstriction (EIB,  $>35\%$  decrease in SGAW), 5 of which had no history of asthma. There was a significant correlation between LCI and percent drop in SGAW after exercise challenge ( $p < 0.05$ ). Discussion: EIB is highly prevalent and underdiagnosed in elite swimmers and it can be prevented with parasympathetic blockade. Parasympathetic blockade leads to post-exercise bronchodilation in swimmers without EIB. These data suggest that vagal mechanisms play a major role in post-exercise airway response and possibly the development of exercise-induced bronchoconstriction in competitive swimmers. LCI correlates with post-exercise airway response in elite swimmers and may be helpful in predicting degree of EIB in this population.

### INDOOR CLIMBING TECHNIQUE ON A TRAVERSE ROUTE: EMG ACTIVITY AND BLOOD LACTATE CHANGES AFTER REPEATED TRIALS

Paoli, A.1, Petrone, N.2, Matteraglia, L.3, Marcolin, G.1

*University of Padova*

1: Department of Biomedical Sciences, University of Padova, Italy. 2: Department of Industrial Engineering, University of Padova, Italy. 3: Faculty of Exercise and Sport Science, University of Verona, Introduction Indoor climbing is becoming very popular both as fitness discipline and competitive sport. Scientific literature concentrated on the physiological demands of this discipline (Sheel 2004; Watts 2004) with particular attention to the forearm muscle fatigue and fingertip force (Macleod 2007). Therefore aim of the present work was to study the overall climbing technique on a route graded 6b measuring EMG activity of upper limbs, lower limbs and trunk. Then to investigate a possible effect of fatigue on the climbing technique after repeated trials on the same route. Methods The surface EMG activity of 16 muscles (forearms (4), arms (2), trunk (2), thighs (4), shanks (4)) was recorded by means of a PDA PocketEMG (BTS-Italy) at a sampling frequency of 1Khz synchronously to video recording from 1 commercial camera. Maximal voluntary contractions (MVCs) were performed for each muscle for EMG normalization. Six advanced climbers performed a 13 meters width traverse route for 6 times without rest time. Blood lactate was collected from the right earlobe before the first run, after the third and after the sixth one. EMG analysis was referred to the whole route but also to 5 specific sequences of movements. EMG signals were integrated, filtered and normalized with respect to MVCs. The ratio among normalized mean activity of upper limb and lower limb muscles was also calculated as well as the time of each performance. Results EMG analysis of the selected muscles showed consistent patterns among the repetitions of the same climber but different patterns among the 6 climbers. A greater activation of the upper limb muscles with respect to the lower ones was detected with an overall mean ratio of  $1.65 \pm 0.2$ . Blood lactate was respectively  $1.6 \pm 0.3$ ,  $2.5 \pm 0.7$  and  $3.7 \pm 2.2$  mmol/l. Discussion Results of the study showed how climbers of similar level exhibited subjective climbing technique with specific patterns of muscle activation. On the other hand the higher employment of the upper limb muscles with respect to the lower limb ones was recorded in all the climbers. The blood lactate increased during the 6 runs but values were index of a slight muscle fatigue. No substantial EMG changes were detected among climbers during the six repetitions. References Sheel AW. (2004). Physiology of sport rock climbing. Br J Sports Med, 38:355-359. Watts PB. (2004). Physiology of difficult rock climbing. Eur J Appl Physiol, 91: 361-372. Macleod D., Sutherland D.L., Buntin L. et al. (2007). Physiological determinants of climbing-specific finger endurance and sport rock climbing performance. J Sports Sci, 25(12):1433-43.

### INSPIRATORY MUSCLE TRAINING IMPROVES SELF PACED WALKING PERFORMANCE IN OVERWEIGHT AND OBESE ADULTS.

Edwards, A., Maguire, G., Graham, D.

*James Cook University*

Title: Inspiratory muscle training improves self paced walking performance in overweight and obese adults. Authors: AM Edwards<sup>1</sup>, G Maguire<sup>2</sup>, D Graham<sup>3</sup>, Institute of Sport & Exercise Science, James Cook University, Cairns, Australia <sup>2</sup>School of Medicine and Dentistry, James Cook University, Cairns, Australia <sup>3</sup>Department of Psychology, James Cook University, Cairns, Australia Introduction: The effectiveness of exercise interventions for overweight and obese individuals is often limited by factors including premature sensations of fatigue [1]. As obesity leads to an increase in respiratory demands [2], it is possible that an intervention such as inspiratory muscle training (IMT) might improve respiratory compliance, exercise tolerance and the benefits of exercise training in this population group [3]. The purpose of this study was therefore to examine whether a programme of IMT improves accumulative distance of self-paced walking in overweight and obese adults. Method: A total of 15 overweight and obese adults were matched for body mass index and lifestyle characteristics before being randomized into experimental (EXP: n=8) and placebo (PLA: n=7) groups. Lung function, inspiratory muscle performance, 6-minute walking test and predicted maximal aerobic power were assessed prior to and following the 4-week IMT intervention. EXP performed 30 inspiratory breaths, twice daily using a proprietary inspiratory resistance device set to 55% of baseline maximal effort, while PLA performed the same inspiratory training procedure but at the minimum resistive setting. Results: Lung function was unchanged in both groups post-training; however inspiratory muscle performance was significantly improved in EXP (31.4 % mean gain;  $P < 0.01$ ) but did not significantly change in PLA. Predicted maximal aerobic power was unchanged in both groups but the distance covered in the 6-minute walking test was significantly greater for EXP (18.8 % gain;  $P < 0.01$ ) over the 4-week period. PLA did not significantly improve walking performance (6.1% non significant gain). The magnitude of performance gain was positively associated with BMI ( $r = 0.736$ ;  $P < 0.05$ ) Discussion: The present study suggests IMT provides a practical, minimally intrusive intervention to significantly augment both inspiratory muscle performance and walking distance covered by overweight and obese adults in a clinically relevant 6-minute walk test. The post-training gains observed in walking distance indicate that IMT may provide a useful priming (preparatory) strategy prior to entry in a physical training programme for overweight and obese adults. References: 1. Ekkekakis P, Lind E, Vazou S. Affective responses to increasing levels of exercise intensity in normal-weight, overweight, and obese middle-aged women. Obesity 2009;18:79-85. 2. Luce J. Respiratory complications of obesity. Chest 1980;78:626-631. 3. Edwards A, Walker R. Inspiratory muscle training and endurance: a central metabolic control perspective. Int J Sports Physiol Perform 2009;4:122-128.

---

# Saturday, July 7th, 2012

---

**08:00 - 09:30**

## Invited symposia

### IS-PM10 Protein Turnover and Inactivity

---

#### PROTEIN SUPPLEMENTATION TO IMPROVE MUSCLE ADAPTATION IN ATHLETES

Phillips, S.

*McMaster University*

Muscle protein turnover encompasses the opposing processes of muscle protein synthesis (MPS) and breakdown (MPB). Interventions aimed at supporting optimal muscle adaptation generally target MPS since it is by far the more responsive of the two parameters and is a primary driver of muscle remodeling and hypertrophy. Available data suggest that various forms of resistive work, and to a lesser extent aerobic work, are able to stimulate MPS in a protein fraction-specific manner. Protein ingestion also stimulated MPS and, through insulin and potentially amino acids themselves, reduces MPB. The amino acid leucine has a position of prominence as the amino acid that 'turns on' MPS. Data from our lab suggests that more rapidly digested proteins, such as whey, that result in a rapid aminoacidemia and leucinemia are particularly effective at stimulating MPS. Strategies to enhance anabolism through synergistic combinations of exercise and nutrition will be discussed in the context of improving muscle adaptation.

#### PROTEIN TURNOVER OF CONNECTIVE TISSUES IN HEALTHY AND INJURED ATHLETES

Kjaer, M.

*Bispebjerg Hospital*

The connective tissue (extracellular matrix (ECM)) is present in many load bearing structures like bone, cartilage, skeletal muscle, ligaments and tendons. As an example of an ECM rich tissue, tendons are designed to withstand considerable loads and it is shown that mechanical loading of tendon results in an up-regulation of collagen expression and an increased synthesis of collagen protein that is likely regulated by strain of the fibroblast. In vivo, the exercise stimulated increase in collagen formation peaks around 24 hrs and remains elevated for about 3 days after exercise. The degradation of collagen proteins also rises after exercise, but appears to peak earlier. The increase in collagen synthesis of the ECM is regulated by growth factors like IGF-I, TGF-beta, estrogen and IL-6, most likely in an auto/paracrine fashion. This has been demonstrated both in vitro and in vivo. Fibroblasts from adult human tendon tissue are able – when isolated - to respond in an embryonic pattern to induce fibrillogenesis in vitro. In addition to changes in collagen turnover, exercise also influences cross linking in the tendon structure, and some of these reactions appear faster than structural changes in collagen fibrils. Finally, signaling for protein synthesis is in general upregulated with injury, but depending upon type of injury, the protein synthesis is either unchanged or elevated. Understanding how ECM adapts to mechanical loading will be the solution to unraveling the pathogenesis of connective tissue overuse and overload diseases like e.g. tendinopathy and ligament ruptures.

#### MUSCLE PROTEIN TURNOVER AND SUPPLEMENTATION AFTER SPORT INJURIES IN ATHLETES

Tipton, K.

*University of Stirling*

Injuries are an unavoidable aspect of participation in physical activity. Nutrition is important for optimal wound healing and recovery, but little information about nutritional support for injuries exists. Immediately following injury, wound healing begins with an inflammatory response. Excessive anti-inflammatory measures may impair recovery. Many injuries result in limb immobilization. Immobilization results in muscle loss due to increased periods of negative muscle protein balance from decreased basal muscle protein synthesis and resistance to anabolic stimuli, including protein ingestion. Oxidative capacity of muscle is also decreased. Nutrient and energy deficiencies should be avoided. Energy expenditure may be reduced during immobilization, but inflammation, wound healing and the energy cost of ambulation limit the reduction of energy expenditure. There is a theoretical rationale for leucine and omega-3 fatty acid supplementation to help reduce muscle atrophy. During rehabilitation and recovery from immobilization, increased activity, in particular resistance exercise will increase muscle protein synthesis and restore sensitivity to anabolic stimuli. Ample, but not excessive, protein and energy must be consumed to support muscle growth. During rehabilitation and recovery, nutritional needs are very much like those for any athlete desiring muscle growth. The most important consideration is to avoid malnutrition and to apply a risk/benefit approach.

08:00 - 09:30

## Oral presentations

### OP-SH10 Physical Education and pedagogics 1

#### ANALYSIS OF PHYSICAL ACTIVITY OF PRESCHOOL CHILDREN - COMPARISON OF DIFFERENT EDUCATION PROGRAMS

Roettger, K.1, Grimminger, E.1, Kreuser, F.2, Assländer, L.1, Korte, J.1, Wehrle, A.2, Korsten-Reck, U.2, Gollhofer, A.1

*University of Freiburg*

Introduction: Physical Activity-Participation at preschool-ages is vital to establish lifelong physical activity habits and could have a protective effect against weight-gain in later life (Herman, Craig, Gauvin, & Katzmarzyk, 2009). Due to the increasing out-of-home care for preschoolers these settings, their structures and education-programs are of emerging interest. Therefore we investigated the influence of country-specific education-programs on physical activity of preschoolers. Comparing the three countries France, Germany and Switzerland in the tri-national region "Upper Rhine" we aimed to identify parameters to enhance and promote physical-activity in early childhood. Methods: The pilot-study measurements were conducted in three cities of the tri-national region with similar population. N= 60 children (age: 5,6±0,59 years) of randomized chosen nursery schools in each city were measured by direct accelerometry for 7 consecutive days. Proxy-report diary and physical-activity questionnaire were completed by parents and caregivers. Anthropometrical data (weight, height, skinfold thickness) and socioeconomic data were obtained. Country-specific timetables and curricula were analysed. Results: Median daily activity was lower in French versus German and Swiss children ( $p < .01$ ). Direct accelerometry revealed no significant differences for physical activity between the children of all countries at the weekend. In the forenoon (9-12.00) French children were significantly more passive than German or Swiss children ( $p < .01$ ). In the afternoon (14-18.00) Swiss children are significantly more active than French or German Children ( $p < .01$ ). In all countries, physical activity was lower at the weekend compared to weekdays ( $p < .05$ ). Conclusion: Compared to the more unstructured system in Switzerland and Germany the regimented and highly structured French system leads to more inactivity in preschoolers on weekday especially in the forenoon. In conclusion, "open concepts" should be preferred for enhancing physical activity in contrast to desk-based teaching (Reilly, 2010). Finally, the overall higher activity of Swiss children and the gradient of PA between weekday and weekend show the importance of physical activity habits established in the family. References: Herman, K. M., Craig, C. L., Gauvin, L., & Katzmarzyk, P. T. (2009). Tracking of obesity and physical activity from childhood to adulthood: the Physical Activity Longitudinal Study. *International journal of pediatric obesity: IJPO: an official journal of the International Association for the Study of Obesity*, 4(4), 281-8. Reilly, J. J. (2010). Low levels of objectively measured physical activity in preschoolers in child care. *Medicine and science in sports and exercise*, 42(3), 502-7.

#### DEVELOPMENT OF THE LEARNING STYLES QUESTIONNAIRE FOR CHILDREN

Cunliffe, D.

*Southampton Solent University*

Introduction It is the duty of the educator to ensure that children are developed to fulfil their potential in both academic success and physical well being. A key factor when educating others is to accommodate for differences between them, yet within the area of cognitive development, the notion that we all possess a preferred learning style, or trait, is somewhat of a taboo within sectors of academia (Coffield et al. 2004). Others accept the notion that perhaps we do not all learn in the same fashion, using one or many preferred methods (Beadle, 2010, Capel & Whitehead, 2010). The current literature of this nature is limited (Salter & Graham, 1985; Stevens-Smith & Bowling, 2002), therefore, the more we are able to understand about the different dimensions of a child's development and their approaches to learning, the easier it could be to teach them the complex techniques, skills and demands required for participation in physical activities. Methods Appropriate ethical clearance was granted from a University's Ethical Committee, and permission sought and granted to assess the preferred learning styles of pupils across school years 7-11 ( $n=1500$ ) from one state school within the UK. The initial phase centered on children's perception of what they had learnt, and involved focus group discussions before analysing the results into five key themes. The acquisition of general content was carried out in adherence to standard guidelines using a triangulation approach, as commonly used in the development of a questionnaire (Terry, Lane, Lane, & Keohane, 1999; Walker & Fraser, 2005). Once the items and answers had been established, to improve reliability, the LSQ-C was administered three times over a six week period, with the order of questions and respective answers changed to avoid any learned response. Results A panel of experts agreed that the five key themes (Functional, Personal, Educational, Psychological and Social Learning) were reliable and in line with child development. When assessed for face validity, content validity and comprehensibility for its use with children, using Cronbach's Alpha, the LSQ-C held a reliability score of .871. Discussion Whilst the results of this research support that the LSQ-C offers face validity, there is a need for additional research to assess whether the results are replicable, therefore, further research will see the project extending to other schools. References •Beadle, P. How to Teach, 201-203. Crown House Publishing, Carmarthen, UK, 2010 •Capel, S. and Whitehead, M. Learning to Teach Physical Education in the Secondary School, 3rd Ed, 69, Routledge, Oxford, UK, 2010 •Coffield et al. Should we be using Learning Styles? What research has to say about practice, 1-5, Cromwell Press Ltd. Trowbridge, UK, 2004 •Salter, W.B. & Graham, G. J. Teaching in Phys. Ed., 4 (3), 212-219, 1985 •Stevens-Smith & Bowling, Teaching Elementary Phys. Ed., Vol.18, 18-22, 2002 •Terry et al. J. of Sp. Sci, 17, 861-872, 1999 •Walker & Fraser (2005) Learning Environments Research, 8, 289-308

#### THE TEACHING EFFECTIVENESS OF PBLTEACHING MODEL ON NURSING COLLEGE HEALTH PHYSICAL FITNESS PROGRAM

Wang, W.Y.1, Chou, C.C.2

*1:HSC(Taoyuan, Taiwan), 2:TPEC(Taipei, Taiwan)*

Introduction To facilitate nurse practitioner students critical thinking and problem-based learning, PBL teaching model was introduced into their PE course. The purpose of this study was to investigate the effects of Problem Based Learning (PBL) teaching model on health fitness knowledge, physical activities, self-directed learning of PE ability and social problems solving ability of a health fitness program for nursing college students. Methods Quantitative and qualitative methods were used. Quasi-experimental design with an experimental group (EG)

and a control group (CG) were adopted to investigate the effects on student learning. Two classes of nursing students volunteered to be the participants, one class was set as EG (n= 47) and another class CG (n=47). All participations finished 100minutes/week fitness program for 12weeks, EG was taught with the PBL teaching model: first 50minutes was discussion course through discussion sheets by teaching tutors and students, and the second 50minutes was physical activity course. The CG was taught by direct teaching method and physical activity, each for 50minutes respectively. Data were collected through quantitative and qualitative methods. Health-related fitness knowledge test (HRFK) , Self-directed learning readiness Scale-PE (SDLRS-PE) , Social Problem-Solving Inventory-Revised (SPSI-R) and pedometers were used to collect quantitative data. Which analyzed by descriptive statistics, one-way ANCOVA, while qualitative data was analyzed thought content analysis from interview, observation, journal and other related documents. Results (1) For HRFK test, PBL showed significant effects in all dimensions except flexibility, with high degree effect size of explanatory power ( $\eta^2= .219$ ). (2) For SDLRS-PE scales, PBL teaching model showed significant effects on love to learning, motivation, creative learning and total score with PBL had high degree effect size of explanatory power ( $\eta^2= .229$ ). (3) For SPSI-R test, PBL teaching model showed significant effects on negative problem orientation, impulse/careless style, escape style and total score with PBL had medium degree effect size of explanatory power ( $\eta^2= .120$ ). (4) EG students' physical activity and fitness knowledge performances indicated similar development trend, showing students could internalize the knowledge related to physical activity under PBL teaching method. Discussion Based on the above result findings, suggestions on PBL theory, teaching practice and future studies were proposed.

## PERCEPTIONS OF BODY SENSATIONS GENERATED BY PHYSICAL ACTIVITY IN RELATION TO ATTRIBUTION STYLE AND REPORTED PHYSICAL ACTIVITY

Sollerhed, A.C.1, Apitzsch, E.2

1. *Kristianstad University*. 2. *Lund University*

**Introduction** Low levels of physical activity (PA) in childhood can lead to implications for current and future health. Degenerative biological processes initiated in childhood increase the risk of the onset of chronic diseases later in life. PA can generate painful sensations such as breathlessness, stiffness, ache, and sore muscles during and after exercise. These sensations can be perceived in different ways and might be barriers for participation. Successes and failures can be explained by a variety of causes (attributions), which affect not only expectations of future success or failure but also emotional reactions and motivation. The aim of the study was to investigate relations between attribution style, perceived body sensations during and after exercise in relation to reported PA among 15 year-old adolescents. **Methods** A questionnaire including items about ways of living, attribution style, perceptions of body sensations during and after exercise, and self-reported PA was used. The sample was 659 teenagers in Sweden and New Zealand, 15-16 years old. The chi squared test and the Student's t-test were used in the statistical analyses, which were carried out by using PASW version 18.0. Results Teenagers who reported high levels of PA were higher in task-orientation (TO) (29.4 vs 26.8;  $p<0.000$ ) and ego-orientation (EO) (20.5 vs 18.1;  $p=0.001$ ) than sedentary peers. Physically active teenagers perceived being out of breath as normal and okay to a higher extent than inactive teenagers (93% vs 73%;  $p<0.000$ ). They also perceived sore muscles as okay to a higher extent (77% vs 46%;  $p<0.000$ ). Teenagers who thought it was okay being out of breath during exercise scored higher both in TO (28.7 vs 26.4;  $p<0.000$ ) and EO (19.8 vs 17.4;  $p<0.000$ ). Those who thought it was normal and okay with sore and stiff muscles during and after exercise scored higher in TO (28.1 vs 24.8;  $p<0.000$ ) and in EO (18.9 vs 17.2;  $p<0.001$ ). **Discussion** Teenagers with high PA levels seemed to be motivated for PA despite some troublesome body sensations. This could be explained by their high TO which is associated with willingness to make efforts. Active children and adolescents also develop a more robust body than those who are inactive. They develop hardiness and control and see challenges as standard and find them stimulating and do not care about temporarily pains. Overall they do not focus on the negative aspects of PA, they enjoy it and regard it as a positive investment for themselves. The reverse could be seen among physically inactive teenagers who perceive the body sensations from PA as emotionally negative, which together with low TO could be strong barriers for effort, and substantially reduce the willingness of all PA especially the strenuous PA.

## EXPLORING CHILDREN'S MOTOR DEVELOPMENT

Saunders, J., Williams, M., Wilson, C.

*Australian Catholic University*

**Introduction** Current research into children's physical activity has focused largely on obesity. Interest in quantifying activity levels has generally related to physiological status. However, recent research by our motor development group in Melbourne suggests the need to be worrying about more than just declining physiological status. Movement-ABC data from a sample of children (255 males: 249 females) aged between 5 and 12 used the 15th percentile or below as the criterion to screen for DCD and found 35% (83 Males: 92 Females) of children fitted this criterion - a prevalence alarmingly greater than that generally cited in the literature. Fifteen years ago a group of researchers (Walkley, J., Holland, B., Treloar, R., & Probyn-Smith, H. 1993) used the notion of Fundamental Movement Skills to provide the basis for physical education curriculum initiatives in Victoria. Yet little success in enhancing children's motor ability seems to have occurred to date. **Method** Applying readily available biomechanical techniques of kinetic and kinematic analysis, our research group has been exploring two of the fundamental movement skills – locomotion and jumping. Wilson examined the locomotion of 218 children aged between 4-12 and Williams examined the vertical jump performance of 124 children. **Results** The major finding from the Wilson study was that children's fundamental locomotor skill was still developing as late as aged twelve. Velocity, cadence, step length and base of support all showed significantly greater variability for children even with the 11-12 year old sample when compared with young adults. The Williams study identified coordination error as the critical difference in performance between normal children and those identified with lower levels of motor ability. Differences were attributable to a greater loss of VCOM and a lower shank angular velocity at take off resulting in a longer elapsed time from the instant of peak VCOM to take off. **Discussion** The increasing availability of reliable biomechanical techniques for the evaluation of movement provides the means of developing greater understanding of child motor development processes. Findings from studies such as those reported here can prove particularly valuable not only in providing effective individual remediation strategies but also for practice in our motor development and physical education programs in schools at both primary and secondary levels. **References:** Walkley, J., Holland, B. Treloar, R. & Probyn-Smith, H. (1993) Fundamental motor skill proficiency of children. *Physical Education*, Spring, 11-14 Williams, M. (2008) Exploration of differences in vertical jump performance between typically developing children and those identified with DCD: A kinematic and kinetic analysis. Unpublished PhD thesis. Australian Catholic University, Melbourne Wilson, C. (2009) The contribution of gait analysis to the understanding of motor development. Unpublished PhD thesis Australian Catholic University, Melbourne.



**RELATIONSHIP BETWEEN BODY IMAGE AND PHYSICAL ACTIVITY ON SPANISH CHILDREN**

Dorado, M., Chinchilla, J.L., Carnero, A.

*University of Malaga, Spain*

**Introduction** A disturbance of body image should be related with some adolescence body composition-related disorders, which has a behavioral etiology, where body shape self-perception should one important risk factor. Some surveys have suggested that physical activity (PA) would be a positive co adjuvant to promote a better body self-perception. However, there is not enough evidence about what is the relationship between body composition, different patterns of PA and body shape on adolescents. To explore the relationship between body shape perception, body composition and PA. **Methods** 265 healthy students were examined (107 boys and 158 girls; 14.6 ± 1.1 years; body mass index, 22.2 ± 4.0 kg/m<sup>2</sup>). Body composition was estimated using bioelectric impedance and anthropometry. Body shape assessed with the body shape questionnaire (BSQ). Daily PA and out-of-school PA (OPA) were determined by a validated physical activity questionnaire for Spanish adult children (PAQ-A). Pearson's correlation coefficient was used to explore the relationships between variables. Independent sample T-test was carried out to compare body image perception between adolescents with and without OPA. **Results** A significant relationship between body image and FFM was found ( $r = 0.32$ ,  $p < 0.001$ ). No significant relationship was found between BSQ score and PA ( $r = -0.07$ ,  $p > 0.05$ ). BSQ score was significantly different between adolescents with OPA and without OPA (59.9 ± 24.4 vs. 71.0 ± 29.5). **Discussion** Our main finding was that adolescents, which had performed OPA showed an improved body shape perception. However, PA was not related with BSQ score. Also, in accordance with other studies on adults the higher FFM better BSQ score. These results suggest that some characteristics of the OPA should help to improve body self-perception; however more research is necessary in order to clarify this relationship. **References** Furnham, A., Badman, N. & Sneade, I. (2002). *J of Psychology*, 136, 6, 581-596. Vocks S, Hechler T, Rohrig S, Legenbauer T. (2009). *Psy Health*, 24, 713-728. Crossen K. Raymore LA. (1997). *New Zealand J of Sports Med*, 25, 3, 42-45.

**08:00 - 09:30****Oral presentations****OP-PM45 Sports Medicine: Game Injuries****MUSCLE LESIONS AND INFLAMMATION IN FUTSAL PLAYERS ACCORDING TO THEIR TACTICAL POSITIONS**

Hatanaka, E.

*Cruzeiro do Sul University*

**Muscle lesions and inflammation in futsal players according to their tactical positions** Hatanaka E1, de Moura, NR1, Santos VC1,2, Bortolon JR1, Borges LS1, Cury-Boaventura MF1, Curi R2, Pithon-Curi TC1 1Institute of Physical Activity Sciences and Sports, Cruzeiro do Sul University (São Paulo, Brazil), 2Department of Physiology and Biophysics, University of São Paulo (São Paulo, Brazil). **Introduction.** Depending on the tactical function during the match, the loads imposed on the metabolism, muscles and immune system may differ among players, thus requiring differentiated adaptations. A less harmful inflammatory profile that is well adjusted to the tactical position may increase the athlete's performance during the match. Thus, the aim of this study was to characterize muscle lesion and inflammation in futsal players according to their positions in a competitive match. **Methods.** The participants in this study were five goalkeepers (23 ± 1.2 years old, body mass 74 ± 2.5 kg, height 178 ± 3.2 cm, body fat 13 ± 2%, VO<sub>2</sub> max 40 ± 2 mL.kg<sup>-1</sup>), eight defenders (21 ± 1 years, body mass 69 ± 2 kg, height 174 ± 1 cm, body fat 10 ± 2%, VO<sub>2</sub> max 42 ± 1 mL.kg<sup>-1</sup>), eight wingers (22 ± 1 years, body mass 68 ± 2 kg, height 169 ± 3 cm, body fat 11 ± 2%, VO<sub>2</sub> max 48 ± 1 mL.kg<sup>-1</sup>), and eight pivots (25 ± 2 years, body mass 71 ± 2 kg, height 173 ± 2 cm, body fat 10 ± 2%, VO<sub>2</sub> max 46 ± 2 mL.kg<sup>-1</sup>). Blood samples were collected from the participants before and immediately after a match. Muscle damage was detected based on CK and LDH activity. The inflammatory status was evaluated by determining CRP, TNF-α, IL-1β and IL-6, IL-10 and IL-1ra. **Results.** LDH activity in goalkeepers was 5.0-fold higher than in defenders, and 1.6-fold higher than in wingers. There was no variation in the concentrations of CRP, TNF-α, IL-1β, IL-8, IL-10 and IL-1ra among tactical positions. However, the IL-6 level in goalkeepers was 17.7-fold higher than in defenders and 14.2-fold higher than in pivots. The goalkeepers showed lower VO<sub>2</sub>max (40 ± 2 mL.kg<sup>-1</sup>) than defenders (42 ± 1 mL.kg<sup>-1</sup>), wingers (48 ± 1 mL.kg<sup>-1</sup>) and pivots (46 ± 2 mL.kg<sup>-1</sup>). Additionally, the goalkeepers presented a higher percentage of body mass (74 ± 2.5 kg) and body fat (13 ± 2%) than defenders, wingers and pivots. **Conclusion.** Goalkeepers showed higher LDH and IL-6 than players occupying other tactical positions, leading to the conclusion that the tactical position of futsal goalkeeper causes more inflammation and muscle damage than other positions. Moreover, this position is usually occupied by athletes with higher body mass and percentage of body fat and lower VO<sub>2</sub> max than players in the other positions. **References.** [1] de Moura NR, Cury-Boaventura MF, Santos VC, Levada-Pires AC, Bortolon JR, Fiamoncini J, Pithon-Curi TC, Curi R, Hatanaka E. (2011). *J Strength Cond Res* (in press). [2] Cray C, Zaias J, Altman NH. (2009). Acute phase response in animals: a review. *Comp Med*. Dec;59: 517-26. Supported by FAPESP.

**USE OF TENSIOGRAPHY FOR EARLY DETECTION OF MUSCLE INJURIES**

Zupet, P., Zorko, M., Rozman, S., Djordjevic, S.

*University medical center Ljubljana*

**USE OF TENSIOGRAPHY FOR EARLY DETECTION OF MUSCLE INJURIES** Petra Zupet<sup>1</sup>, Martin Zorko<sup>1</sup>, Sergej Rozman<sup>2</sup>, Srdjan Djordjevic<sup>2</sup> 1 Sports medicine unit, University Medical Centre Ljubljana, Slovenia 2 TMG-BMC Ltd., Ljubljana, Slovenia **BACKGROUND** Injuries of the hamstring muscles are the most common type of injury in sports where running is the basic movement pattern (1). There is a high rate of reinjury of 15-30% (1-4). Early diagnosis with determination of the injury level is very important. One of the major factors for determination of skeletal muscle strain level is the ability of injured muscle to contract. While most diagnostic methods allow us to observe macroscopic structure changes of an injured tissue, tensiomyography (TMG) can measure contractile properties (5-6) of the injured skeletal muscle. **AIM** The aim of our study was to verify, whether TMG can be used as an independent diagnostic tool in early stages after muscle injury. **METHODS** 11 athletes (4 female, 7 male; age 24 ± 9, 7) were treated in Sports Medicine Unit for hamstring injury. The protocol included obtaining medical history of present injury, clinical examination, paraclinical (imaging) methods and TMG measurement. Three parameters for evaluation of TMG signal were determined: Td (delay time), Tc (contraction time) and Dm (displacement of muscle belly during

contraction). Results are presented in a form of mean value  $\pm$  standard deviation. For a statistical analyzing of differences between injured and non-injured hamstring muscle Student's t-test was used. RESULTS We found a statistical significant difference in TMG signal in all injured subjects ( $T_c = 25,32 \pm 10,0$  non injured vs.  $T_c = 37,1 \pm 8,8$  injured ( $p < 0,006$ )). DISCUSSION Subjects were examined in different time periods after injury (2 - 10 days). In previous studies it was shown that the  $T_c$  parameter highly correlates with percentage of slow twitch fibers type I and heavy chain myosin type composition (5). Our study group was heterogeneous, included athletes from different sport types (chronic training adaptation). This and genetic differences caused relatively high differences in  $T_c$  values. CONCLUSION Contractile property changes after strain injury of hamstrings are detected as changes of  $T_c$  and  $D_m$  parameters in TMG signal. This was confirmed by clinical examination and standard imaging methods. There are further studies needed to verify the exact correlation between the injury grade and TMG parameters. References: 1. Petersen J, Hölmich P. Br J Sports Med. 2005 Jun;39(6):319-23 2. Jarvinen TAH, Jarvinen T, Kaariainen M et al. American Journal of Sports Medicine 2005;33:745-766 3. Malliaropoulos N, Isinkaye T, Tsitis K, Maffulli N. Am J Sports Med. 2011 Feb;39(2):304-10 4. Mendiguchia J, Brughelli M. Phys Ther Sport. 2011 Feb;12(1):2-14 5. Simunic B, Degens H, Rittweger J, Narici M, Mekjavic I, Pisot R. Med Sci Sports Exerc. 2011 Sep;43(9):1619-1625 6. 27. Dahmane R, Djordjevic S, Smerdu V. Med Biol Eng Comput. 2006 Nov;44(11):999-1006

#### DATA QUALITY CONTROL IN SPORTS INJURY SURVEILLANCE STUDIES: AN EXAMPLE ON DISTANCE RUNNERS

Genin, J.I, Urhausen, A.2, Theisen, D.1

*1Sports Medicine Research Laboratory, CRP-Santé (Luxembourg), 2Centre de l'Appareil Locomoteur, de Médecine du Sport et de Prévention (Luxembourg)*

Introduction Sports injury surveillance studies relying on information technology sometimes report poorly on data quality control (2). The aim of this study was to present a data quality algorithm for sports injury epidemiology and to apply it in an analysis of running-related injury (RRI) incidence in novice and experienced runners. Method This study consists in a 24-week follow-up of 301 recreational runners. They were asked to run at least once a week and to upload their training data for running (duration, surface, intensity, mileage) plus any other sport activity on an internet-based diary. They were also asked to self-report all injuries (RRI or not). To ascertain for high-quality data, three inclusion criteria were applied before statistical treatment: uploading compliance was conformed when the athlete's status (training, at rest, injured, sick) was known for  $\geq 75\%$  of the weeks. Uploading delay was conformed when  $\geq 75\%$  of the sessions were uploaded within 15 days after the session was achieved. Self-assessed compliance evaluated monthly was conformed when the participant reported to have uploaded  $\geq 75\%$  of the actually performed sport sessions. In addition, two criteria assessing for the regularity of the running training were applied: the minimum average running training, evaluated throughout the observation period or until RRI occurrence, was set to 1 session/week, and there could be no period of 4 consecutive weeks with no running. Results From the initial 301 logged-on runners, 100 did not comply with the 3 data quality criteria. Another 24 participants were excluded from the final analysis after applying the two running training criteria. The demographics were not different between excluded and included participants. From the 177 runners retained, 43 (27%) sustained a total of 60 RRI; 75% were due to overuse, and the most frequently injured location was the knee (27%). RRI incidence was 14.2 and 4.7 RRI/1000 running hours in novice and experienced runners, respectively. Novice runners were 3.0 times (95% CI: 1.75-5.18) more at risk of sustaining a RRI than experienced ( $\chi^2 = 17.3$ ,  $p < 0.001$ ). Discussion Applying the present quality algorithm reduces the bias caused by lack of reporting and recall in the presented results. However, a selection bias due to this algorithm cannot be excluded. The fact that novice runners are more at risk than experienced is an important finding considering the high prevalence of RRI (1). (1) Buist I, Bredeweg S, Lemmink K, van Mechelen W, Diercks R. (2010). Am J Sports Med, 38, 273-80. (2) Jacobsson J, Timpka T, Ekberg J, Kowalski J, Nilsson S, Renstrom P. (2010). Br J Sports Med, 44, 1106-11.

#### INFRAPATELLAR STRAP REDUCES PAIN IN ATHLETES WITH PATELLAR TENDINOPATHY

Boetje, J., Zwerver, J., van den Akker-Scheek, I.

*University of Groningen*

Infrapatellar strap reduces pain in athletes with patellar tendinopathy (jumper's knee) Boetje J. MD; Zwerver J. PhD; van den Akker-Scheek I. PhD Center for Sports Medicine; University Center for Sport, Exercise and Health; University Medical Center Groningen; University of Groningen; Hanzplein 1, 9700 RB Groningen, The Netherlands OBJECTIVE: To determine if an infrapatellar strap reduces pain in athletes with patellar tendinopathy during functional loading of the patellar tendon. METHODS: 53 adult male ( $n=39$ ) and female ( $n=14$ ) athletes (mean age 28.5 (range 18-48) years) with patellar tendinopathy were included in this study. The mean VISA-P was  $55.0 \pm 14.5$ . The median duration of symptoms 24 (range 3-300) months. The athletes performed ten single leg decline squats and a maximal jumping test without and then with an infrapatellar strap (Push Med Patella Brace, Vivomed Downpatrick UK). Recruitment of participants took place on the Center of Sports Medicine of the University Medical Center Groningen, the Netherlands. Pain after each functional patellar tendon loading tests was recorded on a visual analogue scale. Additionally, the athletes used the strap for a week during training sessions and games and were asked for satisfaction with and side effects of the strap. RESULTS: Pain reported differed significantly when performing ten single leg decline squats without and with a strap,  $4.2 \pm 2.4$  and  $3.3 \pm 2.2$  respectively ( $p < 0.001$ ) and when jumping three times on one leg,  $3.0 \pm 2.6$  and  $2.6 \pm 2.2$  respectively ( $p = 0.02$ ). Sixty percent of the athletes reported that the strap reduced their pain during and after their sporting activities. The only side effect reported was a feeling of compression in the popliteal space due to the strap. DISCUSSION: This study showed that an infrapatellar strap reduces the pain during functional patellar tendon loading tests and sports activities. Generalization of these results might be hampered by the fact that there are many different straps available. Furthermore, little is known about the long-term effects of using an infrapatellar strap on the progression of patellar tendinopathy. CONCLUSION: An infrapatellar strap can reduce pain experienced by athletes with patellar tendinopathy during patellar tendon loading and sports activities.

#### INCIDENCE AND SEVERITY OF COMPETITION INJURIES IN AUSTRALIAN AMATEUR TAEKWONDO ATHLETES: A TWO-YEAR PROSPECTIVE STUDY

Lystad, R.P., Graham, P.L., Bonello, R.

*Macquarie University*

Introduction: There is a seeming paucity of prospective data on injury severity and risk factors for injury in Olympic-style taekwondo, particularly among amateur taekwondo athletes (Lystad et al., 2009). The main purposes of this study were to determine the injury incidence and severity in Australian amateur taekwondo athletes, and to investigate potential risk factors for injury in competition taekwondo. Methods: Data were collected prospectively at New South Wales (Australia) State Taekwondo Championships during 2010

and 2011 seasons. Injuries were diagnosed by tournament sports medicine personnel and recorded according to the Orchard Sports Injury Classification System, version 10. Injury severity was recorded by conducting post-tournament follow-up of injured athletes to determine the actual number of days lost from full participation. Injury incidence rates were calculated per 1,000 athlete-exposures (IIR\_AE) and per 1,000 minutes of exposure (IIR\_ME). All injury incidence rates, rate ratios and relative risks were computed with 95% confidence intervals (CIs) using standard methods. Results: The combined data revealed an overall IIR\_AE of 59.93 (CI: 51.16, 69.77). The lower limb was found to be the most common injury location, the contusion to be the most common type of injury, and receiving a blow to be the most common mechanism of injury. One third of injuries were found to result in more than one week of lost or restricted participation. There was no significant difference between the genders. Children were found to have a significantly lower IIR\_AE compared to their older age groups, and black belts to have a significantly higher IIR\_AE compared to yellow belts. However, none of these differences were present after accounting for the duration of exposures (i.e. comparing IIR\_ME). The proportion of upper limb injuries resulting in fractures was significantly higher than lower limb injuries resulting in fractures (relative risk: 9.90 [CI: 2.12, 46.20]). Discussion: Although significant differences in IIR\_AE were detected within belt ranks and age groups, no significant differences could be demonstrated after accounting for the exposure-time. This highlights the importance of reporting injury incidence rates with the duration of exposures factored into the denominator. Contrary to what has previously been suggested, the current data indicated that as many as one third of injuries resulted in more than one week of restricted participation (Pieter, 2009). Relative to the lower limb a disproportionate number of upper limb injuries were found to result in fracture. References: Lystad, R. P., Pollard H., Graham P. L. (2009). Epidemiology of injuries in competition taekwondo: a meta-analysis of observational studies. *J Sci Med Sport*, 12, 614-621. Pieter, W. (2009). Taekwondo. In: Caine, D. J., Harmer, P., Schiff, M. (eds), *Epidemiology of injury in Olympic sports*, 249-259. Blackwell Publishing, Chichester.

**08:00 - 09:30**

## Oral presentations

### OP-PM46 Neuromuscular Physiology 3

#### COMPARISON OF M-WAVE AND TWITCH RECRUITMENT CURVES RESULTING FROM MUSCLE VS. NERVE STIMULATION OF THE QUADRICEPS MUSCLE

Place, N., Rodríguez, J., Maffioletti, N.A.

*University of Geneva*

COMPARISON OF M-WAVE AND TWITCH RECRUITMENT CURVES RESULTING FROM MUSCLE VS. NERVE STIMULATION OF THE QUADRICEPS MUSCLE Place N.(1), Rodríguez J.(2), Maffioletti N.A.(3). (1) ISMMS, Faculty of Medicine, University of Geneva, Switzerland (2) Departement of Electrical and Electronical Engineering, Public University of Navarra, Spain (3) Neuromuscular Research Laboratory, Schultthess Clinic, Zurich, Switzerland Introduction Surface electrical stimulation can be performed by using electrodes placed over the muscle (muscle stimulation) or over a major motor nerve (nerve stimulation). The purpose of the present study was to compare electrical (M-wave) and mechanical (twitch) properties of the quadriceps muscle evoked by single pulse delivered via muscle vs. nerve stimulation of increasing intensity. We hypothesized that motor unit (MU) recruitment will differ between the two stimulation modes. Methods Twenty two healthy subjects (16 men and 6 women, 29±2 yrs) were recruited for this study. They were seated with a knee angle of 90°. Electrodes were placed over the femoral nerve (diameter: 5 cm) and on the gluteal fold (10 x 5 cm) for nerve stimulation. For muscle stimulation, large electrodes (15 x 9 cm) were located 5–10 cm below the inguinal crease and 5–10 cm above the superior border of the patella. Peak twitch amplitude (Pt) and time to peak twitch (TPT) as well as M-wave amplitude from the vastus lateralis (VL) and vastus medialis (VM) muscles were obtained for stimulus of increasing intensity using muscle and nerve stimulation. The resulting recruitment curves and discomfort (visual analogue scale from 0 to 10) associated to maximal stimulation intensity (defined as the intensity where a plateau in M-wave and twitch responses was obtained) were analysed. Results Muscle and nerve stimulations resulted in similar Pt (57.3 ± 16.8 N vs. 60.6 ± 15.8 N, P>0.05) and similar M-wave amplitude for VL and VM muscles at maximal stimulation intensity. However, some differences between the two stimulation modes were found at submaximal stimulation intensities for both mechanical and electrical responses. TPT decreased (P<0.05) with increased stimulation intensity for both stimulation modes with no difference between stimulation modes. At maximal stimulation intensity, muscle stimulation resulted in a lower discomfort than nerve stimulation (3.2 ± 1.4 vs. 5.6 ± 1.6; P<0.001). Conclusion The shape of the recruitment curves showed some discrepancies between the two stimulation modes, suggesting that MU activation pattern differed. However, the reduction in TPT with increasing intensity suggest that Mus were orderly recruited with both stimulation modes, which is in contrast with the hypothesis of MU random activation with muscle stimulation (Bickel et al. 2011). Maximal M-wave amplitude and Pt were similar with muscle vs. nerve stimulation, suggesting that the use of muscle stimulation with large electrodes might be an alternative to nerve stimulation as it results in less discomfort. Reference Bickel CS et al. *Eur J Appl Physiol*. 111: 2399-407, 2011

#### SHORTENING OF MUSCLE REFLEX LATENCIES WITH PRIOR KNOWLEDGE OF UPCOMING PERTURBATION

Shinya, M., Kawashima, N., Nakazawa, K.

*University of Tokyo*

Introduction Although postural reflexes are involuntarily triggered, higher cognitive functions such as prior knowledge of an upcoming perturbation contributes to the reflexes. For example, anticipating a perturbation during walking shortens muscle reflex latencies compared to latencies in which the subjects were completely naive to the possibility of the perturbation (Shinya and Oda, 2010). Prior knowledge includes two distinct elements: spatial (i.e. direction of perturbation) and temporal (i.e. timing of perturbation). The purpose of this study was to investigate how each of these two elements of prior knowledge for the perturbation contributes to shortening of muscle reflex latencies during walking. Methods Eleven healthy male participants walked on a split-belt treadmill and were perturbed by accelerating or decelerating the right belt at right foot contact. The perturbations were imposed with and without spatial and temporal prior knowledge. Spatial prior knowledge was informed to participants by instructing the direction of the belt perturbation (e.g. only acceleration perturbations would occur in this session). Temporal prior knowledge was given by auditory cue at right foot contact during preceding 3 strides before the perturbation. Muscle reflex latencies were calculated from electromyographic signals measured by surface electrodes placed on the right sides of the gastrocnemius, soleus and tibialis anterior muscles. Results In response to the acceleration

perturbations, reflexive muscle activities were observed in the gastrocnemius and soleus muscles. Gastrocnemius latency was shorter when the participants knew the timing of the perturbations (with prior knowledge:  $58 \pm 8$  ms, without prior knowledge:  $72 \pm 10$  ms). Soleus latency was not different between temporal prior knowledge conditions (with prior knowledge:  $45 \pm 12$  ms, without prior knowledge:  $44 \pm 8$  ms). There was no difference in latencies in any muscle tested between spatial prior knowledge conditions. Discussion The results demonstrated that temporal but not spatial prior knowledge of the upcoming perturbation played a critical role in muscle reflex latencies. The latency observed in the gastrocnemius muscle was consistent with reflex latencies that are mediated by multiple synapses in the spinal cord, subcortical and/or cortical brain area. Neural activity levels in these area might be enhanced when one anticipated the timing of the perturbation. The absence of the effect on soleus may be due to the reflex being mediated by a monosynaptic pathway. References Shinya M and Oda S. (2010). *Exp Brain Res*, 203(2), 437-446

### ACUTE POSTURAL MODULATION OF THE SOLEUS H-REFLEX AFTER ACHILLES TENDON VIBRATION

Lapole, T., Canon, F., Pérot, C.

*Université de Technologie de Compiègne*

Introduction After prolonged vibration exposure, it has been reported H-reflex depression (Ushiyama et al., 2005). Among the parameters susceptible to affect H-reflex responses, it was hypothesized that presynaptic inhibitory mechanisms largely contributed to explain the after-effects of vibration on the H-reflex. Indeed, it has been well reported that during vibratory exposure, the H-reflex is suppressed due to presynaptic inhibitory mechanisms (Gillies et al., 1969). To confirm presynaptic inhibition as main contributor to H-reflex changes after one bout of prolonged vibration, we analyzed the acute changes in postural modulation (standing vs. sitting) of soleus (SOL) H-reflex after a vibratory prolonged exposure. Indeed, postural modulation of the SOL H-reflex has been reported to inform on the level of presynaptic inhibition exerted on Ia afferents (Koceja et al., 1995). Methods Maximal SOL H-reflex (Hmax) and M waves (Mmax) were measured in both sitting and standing positions before and after 1h of Achilles vibration (frequency:50Hz) applied in sitting position (Vibration group, n=11) or before and after 1h of sitting position only (Control group, n=6). Hmax and Mmax were expressed by their amplitudes and Hmax was expressed in % of Mmax. Furthermore, in order to quantify presynaptic inhibition induced by prolonged vibration, an index of SOL H-reflex postural modulation was calculated as the standing Hmax/Mmax ratio relative to the sitting one. Results After 1h of vibration, a significant decrease in the SOL Hmax/Mmax ratio was observed both in sitting and standing positions. However, the decrease was more pronounced in the standing position, leading to a significant decrease of the index of SOL H-reflex postural modulation, while this index remained unchanged for the Control group. Discussion Since the level of presynaptic inhibition of Ia afferents is known to be greater in the standing position than in the sitting one (Katz et al., 1988), we hypothesized that the vibration-induced H-reflex depression would be posture-dependant. In both postures, the H-reflex was depressed after prolonged Achilles tendon vibration. However, the greater depression in the standing position confirms that the vibration-induced H-reflex depression may be largely mediated by presynaptic inhibition mechanisms, originated from Ia afferents, over-activated during the vibratory exposure. References Ushiyama JK, Masani K, Kouzaki M, Kanehisa H, Fukunaga T. (2005), *J Appl Physiol*, 98(4), 1427-1433 Gillies JD, Lance JW, Neilson PD, Tassinari CA. (1969), *J Physiol*, 205(2), 329-339 Koceja DM, Markus CA, Trimble MH. (1995), *Electroencephalogr Clin Neurophysiol*, 97(6), 387-393 Katz R, Meunier S, Pierrot-Deseilligny E. (1988), *Brain*, 111(Pt2), 417-437

### RECURRENT INHIBITION OF SYNERGISTIC MUSCLES DURING MAXIMAL VOLUNTARY ANISOMETRIC CONTRACTION

Duclay, J., Amarantini, D., Martin, A.

*University Paul Sabatier*

RECURRENT INHIBITION OF SYNERGISTIC MUSCLES DURING MAXIMAL VOLUNTARY ANISOMETRIC CONTRACTION Duclay, J.1, Amarantini, D.1, Martin, A.2 1: PRISSMH (Toulouse, France), 2: INSERM U-1093 (Dijon, France) Introduction In a previous study (Duclay et al., 2011), we reported that changes in corticospinal excitability observed for lengthening compared with shortening maximal voluntary contractions (MVC) depends mainly on pre- and postsynaptic inhibitory mechanisms acting at spinal level. However, this specific modulation of the spinal excitability differs between synergistic muscles, i.e. the Soleus (SOL) and the Medial Gastrocnemius (MG). We previously suggested that the reduction of the SOL spinal excitability during lengthening MVC can, at least partly, be linked to an increase in recurrent inhibition. The present study was designed to compare changes in recurrent inhibition during anisometric MVC between synergistic muscles with different sensitivity to spinal inhibitory mechanisms. Methods Experiments were performed on 8 healthy men. Maximal H reflexes (Hmax) and M-waves (Mmax) were evoked in SOL and MG at an ankle angle of 90° during shortening and lengthening MVC (20°/s). During MVC, maximal H reflex with no direct M-wave response was also recorded as reference H-reflex (H1). The paired H reflex technique proposed by Hultborn and Pierrot Deseilligny (1979) was used to record test H reflex (H') to assess recurrent inhibition. The Hmax/Mmax and H'/H1 ratios were computed to investigate the modulations of spinal excitability and recurrent inhibition, respectively. Results Preliminary results indicate that the SOL amplitudes of H' and H1 were by 34.5% and 18.4% lower ( $P < 0.05$ ) during lengthening than during shortening MVC, respectively. Both SOL Hmax/Mmax and H'/H1 ratios were smaller ( $P < 0.05$ ) during lengthening MVC ( $0.49 \pm 0.08$  and  $0.58 \pm 0.09$ , respectively) compared with shortening MVC ( $0.61 \pm 0.05$  and  $0.74 \pm 0.08$ , respectively). In contrast to SOL, no muscle contraction type effect was observed for both MG Hmax/Mmax and H'/H1 ratios ( $P > 0.05$ ). Discussion The main finding was that both Hmax/Mmax and H'/H1 ratios were reduced during lengthening MVC for the SOL but not for the MG, suggesting that neural adjustments at spinal level differ for two synergistic muscles of the triceps surae during lengthening MVC. Furthermore, the larger decrease in H' than in H1 for the SOL during lengthening compared with shortening MVC indicates a change in post synaptic inhibition (Hultborn and Pierrot-Deseilligny, 1979). These results further indicate that the relative contribution of recurrent inhibition to the modulation of the spinal excitability may depend on the muscle being investigated. References Duclay J, Pasquet B, Martin A, Duchateau J. (2011). *J Physiol* 589:2901-16 Hultborn H, Pierrot-Deseilligny E (1979). *J Physiol* 297:229-251

### CO-CONTRACTION OF LOWER LIMB MUSCLES DURING WALKING IN FOUR YEARS OLD CHILDREN

Plevnik, M., Gerzevic, M., Bogerd, C.P., Marusic, U., Pisot, R.

*University of Primorska*

Introduction Co-contraction, or simultaneous activation of agonist and antagonist muscles during the execution of a task, occurs to a limited extent in many activities requiring motor co-ordination and joint stability, including walking and running (Frost et al., 1997). During maturation and skill development, inhibition of antagonist muscle groups is thought to be progressively learned until an efficient movement pattern is obtained (Ford et al., 2008). The goal of this study was to analyse the co-contraction of eight major lower limb muscles

during walking in healthy four-year-old children. Methods 48 four-years-old children walked 4 times for 13 m at their self-selected comfortable walking speed. EMG was continuously obtained from: m. tibialis anterior, m. soleus, m. rectus femoris, and m. biceps femoris, for both the left and right leg. After typical EMG post processing, co-contraction indexes (CCI) were calculated according to Rudolph et al., 2001 and Lewek et al., 2004, for two muscle pairs for both legs: TA-SO and RF-BF. Paired-samples t-test and Spearman's correlation were used for analysis. Results CCI (Mean  $\pm$  SE) for the left and right TA-SO pairs were  $14.9 \pm 2.7$  and  $19.9 \pm 1.6$ , respectively during the contact phase ( $p=0.082$ ) and  $28.8 \pm 2.3$  and  $13.7 \pm 0.7$ , respectively during the swing phase ( $p<0.001$ ). For the left and right RF-BF pairs, CCI during the contact phase ( $p<0.001$ ) were  $11.2 \pm 0.9$  and  $6.5 \pm 0.4$ , respectively and  $8.5 \pm 0.8$  and  $4.4 \pm 0.3$ , respectively during the swing phase ( $p<0.001$ ). Spearman's correlation indicated significant interactions during the contact phase for the left and right TA-SO pairs ( $r=0.39$ ;  $p=0.006$ ) as well as for the left and right RF-BF pairs ( $r=0.36$ ;  $p=0.011$ ). Discussion Very few studies addressed the topic of co-contraction during child's fundamental motor patterns' development (Ford et al., 2008). In this paper, preliminary results were presented and further analysis will be done to verify and better understand the meaning of co-contraction in child's gait pattern development. The purpose is to further investigate how muscle co-ordination is changing with age and what is the role of different factors on co-contraction and other muscle activation patterns. Such factors will include, physical activity, lifestyle, anthropometrics, among others. Ultimately, these results will lead to a better understanding of the role of lifestyle on motor development. Acknowledgement This study is part of the research project "Analysis of fundamental motor patterns – skeletal and muscular adaptation to specific sedentary lifestyle factors in children aged 4-7 years". References Frost G, Dowling J, Dyson K, Bar-Or O (1997). *J Electromyogr Kinesiol*, 7, 179-186. Ford KR, van den Bogert J, Myer GD, Shapiro R, Hewett TE (2008). *Br J Sports Med*, 42, 561-566. Lewek MD, Rudolph KS, Snyder-Mackler L (2004). *Osteoarthritis Cartil*, 12(9), 745-751. Rudolph KS, Axe MJ, Buchanan TS, Scholz JP, Snyder-Mackler L (2001) *Knee Surg, Sports Traumatol, Arthrosc*, 9, 62-71.

### **INFLUENCE OF MUSCLE LENGTH AND LOAD CONDITIONS ON THE OCCURENCE OF PRE-MOTOR SILENT PERIOD DURING BALLISTIC ACTIONS**

Richartz, C., Duchateau, J.  
*Université Libre de Bruxelles*

Influence of muscle length and load conditions on the occurrence of pre-motor silent period during ballistic actions Richartz,C.,Duchateau, J. Laboratory of Applied Biology, Université Libre de Bruxelles, Belgium Introduction Ballistic muscle contractions performed from different initial conditions are very common in sports. If a submaximal static contraction precedes the ballistic action (STABAL) an electromyographic silent period (SP) may be observed during the transition of the two actions (Mortimer et al., 1987; Van Cutsem and Duchateau, 2005). The occurrence of SP is inconsistent from subject to subject (Mortimer et al. 1987; Aoki et al., 1989) ranging between 5% and 60% of the contractions. The aim of this study was to analyse the effect of ankle position and load condition on the occurrence of SP. Methods Nine healthy subjects performed STABAL dorsiflexions from 3 different ankle angles: neutral (0°), plantarflexion (+10°) and dorsiflexion (-10°). For each angle, 3 different loads were applied: 10%, 20% and 30% of maximal voluntary contraction (MVC) torque. Electromyographic activity (EMG) was recorded in the tibialis anterior (agonist muscle) and soleus, gastrocnemius medialis, gastrocnemius lateralis (antagonist muscles) by means of surface electrodes placed over the muscle belly. Ankle range of movement (°) was recorded by an electronic goniometer and angular velocity (°/s) was obtained by computing the first derivation of angular movement. Results The results indicate that SP occurrence was significantly greater when movements departed from a lengthened muscle condition (12,92% at +10° vs 8,37% at -10°;  $p<0.05$ ). SP occurrence depended also of the preload level (13,72% at 10% MVC and 8,17% at 30% MVC;  $p<0.01$ ). Furthermore the trials that presented a SP showed a greater angular velocity than those without SP ( $p<0.05$ ). The normalised average EMG activity (aEMG) during the first 50 ms following the onset of EMG activity was significantly higher in the trials presenting SP compared to those without SP ( $p<0.05$ ). Discussion It has been suggested that SP could be responsible for a non-refractory state of the motoneurons prior to the ballistic action, which supposedly allows a better synchronization of the motor units discharges at the onset of the contraction leading to a greater movement velocity (Van Cutsem and Duchateau, 2005; Richartz et al., 2010). The increased aEMG observed in the early stages of the ballistic action for movements with SP compared to movements without SP confirm this hypothesis. The new finding of this study is that the occurrence of SP depends on the initial conditions under which the movement is performed. References Aoki H, Tsukahara R, Yabe K (1989). *Eur J Appl Physiol*, 58, 26-32. Mortimer JA, Eisenberg P, Palmer SS (1987). *Exp Neurol*, 98, 542-554. Richartz C, Lévênez M, Boucart J, Duchateau J (2010). *Eur J Appl Physiol*, 110(4), 805-814. Van Cutsem M, Duchateau J (2005). *J Physiol*, 562(2), 635-644.

**08:00 - 09:30**

## **Oral presentations**

### **OP-PM47 Neuroscience**

#### **BRAIN CORTICAL CHARACTERISTICS OF SKILLED SENSORIMOTOR PERFORMANCE**

Mierau, A.1, Hannemann, M.1, Hülzdünker, T.1, Karamanidis, K.2, Sueptitz, F.2, Mierau, J.1, Strüder, H.K.1  
*German Sport University*

Athletes can achieve striking sensorimotor skills after years of extensive training. So far, only little is known about the neural mechanisms underlying such skilled performance. Recent electroencephalographic (EEG) studies compared athletes with non-athletes and/or high with low performance within a sample of subjects. These studies showed that activity in the alpha (7-12 Hz) and beta (13-30 Hz) frequency band (e.g. Del Percio et al. 2009) as well as frontal midline theta (4-7 Hz) band activity (e.g. Doppelmayr et al. 2008) are related to attention based sensorimotor performance. However, the available literature provides strong evidence that motor behavior is characterized not only by changes in alpha and beta but particularly in gamma band activity. Moreover, it has been shown that during motor behavior the topographical patterns of gamma and beta activity were more discrete, somatotopically more specific and more consistent with the traditional maps of sensorimotor functional anatomy (Crone et al. 1998) Therefore, the present study should extend previous research by further considering the power in the gamma-1 (30-35 Hz) and gamma-2 (35-40 Hz) bands over the primary motor cortex contralateral to the aiming arm/hand during air pistol shooting in experts and novices for high and low scores, respectively.

As compared to novices, experts showed significantly higher shooting scores and significantly less anterior-posterior fluctuations of the center of pressure immediately prior to the shot. Both, gamma-1 and gamma-2 power were significantly lower in experts compared to novices 3 sec prior to the shot. Furthermore, gamma-2 power was significantly lower in high compared to low scores 1 sec prior to the shot. Our findings suggest that gamma oscillations over the primary motor cortex are related to sensorimotor performance. Higher gamma power values in novices as well as in low score shots may reflect increased compensatory motion of the aiming arm/hand as a result of reduced dynamic stability. References: Crone, N. E., et al. 'Functional Mapping of Human Sensorimotor Cortex With Electroencephalographic Spectral Analysis. II. Event-Related Synchronization in the Gamma Band.' *Brain* 121 ( Pt 12) (1998): 2301-15. Del Percio, C., et al. 'Visuo-Attentional and Sensorimotor Alpha Rhythms Are Related to Visuo-Motor Performance in Athletes.' *Hum Brain Mapp* 30.11 (2009): 3527-40. Doppelmayr, M., et al. 'Frontal midline theta in the pre-shot phase of rifle shooting: differences between experts and novices.' *Neuropsychologia* 46.5 (2008): 1463-7.

### APPROACHING EFFECTIVE CONNECTIVITY MEASURES IN EXERCISE NEUROSCIENCE

Schubert, M., Hansmeier, T., Koutsandr ou, F., Reinecke, K., Wei , M., Baumeister, J.

*University of Paderborn*

Perception, evaluation and optimal reaction within sub seconds are of great interest in many kinds of sport and daily living activities. It requires sensory integration and evaluation in specific brain areas, which interact effectively. This information flow can be measured from the EEG using the concept of granger causality (GC) [3]. This approach will add information about brain network dynamics in sports and exercise. Aim of this study was to demonstrate the feasibility of effective connectivity estimation (ECE) in a standardized test paradigm. Six male subjects performed an oddball-task with 10% target and 10% distractor stimuli. During the task EEG was recorded from 60 scalp positions. Preprocessing included down sampling, zero-phase shift filtering, epoch extraction and baseline correction. Artifacts were either rejected or corrected with independent component analyses (IC analysis). Functional ICs were selected to calculate multivariate autoregressive models. After model validation, connectivity estimation using renormalized partial directed coherence (rPDC) [5] was calculated between components for every subject and stimulus type according to the processing pipeline of the SIFT toolbox for EEGLAB [2] [4]. A significant bidirectional information flow ( $p \leq 0.025$ ) between parietal and frontal located ICs appears between 100 ms and 500 ms after the stimulus for both types (target and distractor) in five subjects. Difference maps show higher amount of information flow after the distractor stimulus. EEG using the concept of GC is able to analyze ECE within the fronto-parietal network, which is recruited by tasks that involve attentional control processes during target detection [6]. Our results are consistent with findings in [1], where bidirectional information flow in the fronto-parietal network was found from fMRI signals in a similar setup. Especially the flexibility of EEG systems and its high temporal resolution allow an insight to network dynamics in more complex tasks and could gain the understanding of sensorimotor control mechanisms in sports and exercise. [1] Br zdl, M., Mikl, M., Marecek, R., Krupa, P. & Rektor, I. (2007). *Neuroimage*, 35 (2), 827-835. [2] Delorme, A., Mullen, T., Kothe, C., Akalin Acar, Z., Bigdely-Shamlo, N., Vankov, A. et al. (2011). *Computational Intelligence and Neuroscience*, 1-12. [3] Jirsa, V. K. & McIntosh, A. R. (2007). New York: Springer. [4] Mullen, T., Delorme A., Kothe C. & Makeig S. (2010). Society for Neuroscience Conference, San Diego, CA, USA. [5] Schelter, B., Timmer, J. & Eichler, M. (2009). *J. Neurosci. Methods*, 179 (1), 121-130. [6] Wang, L., Liu, X., Guise, K. G., Knight, R. T., Ghajar, J. & Fan, J. (2010). *Journal of Cognitive Neuroscience*, 22 (3), 543-553.

### ANTERIOR CINGULATE CORTEX ACTIVATES 24 HOURS AFTER EXERCISE.

Fujimoto, T., Chiba, N., Tashiro, M., Nagamatsu, T., Sensui, H., Masud, M.M., Ishii, K., Gondoh, Y., Nagatomi, R.

*Tohoku University*

After a few days of consecutive exercise, people often feel positive psychological changes not only immediately but also the next day after exercise, despite their fatigue not recovering completely. Our purpose was to study a part of the mechanism of this positive psychological change. We observed the change in regional brain activities 24 hours after four days of consecutive exercise using positron emission tomography (PET) and 18Fluorine-fluoro-deoxy-glucose (18F-FDG). Subjects were nine healthy male volunteers (age,  $21.2 \pm 1.9$  years, means  $\pm$  SD). PET scans were performed two times, before the exercise period and 24 hours after the exercise. During the exercise period, subjects pedaled a bicycle ergometer for 90 minutes two times a day (180 minutes total) at workloads of 55%  $VO_{2max}$ . Subjects' results were recorded on the Mood checklist-short form 2 (MCL-S.2), visual analogue scales (VAS) as a subjective index and critical flicker fusion frequency (CFF). Normalized FDG uptake of the left anterior cingulate cortex (ACC) was significantly higher 24 hours after exercise than before the exercise period (uncorrected,  $p < 0.001$ ). The fatigue VAS was significantly elevated on the 3rd and the 4th exercise days compared with the value before the exercise period ( $p < 0.01$  and  $p < 0.05$ ). Fatigue VAS, 24 hours after exercise recovered to the level before the exercise period. Pleasure score declined significantly from 2nd to 4th exercise day as compared with that of before the exercise period ( $p < 0.05$ ), and it recovered 24 hours after exercise. CFF of the 4th exercise day was significantly lower than before the exercise period ( $p < 0.05$ ), and CFF 24 hours after exercise had declined more. These results demonstrated that subjects would be tired at least neurophysiologically (CFF decrease), but they would not feel much fatigue or stress psychologically 24 hours after exercise. This discrepancy on recovery between the recovery of CFF, the pleasure score, and fatigue VAS level might be related to the ACC function.

### PHYSICAL EXERCISE AND POSTNATAL BRAIN DEVELOPMENT

Arida, R., Gomes da Silva, S., Unsain, N., Masc , D.H., de Almeida, A.A., Amorim, H.A., Ara jo, B.H.S., Sim es, P.S.R., Naffah-Mazzacoratti, M.G., Mortara, R.A., Scorza, F.A., Cavalheiro, E.A.

*Universidade Federal de Sao Paulo*

PHYSICAL EXERCISE AND POSTNATAL BRAIN DEVELOPMENT Arida RM1, Gomes da Silva S1, Unsain N2, Masc  DH2, de Almeida AA1, Amorim HA3, Ara jo BHS3, Sim es PSR3, Naffah-Mazzacoratti MG3, Mortara RA4, Scorza FA3, Cavalheiro EA 3. 1: Universidade Federal de S o Paulo (S o Paulo, Brazil), 2: Universidad Nacional de C rdoba (C rdoba, Argentina), 3: Universidade Federal de S o Paulo (S o Paulo, Brazil), 4: Universidade Federal de S o Paulo (S o Paulo, Brazil) Introduction There is a great deal of evidence showing the capacity of physical exercise to enhance cognitive functions, to reduce anxiety and depression, and to protect the brain against neurodegenerative disorders. Although the effects of exercise are well documented in the mature brain (Cotman et al., 2007), the influence of exercise in the developing brain has been poorly explored. Therefore we investigated the morphological and functional hippocampal changes in adult rats submitted to daily treadmill exercise during the adolescent period. Methods Male Wistar rats aged 21 postnatal day-old (P21) were divided into two groups: exercise group (n=27) and control group (n=27). Animals of the exercise group were submitted to daily exercise in the treadmill between P21 and P60. Running time and speed gradually increased during the subsequent days, until reach 18

m/min during 60 min. After the aerobic exercise program (P60), histological and behavioral (Morris water maze) analyses were performed. Results Physical exercise program during the postnatal development increased the mossy fibers density and hippocampal expression of parvalbumin, brain-derived neurotrophic factor and its receptor tropomyosin-related kinase B, reduced cannabinoid receptor type 1 expression, improved spatial learning and memory, and enhanced the capacity to evoke spatial memories in later stages (when measured at P96). It is important to point out that while physical exercise induces hippocampal plasticity, degenerative effects could appear in undue conditions of physical or psychological stress. In this regard, we also showed that the exercise protocol used here did not induce inflammatory response and degenerating neurons in the hippocampal formation of developing rats. A significant increase in the hippocampal levels of pro- and anti-inflammatory cytokines was observed only when they were submitted to higher intensity of exercise between P40 and P50. Discussion Our findings demonstrate that a moderate exercise program during postnatal development may result in positive structural and functional changes for the hippocampal formation, a highly plastic region of the brain important for memory, learning and emotional processes. References Cotman CW, Berchtold NC, Christie LA (2007). *Trends Neurosci*, 30(9), 464-472.

### CEREBRAL/MUSCLE HEMODYNAMIC AND NEUROMUSCULAR RESPONSES DURING INTERMITTENT BICEPS BRACHII CONTRACTIONS AT DIFFERENT INTENSITIES

Bhambhani, Y.1, Fan, J.L.2, Place, N.2, Rodriguez, J.3, Kayser, B.2

1. University of Alberta; 2. Université de Genève; 3. Public Univ. Navarra

Introduction Numerous activities are performed with the upper extremities which elicit static muscle contractions of varying intensities. This study examined the cerebral and muscle hemodynamics and neuromuscular responses during intermittent static contractions of biceps brachii at 25%, 50% and 75% of the maximal voluntary contraction (MVC). We hypothesized that there would be: 1. significant differences between the three intensities for the hemodynamic and neuromuscular responses, and 2. concordance between hemodynamic and neuromuscular responses at the three intensities. Methods Eleven volunteers performed three MVCs against a biceps dynamometer (elbow angle 90°), followed by M-wave axillary nerve stimulation. They completed 2 min of intermittent isometric contractions (12/min) at 25%, 50% and 75% MVC, interspersed with 3 min rest. M-waves were evoked after the 1st, 12th and 23rd contractions and voluntary EMG was recorded during submaximal contractions. Near infrared spectroscopy (NIRS) was used to record oxyhemoglobin (HbO<sub>2</sub>) and deoxyhemoglobin (HHb) from left prefrontal cortex and right biceps brachii. Doppler ultrasound was used to measure middle cerebral artery velocity (MCAv). Force and EMGrms/M-wave amplitude ratio (RMS/Mmax) were expressed relative to the respective MVC of initial value and averaged over 24 contractions. Results Cerebral HbO<sub>2</sub> and total Hb (index of blood flow) increased while HHb decreased during contractions with significant differences being observed between 75% vs 50% and 25% contractions ( $p < .05$ ). MCAv increased from rest but was not different between three intensities ( $p > .05$ ). Muscle HbO<sub>2</sub> decreased while HHb increased during contractions with differences being observed between intensities ( $p < .05$ ). Muscle total Hb increased from rest at 25% MVC ( $p < .05$ ), but was not higher at 50% and 75% ( $p > .05$ ). RMS/Mmax increased with intensity and was significantly different between intensities ( $p < .05$ ). Discussion Increases in cerebral HbO<sub>2</sub> with concomitant declines in HHb are associated with enhanced neuronal activation (Rasmussen et al., 2007) while increases in muscle HHb with concomitant declines in HbO<sub>2</sub> imply enhanced oxygen utilization (Felici et al., 2009). Increases in RMS/Mmax imply enhanced neuronal activation (Millet et al., 2011). The current hemodynamic and neuromuscular findings indicate that the increases in force output at all three intensities were attained by enhanced neuronal and peripheral muscular activation. Since there was no difference in MCAv between intensities, we speculate that increases in neuronal activation and force output were not accompanied by increases in cerebral blood flow. The increase in RMS/Mmax at the three intensities suggested enhanced central drive (Millet et al., 2011) and was supported by the increase in cerebral HbO<sub>2</sub> measured by NIRS. References Felici et al, (2009). *J Electromyogr Kinesiol* 92:e1-11 Millet et al, (2011). *Eur J Appl Physiol* 111 :2489-500 Rasmussen et al, (2007). *J Cereb Blood Flow Met.* 27:1082-93

### NEURAL MECHANISMS IMPLICATION IN ELECTRICALLY INDUCED FATIGUE

Papaiordanidou, M., Billot, M., Varray, A., Martin, A.

Aix-Marseille University, Faculty of Sports Science

Electrical Stimulation (ES) induces important fatigue development, which has been shown to comprise both neural and muscular mechanisms (Boerio et al, 2005). Studies seeking to find the ES protocol that would minimise fatigue development classically use constant frequency (CFTs) and variable frequency (VFTs) trains (Binder-Macleod and Russ, 1999). Taking under consideration the fact that, when ES is applied in the periphery, neural structures are solicited (Collins et al, 2001) and that electrically induced fatigue may differ according to the stimulation parameters used (Darques et al, 2003), we aimed at comparing the nature of the developed fatigue by these two stimulation paradigms. Ten healthy males received the two protocols, which were randomly assigned to the left or right lower limbs. ES was applied over the triceps surae and protocols consisted of 450 trains (167ms on/500ms off, 30Hz) at an intensity evoking 30% of Maximal Voluntary Contraction (MVC). A doublet (100Hz) was used in the beginning of each train for the VFTs protocol. Torque and electromyographic activity of the soleus muscle were continuously recorded. Neuromuscular tests were performed before and immediately after each ES protocol. Changes in muscle characteristics (excitability and contractile properties) were evaluated by analysis of the muscle compound action potential (Mwave) and associated twitch torque (Pt), while the H reflex and Motor Evoked Potential (MEP) were studied in order to assess spinal and cortical excitability. All parameters were obtained during rest and MVC. MVC significantly decreased to the same extent after the two protocols ( $P < 0.05$ ), giving evidence of similar neuromuscular fatigue development. Mwave amplitude (at rest and superimposed to MVC) and Pt significantly decreased after both ES protocols ( $P < 0.01$ ), demonstrating alterations of the excitation-contraction coupling. Spinal excitability was decreased only during rest ( $P < 0.05$ ) while the ratio MEP/M remained unchanged after both protocols. The results indicate that the two stimulation paradigms gave rise to equivalent neuromuscular fatigue development both quantitatively and in terms of implicated mechanisms. This fatigue was the result of alterations taking place at the muscular level while spinal excitability was decreased at rest. The fact that, during MVC, cortical and spinal excitability remained unchanged shows a modified corticospinal command to cope with the increased presynaptic inhibitions observed at rest. Binder-Macleod and Russ. *J Appl Physiol* 1999; 86: 1337-46 Boerio et al. *Med Sci Sports Exerc* 2005; 37 (6): 973-8 Collins et al. *J Neuroscience* 2001; 21 (11): 4059-65 Darques et al. *J Appl Physiol* 2003; 95: 1476-84

08:00 - 09:30

## Invited symposia

## IS-SH09 The Integrative Role of Sport in Multicultural Societies: From Research to Practice

**ETHNIC AND CULTURAL IDENTITY: A WORKING FRAMEWORK FOR THE INTEGRATIVE ROLE OF SPORT.**

Hatzigeorgiadis, A.1, Kouli, O.2, Elbe, A.3, Ries, F.4, Pappous, A.5, Sanchez, X.6

*1: University of Thessaly; 2: Democritus University of Thrace; 3: University of Copenhagen; 4: University of Seville; 5: University of Kent; 6: University of Groningen*

**Introduction** The multicultural character of contemporary societies is progressively growing and the issue of integration is therefore particularly important. Sport has been recognized as an important socializing agent; nevertheless, sport is also likely to reinforce existing differences. Thus, organized attempts are required towards the goal of social integration, through the development of appropriate sport environments. The purpose of this project is to explore the role of sport in promoting integration among youngsters with different ethnic-cultural background in five European countries. The ethnic and cultural identity approach for the social integration in multicultural groups (Ting-Toomey et al., 2000) was adopted in this project. The purpose of this presentation is to provide evidence for the conceptualization of the adopted framework. **Methods & Results** The Ethnic-Cultural Identity Salience questionnaire, as adapted by Kouli and Papaioannou (2010) for young students, was used. The instrument, which assesses two dimensions of Ethnic Identity (Ethnic Belonging and Feelings of Fringe) and two dimensions of Cultural Identity (Assimilation and Lack of Interaction), was translated into the different languages. The psychometric properties of the instrument were tested through confirmatory factor analysis (CFA) over two multicultural samples. In the first occasion, participants were 1350 young individuals from five countries; Denmark, Germany, Greece, Spain, and UK. The CFA for each subsample provided preliminary support for the validity of the instrument, and gave indications regarding alteration that could improve the fit of the model across the 5 subsamples. Accordingly, the questionnaire was edited in each language and re-administered. In the second occasion, participants were 1260 young athletes. The CFA provided support for models tested for the total sample and the five subsamples; additionally, multi-sample analysis supported the invariance of the model across the samples. **Conclusions** Overall, the ethnic-cultural identity salience approach seems to provide a useful framework for the study of multicultural integration through sport. The development and the psychometric support for the ethnic-cultural identity questionnaire could facilitate research towards this direction. **References** Kouli, O., & Papaioannou, A. (2009). *Psychology of Sport & Exercise*, 10, 45-51. Ting-Toomey, S., Yee-Jung, K.K., Shapiro, R.B., Garcia, W., Wright, T.J., & Oetzel, J.G. (2000). *International Journal of Intercultural Relations*, 24, 47-81.

**THE INTEGRATIVE ROLE OF SPORT IN MULTICULTURAL GROUPS: PERSONAL, MOTIVATIONAL AND TEAM FACTORS.**

Elbe, A.1, Sanchez, X.2, Ries, F.3, Kouli, O.4, Pappous, A.5, Hatzigeorgiadis, A.6

*1: University of Copenhagen; 2: University of Groningen; 3: University of Seville; 4: Democritus University of Thrace; 5: University of Kent; 6: University of Thessaly*

**Introduction** The sport environment is considered a suitable setting for the development of social and moral values in young athletes. Nevertheless, sport participation per se does not guarantee the desired outcomes. The presentation focuses on the examination of sport factors related to the ethnic and cultural identity of young athletes with non-dominant ethnic-cultural background. **Methods** Participants were 175 young athletes (147 males and 28 females) from Greece ( $n = 80$ ) and Spain ( $n = 95$ ) with a mean age of 15.91 ( $\pm 1.27$ ). Among them 41 were individual sport athletes and 134 were team sport athletes. In addition to ethnic and cultural identity, personal-demographic, motivational and team factors were considered. Participants completed measures of motivational climate, autonomy supportive and controlling coaching behavior, and team cohesion. **Results** Analyses of variance showed that female athletes and team sport athletes showed a more integrative profile, compared to male and individual sport athletes, characterized by higher scores on assimilation and lower scores on lack of interaction. In addition, considerable differences in the dimensions of ethnic and cultural identity were identified between the subsamples from Greece and Spain. Subsequently, separate regression analyses were conducted for the two subsamples to identify the degree to which motivational and team factors could predict ethnic and cultural identity. The analysis for the sample from Greece showed that the predictor variables could make a significant prediction for lack of interaction, predicting 34% of the total variance ( $p < .01$ ), and a prediction that approached significance for feelings of fringe, predicting 14% of the total variance ( $p = .07$ ). The analysis for the sample from Spain showed that the predictor variables could not significantly predict any of the ethnic-cultural identity dimensions. **Conclusions** For the sample from Greece, the results supported that appropriate sport environments can promote integrative patterns of cultural identity. The lack of significant findings for the sample from Spain can be attributed to the heterogeneity of this sample, as some of the athletes shared the same native language with the dominant sample, whereas other did not. Overall, the study provides valuable evidence regarding the role of sport participation and the sporting environment towards the goal of integration in multicultural societies.

**IMPROVING INTERGROUP RELATIONS IN YOUNG ATHLETES FROM DIFFERENT ETHNIC AND CULTURAL BACK-GROUNDS: TOWARDS THE DEVELOPMENT OF AN INTERVENTION PROGRAM.**

Pappous, A., Ries, F., Stathi, S., Kouli, O., Elbe, A.M., Sanchez, X., Hatzigeorgiadis, A.

*University of Kent., University of Seville., University of Greenwich., Democritus University of Thrace., University of Copenhagen., University of Groningen., University of Thessaly*

This presentation will focus on a research project aiming to test the effectiveness of established social psychology interventions in improving attitudes in young athletes from different ethnic and cultural backgrounds. The prospective intervention programme will be based on the theoretical framework of the Intergroup Contact Theory which is an approach that has focused on reducing intergroup bias, and has become one of the most influential theories in the field of intergroup relations. In this study it is planned to take part 60 participants, randomly allocated to one of the three conditions: positive contact, direct contact and control condition (20 participants per condition). The students will take part in the interventions 3 times per week for 3 weeks. In all conditions participants will be given a short questionnaire asking various questions about their views on young people from different ethnic and cultural backgrounds. In the Imagined



Contact condition participants will be asked to imagine positive interactions with people for different ethnic background. In the Direct contact group participants from different ethnic backgrounds they will engage in a physical activity following instructions from Pettigrew & Tropp (2000) who identified five factors which are considered to be essential for optimal bias-reducing contact: equal status between majority and minority groups; a shared goal between members of both groups; a cooperative, rather than competitive, framework for accomplishing the common goal; institutional support for the interactions between members of each group; and minority members who moderately disconfirm the prejudicial stereotypes about their group. The participants that will form part of the control group will perform an unrelated imaginary scenario. One week after the final intervention session, a questionnaire containing the dependent measures will be administered. These will be measures of prejudicial attitudes, stereotyping, and empathy and indented behaviour.

## 08:00 - 09:30

### Invited symposia

#### IS-BN07 Core Stability and Injury in Sports (\*)

##### TRUNK MOTOR CONTROL AND ITS INFLUENCE ON LOWER EXTREMITY MECHANICS

Chaudhari, A., Jamison, S., Best, T.

*The Ohio State University*

Previous research has demonstrated that activity-based interventions can be effective for knee injury prevention and rehabilitation, but has not elucidated the key mechanisms that reduce knee loading in vivo during sports-related dynamic motion. Anecdotal data throughout the scientific literature and popular press advocate for improved trunk motor control or "core stability" for injury treatment and, more importantly, prevention of injury involving the lower extremity as well as low back and upper extremity. Despite this widespread assertion that "you need to work on your core," a critical barrier to progress in the prevention of musculoskeletal injuries is the lack of understanding of the mechanism by which trunk motor control could modulate known biomechanical predictors of injury risk. This talk will discuss the current evidence that exists to define the role of trunk motor control in lower extremity mechanics, as well as future research directions to improve our understanding of lower extremity injury mechanisms and accelerate development of more efficient and effective injury prevention programs.

##### WHAT ARE CURRENT TRAINING PROGRAMS LACKING? TOWARDS HEALTHY TRAINING...

Verhagen, E.

*EMGO-Institute/VU University medical center*

Regular participation in physical activity and sports is beneficial for health. Thereby, safety in sports and physical activity is an important prerequisite for continuing participation in sports, as well as maintenance of a healthy physically active lifestyle. However, injuries are side effects of otherwise healthy activities and should not be neglected. The consistent findings that relative inactive individuals are at increased risk for injury pose an important issue in regards to public health and injury prevention. It is this part of the entire population that is encouraged through various channels to become more active for health reasons. Based upon current sports injury prevention research paradigms, one would expect that thus established activity level injury difference would have led to specific prevention programs. However, injury preventive behaviors and safety message are based upon research in more active sporting populations. As such, the main risk factors of injuries are for a large part not targeted in this important population at risk. This implies there is much to gain by studying and targeting the true injury causing factors in the larger part of low level and novice athletes.

##### CORE TRAINING TO PREVENT INJURY

Best, T.

*The Ohio State University*

Popular scientific and lay press advocate for core training and injury prevention and rehabilitation. Despite these assertions, limited well-conducted, controlled studies provide a direct link between core training and an alteration in primary and secondary injury risk prevention. In this session, we will review recent studies from our laboratory and others involving core training that delineate specific strategies to mitigate biomechanical risk factors for lower extremity injury. The goal is to develop consensus from the current literature and to formulate evidence-based questions that can move the field forward regarding core training and injury prevention/rehabilitation.

## 08:00 - 09:30

### Oral presentations

#### OP-BN09 Sports Biomechanics 4

##### PITCHER AGING AFFECTS THROWING SHOULDER BIOMECHANICS AND PROPRICEPTION: THE ITALIAN EXPERIENCE

Pegreff, F.1, Vittori, L.1, Foschi, E.1, Latessa Maietta, P.1, Paladini, P.2, Campi, F.2, Pellegrini, A.2, Porcellini, G.2, Tentoni, C.2  
*University of Bologna*

Introduction: Baseball is a sport increasingly practiced in Italy. The pitcher is at risk from repetitive stress on the dominant upper arm. Because of this, pitchers train far more on the dominant arm leading to asymptomatic biomechanical changes. The purpose of this study

was to compare shoulder intra/extra rotational power and shoulder motor skill in young and senior athletes. Methods: Twenty right-hand healthy pitchers playing for at least four years were recruited : Group A (12±2yrs) and Group B (24±1yrs). Subjects with a history of shoulder dislocation, shoulder surgery or structural injuries to the shoulder complex were excluded from the study. Isokinetic tests (IT) were performed to evaluate intra/extra rotational power, and shoulder motor skill test (SMST) to evaluate proprioception. Results: Performing IT, we have found in both groups a significant higher external rotation compared to internal rotation in the throwing shoulder (TS), while in the contralateral shoulder (CS) the balance was preserved ( $p < 0.003$ ). In Group A, SMST was 4±2 points (TS) and 4±1 points (CS),  $p = n.s$ . In Group B, SMST was 9±1 points (TS) and 4±2 points (CS),  $p < 0.005$ . Discussion and Conclusion: Italian pitchers demonstrated a higher external rotational power in the throwing shoulder after only four years of practicing baseball. Motor skill ability seems to develop later in the dominant shoulder. This study suggests that a baseball training program, especially for young pitchers, should include not only exercises to restore internal/external rotation balance but also motor skill exercises, to improve throwing ability, limit the number of throws, prevent shoulder injury over time.

### **EXERCISE OF MECHANISMS OF DYNAMIC STABILITY IMPROVES THE STABILITY STATE AFTER AN UNEXPECTED GAIT DISTURBANCE IN ELDERLY**

Bierbaum, S.1, Arampatzis, A.2

1: University of Stuttgart, 2: Humboldt-University of Berlin

Introduction Elderly individuals are more challenged in their dynamic stability by unexpected changes during gait than young persons. This is represented in a reduced recovery performance in response to obstacles and unexpected perturbations (Tseng et al., 2009; Galna et al., 2009). However, the adaptive potential of elderly persons seems to be preserved and therefore the training of the mechanisms of dynamic stability as well as the contribution of muscle strength may improve the dynamic stability after unexpected perturbations. Methods 37 persons in the age from 65-75 years participated in the study divided in two experimental groups (SG: n=14; MG: n=13) and a control group (CG: n=10). SG- and MG-group performed a training of exercises which included the mechanisms of dynamic stability. MG-group exercised additionally muscle strength. Exercise volume and intervention duration was equal for both groups (14 weeks, two times a week and ~1.5h per session). Prior to the intervention and afterwards, subjects performed a gait protocol in which they experienced an unexpected perturbation. Dynamic stability was analyzed according to the concept of the extrapolated center of mass (Hof, 2008). Results Margin of stability after an unexpected perturbation during gait has been increased significantly after the intervention in the SG-group indicating an improvement in stability state (pre: -30.3±5.9cm; post: -24.1±5.2cm). Further, after the intervention, both intervention groups showed an increase of the base of support after the perturbation (SGpre: 90.9±6.6cm, SGpost: 98.2±8.5cm; MGpre: 91.4±6.2cm, MGpost: 97.9±12.7cm). Control group showed no difference between pre and post measurement. Discussion The exercise of the mechanisms of dynamic stability led to a better application of these mechanisms after an unexpected perturbation during gait. Both experimental groups increased the base of support after the intervention as an important mechanism to regain balance after a gait perturbation. However, a clear improvement in the stability state (i.e. margin of stability) during the disturbance has been achieved only in the SG-group. Therefore we suggest that the repeated exercise of the mechanisms of dynamic stability contributes adequately to the accomplishment of improved dynamic stability, but that the performed additional strength training for healthy elderly individuals shows no further effect on the ability to recover balance after unexpected perturbations during gait. References Galna B, Peters A, Murphy AT, Morris ME (2009). *Gait Posture*, 30, 270-275. Hof, AL (2008). *Hum Mov Science*, 27, 112-125. Tseng SC, Stanhope S, Morton S (2009). *J Gerontology*, 64, 807-815.

### **ANTICIPATIVE POSTURAL ADJUSTMENT STRATEGIES DURING CUTTING MANEUVER**

Mornieux, G., Gehring, D., Fürst, P., Gollhofer, A.

University of Freiburg

Introduction During complex whole body movements like cutting maneuvers, the time available to prepare the movement is of importance (Houck et al., 2006). With more time available, the anticipative postural adjustments (Patla et al., 1999; Jindrich et al., 2009) taking place at the foot, hip, trunk and head levels can be optimized in order to accelerate the center of mass in the new direction. For that purpose subjects typically regulate their foot placement already prior to the change of direction and adjust their trunk orientation (Patla et al., 1999). We hypothesized that less anticipation time would not allow regulating the foot placement, which in consequences would be compensated by a greater trunk orientation strategy. Methods 13 males (179±3 cm; 74±7 kg) performed cutting maneuvers with different cutting angles at a 5m/s approach velocity. All trials were randomized and subjects got the information in which direction they had to cut by means of a light system at different anticipation times, i.e. 850ms, 600ms or 500ms before the change of direction. Kinematics (Vicon) of the trunk and hip joints as well as the step width were measured at the time of foot off (FO) one step prior to the change of direction and then at the initial contact (IC) while changing direction. A variance analysis was used to determine the influence of the anticipation time on the different dependent variables during the 45° cutting maneuver. A significance level of  $p < 0.05$  was selected. Results With less anticipation time, the trunk was significantly less rotated towards the cutting direction at FO and IC ( $p = 0.03$ ). The step width was significantly reduced with less anticipation time at FO ( $p = 0.03$ ) and remained unchanged at IC. Finally, at IC, less anticipation time significantly increased the trunk abduction (from 15° to 19°;  $p = 0.01$ ) and tended to increase the hip abduction ( $p = 0.05$ ). Discussion The reduced trunk rotation reflected the difficulties for subjects to initiate the orientation of the whole body in the cutting direction when the anticipation time was limited. As the acceleration of the center of mass in the new direction could not be initiated through an appropriate foot placement, subjects used an increased trunk abduction strategy to realize the cutting maneuver with less anticipation time. However, increased trunk abduction could be associated with increased knee joint loading (Hewett and Myer, 2011). Therefore reducing the anticipation time to perform cutting maneuvers might be associated with higher knee injury risk. References Hewett TE, Myer GD (2011). *Exerc Sport Sci Rev*, 39(4), 161-166. Houck JR, Duncan A, De Haven KE (2006). *Gait Posture* 24(3), 314-322. Jindrich DL, Qiao M (2009). *Chaos*, 19(2), 026105. Patla AE, Adkin A, Ballard T (1999). *Exp Brain Res*, 129(4), 629-634.

### **MUSCLE WEAKNESS IN PARKINSON DISEASE AS CONSEQUENCE OF IMPAIRED NEUROMUSCULAR CONTROL**

Moreno Catalá, M., Woitalla, D., Arampatzis, A.

Humboldt Universität zu Berlin

MUSCLE WEAKNESS IN PARKINSON DISEASE AS CONSEQUENCE OF IMPAIRED NEUROMUSCULAR CONTROL 1María Moreno Catalá, 2Dirk Woitalla, 1Adamantios Arampatzis 1Department of Training and Movement Sciences, Humboldt-University Berlin, Germany 2St. Joseph

Hospital of the Ruhr-University Bochum, Germany Introduction Muscle weakness has been observed in patients with the Parkinson Disease (PD) and correlated with clinical severity and several movement impairments like falls, reduced walking speed or dynamic postural instability (Stevens et al., 2011; Durmus et al., 2010; Nocera JR. et al., 2010). However the specific cause of this weakness is not well known. The aim of this study was to examine the muscle strength of the plantar flexors (PF) and knee extensors (KE) in faller and non-faller PD patients as well as in healthy control participants in order to determine whether muscle weakness originated from central or peripheral factors. Methods 23 young PD patients (13 fallers and 13 non-fallers, stage I-III H&Y scale) and 15 matched healthy controls performed several isometric maximal voluntary knee extension and plantar flexion contractions (MVC) of the most affected leg on a dynamometer. The antagonistic moment of hamstrings (HA) and tibialis anterior (TA) during contractions was estimated by establishing a relationship between EMG amplitude and exerted moment for HA and TA whilst working as agonist (Mademli et al. 2004). In order to assess the activation deficit of the plantar flexor (PF) and knee extensor (KE) muscles the twitch interpolation technique was used. Results The control participants showed higher moment values ( $p < 0.05$ ) in both PF ( $161 \pm 45$  vs  $115 \pm 29$  Nm) and KE ( $203 \pm 69$  vs  $159 \pm 45$  Nm) compared to the Parkinson fallers. No significant differences ( $p > 0.05$ ) were found for the resultant moment between the control group and the non-faller Parkinson group. During the MVCs the antagonist moment of the TA and the HA were significant higher ( $p < 0.05$ ) in the Parkinson fallers compared to the control group. Furthermore the Parkinson fallers showed a significant higher ( $p < 0.05$ ) activation deficit compared to the control group of the PF (14 vs. 9%) and KE (22 vs. 10%). Discussion Our results showed that the reason of muscle weakness in the Parkinson fallers derived mainly from central impairments. The reduced ability to activate the whole muscle and an impaired neuromuscular control between agonists and antagonists affected significantly the torque production. These impairments may contribute to the increased fall risk in these patients with PD. REFERENCES. 1. Stevens J. et al. (2011). *Neurorehabil Neural Repair*, Dec 2. 2. Durmus B. et al. (2010). *J Clin Neurosci*, 17(7):893-6. 3. Nocera JR. et al. (2010). *Arch Phys Med Rehabil*, 91(4):589-95. 4. Mademli L. et al. 2004. *J Electromyogr Kinesiol*, 14(5):591-7.

### **DYNAMIC KNEE JOINT VALGUS – THE RESULT OF A SPECIFIC NEUROMUSCULAR PATTERN DURING SIDECUTTING MANOEUVRES IN YOUNG FEMALE ELITE ATHLETES?**

Zebis, M.K.1,2, Bencke, J.2, Petersen, M.B.2, Curtis, D.2, Bloch-Lauridsen, H.2, Hölmich, P.2, Andersen, L.L.3, Myklebust, G.4, Aagaard, P.1

1: University of Southern Denmark (Odense, Denmark), 2: Copenhagen University Hospital (Denmark), 3: NRCWE (Copenhagen, Denmark), 4: OSTRC (Oslo, Norway)

Introduction Identifying risk factors for future ACL-injury is a promising way towards effective injury prevention. Dynamic lower extremity valgus has been identified to predict ACL-injury risk in female athletes (Hewett et al., 2005). Similar, the neuromuscular activity of agonist-antagonist knee joint muscles has been identified as a potential risk factor (Zebis et al., 2009). In the present study we investigated the association between knee valgus positioning and the underlying neural pre-activation pattern in medial (m. semitendinosus) vs. lateral (vastus lateralis) thigh muscles, in a movement associated with non-contact ACL-injury. The present investigation involved a population of young female elite athletes, known to be at high risk of sustaining non-contact ACL-injury (Lind et al., 2009). Methods Forty young female elite handball and soccer players (age  $15.9 \pm 1.4$  years) agreed, with their parent's consent, to participate. Five repetitions of each player's individual sidecut manoeuvre were investigated using an 8 camera Vicon 612 system and an AMTI force platform. Knee abduction (valgus) angle at initial contact (IC) was measured. Vastus lateralis (VL) and semitendinosus (ST) muscle activity (EMG) was measured in the 50 ms time interval prior to foot strike. EMG activity was normalized to peak EMG amplitude recorded during MVC, and VL minus ST pre-activity was calculated. Results The players were divided into a valgus or a varus group based on frontal plane knee joint angle at IC. Sixteen players landed in a knee valgus position ( $-1.7 \pm 0.8^\circ$ ) and 24 players in a varus position ( $3.7 \pm 2.4^\circ$ ) ( $P < 0.0001$ ). Valgus players showed larger VL minus ST EMG values compared with varus players ( $20 \pm 18\%$  vs.  $1 \pm 23\%$ ) ( $P = 0.004$ ). Discussion During rapid sidecutting, substantial neural pre-activation of the medial hamstring muscle (ST) is important to medially compress the knee joint and thereby limit the risk of excessive knee valgus positioning. The present data suggest that the occurrence of knee joint valgus during sidecutting is the result of reduced pre-activity in ST accompanied by high lateral quadriceps activity in the initial landing phase, altogether resulting in a movement profile with high risk of ACL-injury. References Hewett et al. (2005). *Am J Sports Med*. 33, 492-501. Zebis et al. (2009). *Am.J.Sports Med*. 37, 1967-1973. Lind et al. (2009). *Knee.Surg.Sports Traumatol.Arthrosc*. 17, 117-124.

### **LEG LENGTH DIFFERENCE IN CYCLISTS: KINETIC IMBALANCES AND CORRECTIONAL OPTIONS**

Mann, M.

*Universal College of Learning (UCOL)*

Introduction: The purpose of this study was to investigate the relationship of leg length differences and kinetic imbalances in addition to the effect of existing correctional procedures on such imbalances in cycling. Methodology: On a preliminary visit, total, upper and lower leg lengths were measured from the greater trochanter of the femur (GT) to heel (H), the GT to lateral condyle (LC), and LC to H, respectively. Two interventions: crank length (CL) and cleat wedge (CW) and a control (normal bike set-up (N)) were performed in a randomised order with a 2-5 d period between trials. Participants ( $n=10$ ) performed a maximal isokinetic test (to allow for normalisation of EMG data) followed by three 15min work sessions (CL: CW: N) at ventilatory threshold (VT). Heart rate, cadence, power output and expired air were averaged over each 15min interval. Net torque, EMG taken from left and right vastus lateralis (VL), were taken and averaged during 40-50s of the 5th, 10th and 15th min. Video footage synchronised with torque measurements was digitised and used to analyse 2D mechanical angles (thigh to horizontal, knee joint and ankle joint). Results: There were no significant differences ( $p > 0.05$ ) between conditions indicating reliability for power output (W), cadence (rpm),  $VO_2$  ( $L \cdot min^{-1}$ ) and HR (bpm), averaged over each 15min period. In the cleat wedge condition, there was a reduction in between-leg variance ( $P < 0.05$ ) and a small effect size ( $ES = 0.18$ ) between left and right leg torque. EMG variability reduced under the same condition giving a medium effect size ( $ES = 0.51$ ). Discussion: results suggest that, given a longer intervention using the CW condition, imbalances could be reduced leading to improved performance and minimising friction, pressure and overuse injuries conditions common to endurance cyclists. Further research is required, using more subjects and an intervention period, as to how cyclists optimise force production while reducing variability between left and right legs.

08:00 - 09:30

## Oral presentations

### OP-PM48 Health and Fitness 3

#### **PHYSICAL ACTIVITY COUNSELLING AND EXERCISE REFERRAL INCREASES TOTAL PHYSICAL ACTIVITY IN LONG TERM UNEMPLOYED INDIVIDUALS: A CONTROLLED ACCELEROMETER TRIAL**

Gabrys, L., Michallik, L., Thiel, C., Vogt, L., Banzer, W.

*Goethe-University Frankfurt*

**Introduction** Physical activity is seen as an integral component of a healthy lifestyle and has the potential to produce significant health benefits amongst individuals (Pedersen & Saltin 2006). It therefore plays a major role in the field of public health and primary prevention. Compared to the general population, unemployed persons show higher levels of physical inactivity and less physical activity (Pockrandt et al. 2007). For this and other reasons like e.g. unhealthy eating, smoking or substance abuse unemployment is associated with a greater health risk that additionally rises with increased duration of unemployment (Hollederer 2011). Therefore, a sports medical service of physical activity counselling and exercise referral was established at regional job centres to refer older unemployed persons to existing local exercise for health programs. The aim of this accelerometer study is to assess the change in physical activity following standardised physical activity counselling and exercise referral. A secondary focus lies on the changes in subjective health outcomes such as health- and fitness status in elderly long-term unemployed persons over 50 years of age. **Methods** A sample of 51 long-term unemployed persons over 50 years received physical activity counselling and exercise referral to attend local exercise for health programs at no charge for the next months. Further 21 unemployed persons and 17 employed persons, defined as control groups with no counselling nor exercise referral, were included. Physical activity levels of all 89 participants were measured over 7 consecutive days prior to and 12 weeks after counselling by biaxial accelerometer (ActiGraph GT1M). **Results** Overall 58 persons completed pre/post measurements. Participants who started exercising increased their amount of moderate to vigorous physical activity (MVPA) from  $26 \pm 14$  to  $35 \pm 25$  minutes/day as well as total physical activity from  $207 \pm 86$  to  $288 \pm 126$  counts/minute significantly. At baseline, employed persons were more active than unemployed persons. Subjective health status decreased significantly in the unemployed control group after 12 weeks. **Discussion** Unemployed persons are less active and less healthy compared to employed study sample. Unemployed persons who are willing and motivated to change physical activity behaviour benefit from physical activity counselling and exercise referral and increase MVPA to a health promoting level according to the guidelines. Physical activity inequalities could be reduced. **References** Hollederer, A (2011). Unemployment and health in population of Germany. *Journal of Public Health* 19, 3:257-268 Pedersen, BK; Saltin, B (2006). Evidence for prescribing exercise as therapy in chronic disease. *Scand J Med Sci Sports*: 16 (Suppl. 1): 3-63 Pockrandt, C et al. (2011). Health Behaviour and Health-Risk Behaviour among Job-Seekers: A Screening at an Employment Agency [in german]. *Gesundheitswesen*; 69: 628- 634

#### **WALKING AND TALKING FOR FITNESS AND WELL-BEING: EFFECTS OF A STRUCTURED WALKING INTERVENTION IN A COMMUNITY-BASED SOCIAL ORGANIZATION FOR OLDER ADULTS**

Pelssers, J., Delecluse, C., Opendacker, J., Kennis, E., Van Roie, E., Boen, F.

*KU Leuven*

**Introduction** This study evaluated a ten-week structured walking intervention with systematic training progression in a community-based social organization for older adults on promoting physical activity, fitness and well-being among older adults (>55). The intervention prescribed pedometer-based walks in weekly walking schedules. These were competence-tailored based on a walking assessment (6' walking test) and structured in walking load according to the principles of training progression. The intervention was implemented as a social activity in community-based meeting points of a social organization for older adults, including group walks. **Methods** The intervention condition consisted of 29 meeting points (n = 432) while 10 meeting points (n = 148) formed a waiting-list control condition. Measurements were at intervention start (pre-test) and end (post-test). The Godin LTEQ (Godin et al., 1985) was used to assess physical activity. The 6' walking test (6MWT; Butland et al., 1982) was used to assess fitness. Well-being included measures of anxiety (STAI; Spielberger et al., 1983), well-being (Marcoen et al., 2002), and subjective health. **Results** Intention-to-treat linear mixed models revealed intervention effects on moderate intensity (F = 7.276, p < .01) and total physical activity (F = 6.185, p < .05), fitness (F = 9.486, p < .01), anxiety (F = 5.261, p < .05) and subjective health (F = 3.960, p < .05), and suggested an effect on low intensity physical activity (F = 3.291, p = .07). The effects consisted of increased low intensity (t = -6.482, p < .001) and total physical activity (t = -3.589, p < .001), fitness (t = -7.017, p < .001) and subjective health (t = -4.723, p < .001), and of reduced anxiety (t = 4.957, p < .001) over time. Moderate intensity physical activity remained unchanged in the intervention condition (t = -1.707, p = n.s.), but was reduced in the control condition (t = 2.131, p < .05), indicating the counteraction of a season effect. **Conclusions** The intervention was effective in promoting physical activity, fitness and aspects of well-being. The results underline the value of (A) training progression in structured walking interventions and of (B) community-based social organizations for older adults as intervention setting. **References** Butland RJA, Pang J, Gross ER, Woodcock AA, Geddes DM. (1982). *Brit Med Jour*, 284, 1607-08. Godin G, Sheppard RJ. (1985). *Can Jour App Sport Sci*, 10, 141-46. Marcoen A, Van Cotthem K, Billiet K, Beyers W. (2002). *Tijds. Gero. Geriatrie*, 33, 156-165. Spielberger CD, Gorsuch RL, Lushene R, Vagg PR, Jacobs GA. (1983). *Manual for the State Trait Anxiety Inventory*. Consulting Psychologists Press, Palo Alto.

#### **HIGH INTENSITY INTERVAL TRAINING: A TIME SAVING ALTERNATIVE TO TRADITIONAL EXERCISE PRESCRIPTION FOR OVERWEIGHT, PHYSICALLY INACTIVE ADULTS**

Draper, N., Lunt, H., Marshall, H., Logan, F., Hamlin, M., Cotter, J., Shearman, J., Kimber, N., Blackwell, G., Frampton, C.

*University of Canterbury*

**Introduction** The incidence of obesity continues to rise in many developed countries and have been closely linked rises in physical inactivity (Blair, 2009). 'Lack of time' has been commonly cited as a major reason the decline in physical activity in these countries (Godin et al., 1994; Blair, 2009). Previous laboratory based research with clinical population and young active males suggest that high intensity interval training (HIIT) may provide a time saving alternative to traditional exercise prescription (Gibala et al., 2006). The application of these

findings to pre-clinical populations in a real-world setting has yet to be reported. The aim of this study was to investigate whether the time saving benefits of HIIT could translate to a community setting with participants who were overweight and physically inactive. Methods Forty-nine participants (36 female, 13 male; mean  $\pm$  SD) age 48.2  $\pm$  6.0 years, BMI 32.4  $\pm$  4.2 kg/m<sup>2</sup> were randomly assigned to low intensity endurance training (LIET – active control), HIIT and maximal volitional interval training (MVIT). All groups completed a 10 min warm-up and 5 min cool-down, followed by a group specific exercise protocol - LIET 33 min continuous exercise at 65 – 75 % HRmax; HIIT 4  $\times$  4 min exercise bouts with 3 min recoveries at 85 – 95 % HRmax; MVIT 4  $\times$  30 s maximal efforts with 4 min recoveries. The exercise sessions (3  $\times$  pw) took place at a local park, HIIT and LIET groups walking on the flat, MVIT group using a slope. Pre and post the 12 week intervention testing included, resting blood pressure (BP), VO<sub>2</sub>max, and waist circumference. Results Results indicated there were no significant differences between the groups, however, resting BP, waist circumferences, HR and VO<sub>2</sub> during the VO<sub>2</sub>max test were significantly lower post exercise intervention. Discussion Our findings suggest that both HIIT and MVIT present time saving alternatives to traditional LIET with similar health benefits post exercise intervention for overweight and previously physically inactive adults. Participants in the MVIT group reported a higher incidence of musculoskeletal injuries than either the LIET or HIIT groups. This finding suggests that for maximal effort exercise such as that completed by the MVIT group should be completed on non-weight-bearing exercise modes such as cycling or deep-water running. In a real world setting with overweight and previously inactive participants HIIT provides a time saving alternative to LIET with no apparent increased risk of injury. References Blair SN. (2009). *Brit Med J*, 43(1), 1-2. Gibala MJ, Little JP, van Essen M, Wilkin GP, Burgomaster KA, Safdar, A., Raha S, Tarnpolsky MA. (2006). *J of Physiol*, 575(3), 901. Godin GR, Desharnais P, Valois P, Lepage P, Jobin J, Bradet R. (1994). *Am J of Health Prom*, 8, 279-285.

### STRENGTH COMBINED WITH WALKING BUT NOT WALKING TRAINING ALONE MAINTAINS FUNCTION IN OLD ADULTS

Hortobágyi, T.

*University of Groningen Medical Center*

STRENGTH COMBINED WITH WALKING BUT NOT WALKING TRAINING ALONE MAINTAINS FUNCTION IN OLD ADULTS Hortobágyi, T. Center for Human Movement Sciences, University of Groningen Medical Center (The Netherlands) Introduction Old adults use walking in an effort to maintain levels of physical activity and function. The purpose of the study was to clarify if walking alone is sufficient to circumvent losses in function and mobility in old adults or it would have to be combined with strength training. Methods Healthy old adults were randomly assigned to a walking (W, n=12) or a walking+strength training (W+S, n=12) exercise group in a retirement center and tested at baseline then bimonthly for 12 months for measures of function. Both groups followed ACSM exercise training guidelines. Results Relative to baseline, at 12 months W+S lifted 9.0 (SD  $\pm$ 3.8) kg more in two-legged 3-RM knee extension, improved 4.2 ( $\pm$ 2.3) kg in handgrip strength, performed 11 more knee extension repetitions at 75% of the initial 1RM load, had 5.0 ( $\pm$ 2.0) fewer falls, improved gait velocity by 0.51 ( $\pm$ 0.99) measured over 400-m path, and walked spontaneously 14.8 minute more per day (all  $p < 0.05$ ). Relative to baseline, at 12 months W lifted 8.0 (SD  $\pm$ 4.5) kg less in two-legged 3-RM knee extension ( $p < 0.05$ ), produced 4.2 ( $\pm$ 2.3) kg less in handgrip strength ( $p < 0.05$ ), performed 1.4 fewer knee extension repetitions at 75% of the initial 1RM load (n.s.), had no change in the number of falls, walked 0.10 ( $\pm$ 0.50) m/s slower measured over 400 m, and walked spontaneously 0.31 ( $\pm$ 0.2) minute more per day (n.s.). Changes in gait velocity and 3-RM leg strength correlated  $r = -0.79$  in W+S only. Neither program produced any changes in resting blood pressure and heart rate. Discussion Maintaining mobility and independence are key goals in old adults. Walking is often recommended as an exercise modality to maintain function. Within the limitations of the present study it, however, seems that a long-term walking program is actually accompanied by a loss of muscle strength and a dampened function-maintaining effect as compared with W+S. The data suggest that inclusion of 1-2x/week strength training sessions in healthy old adults' exercise program can slow loss of function and perhaps improve spontaneous gait speed. Walking alone does not seem to provide such a protective effect.

### A COMPARISON OF INTERVENTIONS TO SUPPORT WEIGHT LOSS AND IMPROVED BODY COMPOSITION

Stopforth, M., Baker, M.

*Southampton Solent University*

A COMPARISON OF INTERVENTIONS TO SUPPORT WEIGHT LOSS AND IMPROVED BODY COMPOSITION Stopforth, M.L & Baker, M. SOLENT UNIVERSITY, ENGLAND Introduction Obesity is a rapidly spreading epidemic, with treatment costing the UK billions of pounds a year (DOH, 2009). Annessi and Whitaker (2010) stated that behavioural support alongside nutritional education had a positive impact on weight loss. Commercial weight loss groups have been found to be effective (Jebb et. al., 2010), but as 30.1 million adults in the UK accessed the daily in 2010 (Office for National Statistics, 2010), support via the internet may also be viable way of providing support. Previous research has shown computer assisted dieting to be better than no support (Shroder, 2009), but the current pilot study aimed to compare computer aided support with a weekly support group and education alone. Methodology 26 participants whose high level of body fat posed a significant risk to their health were randomly allocated to one of three intervention groups: Social Support (SS; n=9); Online Support (OS; n=9); or Education Only (EO; n=8). All 26 participants attended an educational session which followed the NICE (2006) guidelines on obesity prevention and management. The OS group were then given a tutorial on how to use an online weight loss support tool, and the SS group attended weekly support sessions. Participants' body fat (%) and body mass (kg) were measured pre and post intervention (12 weeks). 24 participants completed post testing. Results Results showed a significant decrease in body fat ( $F(1,21) = 18.40$ ,  $p < 0.005$ , partial  $\eta^2 = 0.47$ ) and body mass ( $F(1,21) = 22.46$ ,  $p < 0.005$ , partial  $\eta^2 = 0.52$ ) in all three groups. However, there was no significant difference between the groups ( $F(2,21) = 2.20$ ,  $p = 0.32$ ). Discussion These findings suggest that low-cost (to the client) interventions such as online support or the provision of a one off educational session are as effective methods as methods requiring greater professional input, such as weekly support meetings. References Annessi, J. & Whitaker, A. (2010). Psychological Factors Associated With weight Loss in Obese and Severely Obese Women in a Behavioural Physical Activity Intervention. *Health Education & Behaviour*, 37 (4): PP 593-606. DOH, (2009). Let's Get Moving. Jebb, S. et. al., (2010). Referral to a commercial weight management programme enhances weight loss achieved in primary care. *Obesity Reviews*. 11 (suppl. 1) PP: 240 – 241. NICE, (2006). Obesity: Guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children. NICE clinical guideline 43. Office for National Statistics, (2010). Internet Access. [Accessed 19.11.2010]. Available from: <http://www.statistics.gov.uk/cci/nugget.asp?id=8> Schroder, K., (2009). Computer-assisted dieting: Effects of a randomised controlled intervention. *Psychology & Health*. 25 (5) PP: 519 – 534.

08:00 - 09:30

## Oral presentations

### OP-PM49 VO<sub>2</sub>max and O<sub>2</sub> Kinetics

#### DETERMINANTS OF DELAYED OXYGEN UPTAKE KINETICS DURING ONSET OF SUBMAXIMAL EXERCISE IN CHRONIC HEART FAILURE

Niermeijer, V.1, Spee, R.F.1, Wessels, B.2, Wijn, P.F.F.2, van Loon, L.J.C.3, Kemps, H.M.C.1

1: MMC (Veldhoven, the Netherlands), 2: TU/e (Eindhoven, the Netherlands), 3: MUMC+ (Maastricht, the Netherlands)

**Purpose** The rate of increase in oxygen uptake during submaximal exercise (VO<sub>2</sub> onset kinetics) has been shown to be a good marker of prognosis and functional capacity in patients with chronic heart failure (CHF) (Kemps, 2007). The purpose of the present study was to investigate the pathophysiological background of delayed VO<sub>2</sub> onset kinetics in CHF patients. Methods Twelve stable CHF patients (NYHA II-III) and 8 healthy subjects, matched for age and body mass index (BMI), were included. All subjects performed a submaximal constant load exercise test at 80% of the ventilatory threshold. VO<sub>2</sub> onset kinetics were expressed as the time constant of the mono-exponential VO<sub>2</sub>-increase ( $\tau$ -VO<sub>2</sub>). In order to assess changes in the ratio between oxygen delivery and oxygen utilization at the skeletal muscle level (Tissue Oxygenation Index, TOI), Near Infrared Spectroscopy (NIRS) was applied simultaneously at the vastus lateralis muscle. The rate of decrease in TOI was assessed by the mean response time, including a time delay and the time constant of the initial mono-exponential TOI-decrease. Results As expected peak oxygen uptake was significantly lower in CHF patients ( $20 \pm 5$  versus  $37 \pm 14$  ml/min/kg,  $p=0.005$ ). Also, VO<sub>2</sub> onset kinetics were delayed in CHF patients ( $\tau$ -VO<sub>2</sub>:  $64 \pm 25$  versus  $41 \pm 23$  sec,  $p=0.02$ ). This delay was associated with slower TOI onset kinetics in CHF patients (MRT-TOI:  $27 \pm 11$  versus  $19 \pm 3$  sec,  $p=0.02$ ). These results indicate a slower decrease in oxygen delivery relative to oxygen utilization in CHF patients, thereby suggesting, at least at a group level, a limiting role of oxygen utilization in exercising muscles. However, there was a considerable between-patient variation as shown by the lack of correlation between  $\tau$ -VO<sub>2</sub> and MRT-TOI in CHF patients ( $\rho$ :  $-0.25$ ,  $p=0.43$ ). Conclusion The results of the present study suggest that impaired skeletal muscle metabolism is an important contributor to delayed VO<sub>2</sub> onset kinetics in moderately impaired CHF patients. However, given the considerable between-patient variation, further research is needed to identify subgroups with different physiological profiles (Bowen, 2011). References Bowen TS, Cannon DT, Murgatroyd SR, Birch KM, Witte KK, Rossiter HB (2011). J Appl Physiol (October 27, 2011). doi:10.1152/jappphysiol.00779.2011 Kemps HMC, de Vries WR, Hoogeveen AR, Zonderland ML, Thijssen EJM, Schep G (2007). Eur J Appl Physiol, 100, 45-52.

#### RELATIONSHIP BETWEEN V'O<sub>2</sub> KINETICS AND MAXIMAL OXYGEN UPTAKE IN THE ELDERLY.

Koschate, J., Drescher, U., Brixius, K., Montiel, G., Predel, H.G., Hoffmann, U.

German Sport University Cologne

**Introduction:** Maximal oxygen uptake (V'O<sub>2</sub>max) as well as V'O<sub>2</sub> kinetics depend on central factors, such as cardiac output and peripheral determinants like oxidative capacity of the muscles. Babcock et al. (1994) already showed results concerning the relation between V'O<sub>2</sub>max and V'O<sub>2</sub> kinetics within a group manifesting a wide age range; 30-60 years. This relation remains to be demonstrated in a homogeneous age group and would prove a considerable influence of V'O<sub>2</sub>-kinetics on aerobic capacity. Using a submaximal, non-invasive exercise test combined with an especially developed instrument, the Backward-Calculation-Method (BCM), muscular oxygen uptake kinetics will be calculated and correlated to V'O<sub>2</sub>max in elderly subjects. Method: 22 male elderly subjects were analyzed (72.91 ( $\pm 2.8$ ) years, 84.1 ( $\pm 9.1$ ) kg, 174.9 ( $\pm 4.2$ ) cm, 1.87 ( $\pm 0.41$ ) L\*min<sup>-1</sup>). All subjects completed an 'allout' test to measure V'O<sub>2</sub>max and a moderate test using pseudo random binary sequences (PRBS) to evaluate cardiorespiratory kinetics on a cycle ergometer. During the moderate test heart rate (H) and respiratory V'O<sub>2</sub> (R) were measured and muscular V'O<sub>2</sub> (M) was calculated. For this calculation the BCM-Method was used to compute the cardiorespiratory kinetics applying auto (ACF) and cross correlations (CCF). By the use of ACF and CCF a 'peak' (peak cross correlation time between work and parameter; velocity of the kinetics) was derived for each parameter. Data were analyzed via parametric correlations and linear regression, using IBM SPSS Statistics 20. Results: Mpeak and V'O<sub>2</sub>max correlate significantly ( $r=0.428$ ;  $p=0.023$ , one-tail) as well as Rpeak and V'O<sub>2</sub>max ( $r=0.425$ ;  $p=0.024$ , one-tail). There was no significant correlation concerning Hpeak and V'O<sub>2</sub>max. Performing a stepwise linear regression, including Hpeak, Mpeak and Rpeak as independent and V'O<sub>2</sub>max as the dependent variable, Mpeak shows the most important influence on V'O<sub>2</sub>max ( $p=0.047$ ). Discussion: There is good evidence regarding a relationship between V'O<sub>2</sub>max and V'O<sub>2</sub> kinetics in a homogeneous age group. Therefore, calculation of V'O<sub>2</sub> kinetics via PRBS might be used as an indicator for changes in V'O<sub>2</sub>max. The independency of this submaximal test concerning high motivation, which is usually needed to measure V'O<sub>2</sub>max, can be seen as a benefit for the elderly population or patients where V'O<sub>2</sub>max cannot be measured. Additionally these results demonstrate the importance of the calculated muscular V'O<sub>2</sub> with a potentially superior influence on V'O<sub>2</sub>max over V'O<sub>2</sub> measured at the mouth. References: Babcock, M. A., Paterson, D. H., Cunningham, D. A. & Dickinson, J. R. (1994). Exercise on-transient gas exchange kinetics are slowed as a function of age. Medicine & Science in Sports & Exercise, 26(4), 440-446.

#### DOES METABOLIC STRESS AFFECT THE DECREASE IN OXYGEN UPTAKE AT THE END OF ALL-OUT EXERCISE ?

Thomas, C.

INSEP

DOES METABOLIC STRESS AFFECT THE DECREASE IN OXYGEN UPTAKE AT THE END OF ALL-OUT EXERCISE ? Thomas, C.1,2, Delfour-Peyrethon R. 1, Perrey, S. 4, Dorel, S. 1,5, Lepretre, P.M., 6, Bishop, D. 3, Hanon, C. 1. 1 : INSEP (Paris, France), 2 : UEVE (Evry, France), 3 : ISEAL (Melbourne, Australia), 4 : M2H, Euromov (Montpellier, France), 5 : MIP EA 4334 (Nantes, France), 6 : UPJV (Amiens, France) Introduction The present study investigated the effects of altering extracellular buffer capacity during acute all-out exercise on VO<sub>2</sub> decrease. Although some previous studies have investigated the effects of prealkalosis on VO<sub>2</sub> kinetics during submaximal and supramaximal exhaustive exercises with controversial effects, we hypothesised that the VO<sub>2</sub> decrease at the end of supramaximal exercise performed until exhaustion could be affected by acidosis, and we further posited that preexercise-induced alkalosis could prevent the VO<sub>2</sub> decrease. Methods We investigated the oxygen uptake response and performance during 70-s all-out exercise performed in two conditions,

preexercise alkalosis (BIC : 0,3 g.kg<sup>-1</sup> NaHCO<sub>3</sub>) and placebo (PLA : 0.2 g.kg<sup>-1</sup> CaCO<sub>3</sub>) in highly-trained subjects. Exercise tests were conducted using an electronically braked cycle ergometer (Excalibur Sport, Lode, Groningen, The Netherlands). Blood samples were collected at rest, before the test and at 0, 5 and 8 min of 70-s exercise recovery (i-STAT, Abbott, Les Ulis, France). Results Significant differences between PLA and BIC are observed for power output during the last 50s (P < 0.05) and total power output (P < 0.01). Oxygen uptake response increase to a steady state corresponding to 95.2 ± 3.2 and 99.7 ± 2.8 % of VO<sub>2</sub>max for PLA and BIC respectively, before to significantly decrease of 9.2 ± 3.2 for PLA and 7.8 ± 1.9 % for BIC with no significant difference among groups. Discussion The results suggests that the decrease in VO<sub>2</sub> at the end of supramaximal exercise of 70 s can not be explained by middle acidosis (pH=7.13±0.01 in PLA vs 7.22±0.01 in BIC) since VO<sub>2</sub> decrease was also observed in alkalosis condition. As VO<sub>2</sub> decrease was related to a decrease in Ventilation in Pla group (r=0.71, P<0.01), muscle respiratory fatigue could be involved in this phenomenon. Indeed, subjects who presented higher VO<sub>2</sub> decrease are those with higher ventilation decrease in both conditions, but they did not present a decrease in arterial oxygen saturation compared to other subjects. If ventilatory muscle fatigue could be an important factor contributing to VO<sub>2</sub> decrease, others additional factors could be involved to explain this phenomenon, but not metabolic stress. References Perrey S, Candau R, Millet GY, Borrani F, Rouillon JD. (2002). *Int J Sports Med.* 23(4):298-304. J Physiol. 2005. 566(Pt 1):273-85. González-Alonso J, Calbet JA. *Circulation.* 2003. 107(6):824-30. Mortensen SP, Dawson EA, Yoshiga CC, Dalsgaard MK, Damsgaard R, Secher NH, González-Alonso J. (2005). Hanon C, Thomas C (2011). *J Sports Sci.* 29(9):905-12.

### IMPLICATION OF CEREBRAL DEOXYGENATION IN EXERCISE LIMITATION DURING INCREMENTAL EXERCISE

Oussaidene, K.

*université Lille2*

IMPLICATION OF CEREBRAL DEOXYGENATION IN EXERCISE LIMITATION DURING INCREMENTAL EXERCISE Oussaidene, K.1, Prieur, F.2, Bougault, V.1, Borel, B.1, Mucci, P.1 1: UDSL, EA 4488 (Ronchin, France), 2: CIAMS, EA 4532 (Paris-Sud - Orléans, France). Introduction During incremental exercise, cerebral oxygenation decreases at heavy intensities (Rupp & Perrey, 2008). This may induce an alteration of the central nervous control of motor output (Amann et al., 2006) and limit performance. Our objective was to investigate the involvement of O<sub>2</sub> availability in the brain as a limiting factor of incremental exercise by the use of hyperoxia. Methods Eight men, untrained in endurance physical activities (mean ± SD: age 27 ± 6 years, body mass 77 ± 6 kg, height 180 ± 5 cm, physical activities ≤ 3h/week, maximal oxygen consumption (VO<sub>2</sub>max = 3.49 ± 0.48 L.min<sup>-1</sup>), performed two incremental ramp exhaustive exercise (1W/3s) until volitional fatigue, on cycle ergometer, in a random order in normoxia (FIO<sub>2</sub> = 0.21) and hyperoxia (FIO<sub>2</sub> = 0.30). Cerebral oxygenation (COx) was assessed by near-infrared spectroscopy (OxyMon MKIII, Artinis) and pulmonary gas exchange and arterial hemoglobin O<sub>2</sub> saturation (SpO<sub>2</sub>) were measured. The respiratory compensation point (RCP) and the COx threshold decline (ThCOx) were determined during exercise in each subject in each condition. Results Hyperoxia improved significantly the maximal power output (Wmax: 302 ± 20 vs. 319 ± 28 W) and SpO<sub>2</sub> (95.75 ± 0.88 vs. 97.00 ± 0.53 %) compared to normoxia (P<0.05). In both conditions, COx decreases from heavy intensities (i.e > RCP) until achieving a minimal exercise level at Wmax (COxWmax). COxWmax was similar between normoxia and hyperoxia (4.73 ± 6.30 vs. 5.56 ± 4.73 μM, respectively). ThCOx decline was delayed with hyperoxia and appears for higher exercise intensities (259 ± 23 vs. 288 ± 30 W, P<0.05). This shift was significantly related to the improvement in Wmax (r = 0.71, P<0.05). Discussion In both conditions, COx decreased above RCP which is in agreement with the involvement of exercise hyperventilation in cerebral deoxygenation during exercise (Rooks et al., 2010). The significant relationship between the delay in the ThCOx decline and the Wmax improvement with hyperoxia supports a significant role of cerebral oxygenation in Wmax limitation in healthy untrained subjects. The lack of difference in COx Wmax in the two conditions suggests that a critical level of cerebral oxygenation was achieved at the end of exercise. References Amann M, Eldridge MW, Lovering AT, Stickland MK, Pegelow DF, Dempsey JA. (2006). *J Physiol.* 575, 937-952. Rupp T, & Perrey S. (2008). *Eur J Appl Physiol.* 102, 153-163. Rooks CR, Thom NJ, McCully KK, Dishman RK. (2010). *Progress Neurobiol.* 92, 134-150.

### IMPACT OF EXERCISE DURATION, INTENSITY AND EQUICALORIC ENERGY EXPENDITURE ON EXCESS POST-EXERCISE OXYGEN CONSUMPTION IN ADOLESCENT BOYS.

Serresse, O., Herbert, M.

*Université Laurentienne*

Introduction Whether exercises can modify the magnitude of EPOC remains a controversial subject. The purpose of this study is to describe the effects of exercise duration, intensity and energy expenditure on oxygen consumption, energy expenditure (EE) and fat oxidation (FO) during a 90min post exercise recovery period (PERP). Methods Ten adolescent boys were tested on four different occasions. On day 1, resting metabolic rate, anthropometric data and maximal oxygen consumption (VO<sub>2</sub>max) were measured. EE, metabolic response and FO from three different ergocycle exercise conditions (Cond) were investigated [(Cond1; 50% of VO<sub>2</sub>max for 30 min), (Cond2; 50% of VO<sub>2</sub>max for 60 min) and (Cond3; high intensity equicaloric as Cond2)]. Cond1 and 2 were randomly assigned. After all three conditions, EPOC, EE and FO were analysed during 90 minutes. Results No differences were observed between Cond1 and 3 for duration and Cond2 and 3 for EE during exercise. Energy expenditure during PERP were similar between the conditions (Cond1; 680kJ, Cond2; 687kJ, Cond3; 777kJ). Despite no differences in oxygen consumption and EE, energy from FO was significantly higher in Cond3 compared to Cond1 and 2. The total amounts of EE, during Cond2 and Cond3 and the PERP were significantly greater than Cond1 (Cond1; 1780KJ, Cond2; 2892KJ and Cond3; 3050KJ), but only the energy from FO during Cond2 was significantly higher than Cond1 and Cond3 (Cond1; 648KJ, Cond2; 996KJ and Cond3; 688KJ). Discussion Low intensity (LI) and High intensity (HI) equicaloric exercise did not significantly affect EE during 90min PERP and these results are in agreement with previous studies on 60min (Lazzer, et al., 2010) and on 24-h (Melanson, et al., 2002, Saris, et al., 2004) post-exercise EE. Longer duration and same intensity did not affect the EE post-exercise as reported by others (Lyons, et al., 2006, Warren, et al., 2009). The effects of intensity and duration on substrate oxidation are particularly relevant and important for obesity treatment. Contrary to Melanson et al. (2002) and Lazzer et al. (2010), FO post-exercise was found to be higher in HI when matching for exercise EE. When matching for intensity, the duration seems to have no effect on FO post-exercise. Total FO (exercise plus PERP) seems to be better during LI and long duration exercise. Consequently, it is wise to encourage LI and long duration exercises which enhance FO rates. References Lazzer, S., et al. (2010). *Eur J Appl Physiol.* 108, 383-91. Melanson, E. L., et al. (2002). *J Appl Physiol.* 92, 1045-52. Saris, W. H., et al. (2004). *Int J Obes Relat Metab Disord.* 28, 759-65. Lyons, S., et al. (2006). *Appl Physiol Nutr Metab.* 31, 196-201. Warren, A., et al. (2009). *Int J Sport Nutr Exerc Metab.* 19, 607-23.

09:50 - 11:20

## Invited symposia

## IS-PM14 The Athletes Paradox Revisited: Athletic Lessons for Diabetic People (\*)

**EXERCISE INTERVENTIONS TO ENHANCE INTRAMUSCULAR LIPID METABOLISM AND INSULIN SENSITIVITY**

Shaw, C.S.

*Victoria University*

Intramuscular lipids (IMCL) are stored in discrete lipid droplets within the cytosol of skeletal muscle fibres. Imaging techniques have demonstrated that IMCL concentrations are 2-3-fold greater in type I muscle fibres and that lipid droplet morphology, localization and interaction with related proteins and organelles can change depending upon physical activity. Elevated IMCL concentrations in sedentary individuals are associated with impairments in insulin signal transduction and impaired glucose homeostasis. On the other hand, in endurance-trained individuals who are highly insulin sensitive, IMCL concentrations are also elevated and contribute significantly to fatty acid oxidation during exercise. At present, the exact mechanistic link between lipid accumulation and insulin resistance is unclear, although it is likely related to elevated concentrations of specific lipid metabolites rather than total IMCL concentrations. The improvements in oxidative capacity following endurance training permit improvements in IMCL oxidation during exercise and the regular depletion of the IMCL pool results in enhanced rates of intramuscular triglyceride synthesis. Recent evidence suggests that an improvement in this turnover of the IMCL pool is likely to reduce the concentrations of certain lipid metabolites and mediate the improvement in insulin action in skeletal muscle with regular exercise. In support of this hypothesis, endurance-type exercise training in insulin sensitive individuals and obese type 2 diabetes patients, results in increased IMCL storage alongside enhanced oxidative capacity and improvements in glycemic control. These adaptations are associated with increased IMCL oxidation during exercise specifically in type I muscle fibres. Furthermore, an increase in the expression of the lipid droplet-related proteins, perilipin 2 and perilipin 5, may be important in the observed improvements in IMCL metabolism. Such adaptations are not restricted to endurance-type activities. Recent data from our lab demonstrate that high intensity interval training induces comparable improvements in oxidative capacity and insulin sensitivity to endurance exercise, in addition to increases in IMCL content, perilipin protein expression and IMCL oxidation. These findings add to the growing evidence in support of high intensity interval training as an effective means to improve muscle insulin sensitivity. Furthermore, recent data from our lab provide evidence that the well described insulin sensitizing effect of resistance training may also be mediated in part by improvements in IMCL metabolism. Ongoing investigations will further our understanding of lipid droplet metabolism in skeletal muscle and its role in determining skeletal muscle insulin sensitivity.

**MYOCELLULAR LIPID DROPLET COAT PROTEINS IN TRAINED AND UNTRAINED SUBJECTS IN RELATION TO FAT OXIDATIVE CAPACITY AND INSULIN SENSITIVITY**

Hesselink, M.

*Maastricht University*

Storage of fat in myocellular lipid droplets has long been considered an inert resultant of spill-over of fatty acids from adipose tissue, originating from limited expandability of the adipose tissue or derangements in adipose tissue lipolysis. Nowadays, lipid droplets are considered active organelles involved in maintenance of cellular function. Fatty-acids released from myocellular lipid droplets serve at least 3 distinct processes, most of which are related to fat metabolism and maintenance of oxidative capacity: phospholipid synthesis, fuelling oxidative energy metabolism and signalling to PPAR responsive genes. Thus, aberrations in lipid droplet synthesis and degradation (jointly referred to as lipid droplet dynamics) are likely to affect myocellular function. Multiple proteins coating the lipid droplet, like proteins from the PAT family, lipases and (co)activators of these lipases are determinants of lipid droplet dynamics, which in turn is an important determinant of cellular mitochondrial function. Lack of lipolytic activity in ectopic tissues profoundly impedes (myo)cellular and mitochondrial function. In mice lacking the major triglyceride lipase ATGL, the negative effects of ATGL ablation can be circumvented by administration of a PPAR agonist. Testing this concept in 2 patients with mutations in the ATGL gene revealed important information on the role of lipid droplet lipolysis in muscle oxidative capacity. In a series of cell, animal and human experiments we have monitored basal levels of these proteins in healthy young subjects, trained athletes, obese normoglycemic subjects and obese type 2 diabetic subjects. In the latter 2 populations we have examined the effect of endurance training on these proteins. Of particular interest in this respect is the role of the lipid droplet coat protein OXPAT/PLIN5. We unmasked PLIN5 as a protein also present at interaction sites of lipid droplets and mitochondria. This observation was recently linked to the mitochondrial fusion protein OPA1. Thus, we studied if modulation of PLIN5 content affected OPA1 and interaction of mitochondria with LD. We observed that overexpression of PLIN5 in rats resulted in a near significant increase in OPA1 and a higher tolerance of mitochondria for fatty acids before lipotoxicity evolves. We are currently investigating if similar mechanisms also operate in human skeletal muscle upon training. Jointly, these studies indicate that a tight interplay of proteins involved in lipid droplet dynamics contributes to maintenance of muscle mitochondrial function and may partly explain the phenomenon referred to as the athlete's paradox.

**THE EFFECTS OF CHRONIC EXERCISE TRAINING REVEAL MECHANISTIC INSIGHTS INTO THE PATHOPHYSIOLOGY OF OBESITY AND TYPE 2 DIABETES**

Amati, F.

*University of Lausanne*

Skeletal muscle insulin resistance (IR) is associated with obesity and physical activity, and is crucial for the development of type 2 diabetes. The causes of insulin resistance within muscle are not known. One of the hypotheses being explored to explain the mechanisms by which obesity leads to IR is lipotoxicity. Also known as the lipid metabolite theory, lipotoxicity happens when fatty acid spillover in excess of the oxidative needs into harmful pathways of nonoxidative metabolism. Concerted efforts have been made of the past several years to understand the potential role of intramyocellular lipids (IMCL) accumulation in the development of IR. Multiple human studies confirmed the inverse association between IMCL and insulin sensitivity. However, this inverse association between IMCL and IR is not observed in



chronic exercise training and/or conditions for efficient fatty acid utilization. Chronic exercise has been shown to increase IMCL in parallel with improved IR, thus leading to a paradigm, known as the 'athlete paradox' where IMCL accumulation per se does not directly affect insulin action but where this negative effect appears to be linked with non utilization of the fatty acid reservoir and with the accumulation of metabolically active lipid intermediates. Among others, diacylglycerol (DAG) have been largely implicated in cellular and animal studies. In cross-sectional and intervention studies, we measured comprehensive profiles of distinct molecular species of DAG in skeletal muscle of obese, normal weight and athletic human subjects. Total DAG content was higher in athletes and was positively associated with insulin sensitivity. Furthermore, dissaturated DAG were significantly lower in highly insulin sensitive athletes compared to their insulin resistant counterpart. Our results, in accord with other recent studies, point to the fact that some DAG moieties are particularly abundant in human skeletal muscle: C16:0/C18:0, C16:0/C18:1 and Di-C18:0. Summed together, these three DAG species account approximately for 80% of total DAG. These results suggests that it is not the overall content of DAG that may be deleterious but that particular DAG moieties, even in smaller amounts, may carry the lipotoxic effect. Thus, DAG content in chronically exercised insulin sensitive muscle may represents another athlete paradox.

09:50 - 11:20

## Oral presentations

### OP-SH11 Physical Education and pedagogics 2

#### QUALITATIVE ANALYSIS OF THE INTERACTIVE DECISIONS OF THREE COACHES INVOLVED IN A "START TO RUN" SESSION

Cloes, M., Dethioux, S.

*University of Liege*

**Introduction** A growing number of programs are implemented to enable a smooth resumption of physical activity. "Start to run" is a running program promoted by the athletics federation that has gained a great notoriety in Belgium. It proposes sessions of 10 weeks during which participants are trained to run 5 km without stop (10 km for those who are not beginners). No data seems to be available about the coaching process in this specific context of active leisure. The purpose of this study was to enlarge knowledge on this topic. **Methods** Based on the principles of the qualitative research, we analyzed three sites: three groups involved in a Start to run session in different communities of the Liege's area (Wallonia, Belgium). In all sites, data were collected before, during, at the end and 12 weeks after the session. They provided information on the context as well as on the process (coaches and participants behaviors and perceptions), and participants' achievement and maintenance. In this paper, we will focus our analysis on the interactive decisions of the coaches. It will be based on the observation of three lessons in each site (2d, 5th and 8th weeks): one of the authors attended to the training session as participant observer. Moreover, we will also use data collected through interviews (description of the organization and content of the program) and questionnaires (feelings about the lessons). Participants were also requested to provide their perceptions about the lessons. As evidenced above, the validity of the analysis is guaranteed by the triangulation of the data. **Results** The three coaches described a similar teaching model but only subject #2 pointed out technical drills. Only subject #3 respected the "official" program developed by the athletics federation. The two other adapted it according to their experience and purposes of their groups. All of them considered that they were providing enough feedback and were active. On the other hand, they thought themselves as needing to encourage more and to be more effective in group management. Globally, participants confirmed the opinions of their respective coaches but they seemed more critical in group #3, showing a lower satisfaction about the motivational behaviors and feedback. The observation pointed out some problems in the clarity of the explanations (subject #1) and some divergences were reported with the actors. **Discussion** The triangulation of the data allows us to consider that the three coaches are doing a very good job and adapt themselves to the expectations and needs of the participants. The identification of the positive and negative aspects in each subject provides a basis to propose some recommendations. Moreover, we pointed out that encouraged to speak about their own teaching process, all coaches modified spontaneously their interactive decisions during the study. This underlines the interest of this systematic analysis in leisure physical activity as well as in other educational contexts.

#### DOES PERCEIVED SPORT COMPETENCE INFLUENCE PHYSICAL ACTIVITY ENJOYMENT?

Nart, A.I, Scarpa, S.2, Biancalana, V.1

*1: UNIURB (Urbino, Italy), 2: UNIPD (Padua, Italy)*

**Introduction** In the sport and physical activity (PA) field, enjoyment is a positive affective response to the sport experience (Scanlan & Simons, 1992) and it can also be considered an important factor in promoting active lifestyles and regular PA among school-aged children (Carraro et al., 2008). The aim of the present study was to investigate the effects of perceived sport competence on PA enjoyment. **Methods** Participants were 394 pupils (173 boys and 221 girls) aged between 12 and 13 years ( $M=12.2$ ). The Physical Self-Description Questionnaire-Short (PSDQ-S; Marsh et al., 1994) and the Physical Activity Enjoyment Scale (PACES; Carraro et al., 2008) were completed. Pearson's correlation test was used to measure the association between variables. Multiple linear regression analysis was conducted to investigate the correlation between PSDQ-S scores (independent variables) and PACES total score (dependent variable). **Results** Pearson's correlation test revealed the following positive associations between PSDQ-S variables and PACES total score: endurance ( $r = .527, p < .001$ ); flexibility ( $r = .206, p < .001$ ); strength ( $r = .365, p < .001$ ); coordination ( $r = .427, p < .001$ ); sport skill ( $r = .546, p < .001$ ). Multiple linear regression analysis showed the following score indices:  $SE = 7.76$ ;  $t = 20.79$ ;  $R^2 = .363$ ;  $F(5, 388) = 44.13$ ;  $p < .001$ . **Discussion** Our results highlighted positive associations between physical self-concept scales and PA enjoyment, and our hypothesis that perceived sport competence can be considered a good predictor of PA enjoyment was confirmed. The results could contribute to our understanding of the processes involved in the promotion of active lifestyles and regular PA among young people. **References** Carraro A, Young M, Robazza C (2008). Social Behavior and Personality, 36, 911-918. Marsh H (1996). Journal of Sport & Exercise Psychology, 18, 111-131. Scanlan T, Simons J (1992). Champaign IL: Human Kinetics. Scarpa S, Gobbi E, Paggiaro A, Carraro A (2010). Giornale Italiano di Psicologia dello Sport, 8, 25-31.

## MOTIVATIONAL CLIMATE, ACHIEVEMENT GOALS AND STUDENTS' ATTITUDE TOWARDS PHYSICAL EDUCATION

Martins, J.1, Marques, A.1, Sarmiento, H.2, Carreiro da Costa, F.1,3

1: CIPER, Faculty of Human Kinetics, Technical University of Lisbon; 2: University of Trás-os-Montes and Alto Douro; 3: Lusophone University of Humanities and Technologies

**Introduction:** In Physical Education (PE) settings there is a lack of research on associating motivational climate and goal orientation with individuals' attitude towards PE. Therefore, this study examined the relationship of students' attitude towards PE with their perceptions of PE classes' motivation climate and their goal orientations. **Methods:** Participants were 685 PE pupils (313 male, 372 female; aged 16.9±1.1 years) of 6 public schools. Motivational climate and achievement goals (focusing on mastery, performance-approach, and performance-avoidance goals; adapted from Papaioannou et al., 2007), attitude towards PE and physical activity (PA) participation were assessed using a self-report questionnaire. A hierarchical regression analysis was performed with attitude toward PE as dependent variable and motivational climates and goals as independent variables. Significance level was  $p < 0.05$ . **Results:** In the first step the three variables of motivational climate were entered. The perception of a mastery ( $\beta = 0.201; p < 0.001$ ), performance-approach ( $\beta = 0.084; p < 0.05$ ) and performance-avoidance ( $\beta = -0.258; p < 0.001$ ) environment had a significant contribution into the equation explaining 13.9% of the total variance of students' attitude towards PE. The entry of the three variables of achievement goals in step 2 increased significantly the explained variance by 29.4%. At this step however, the contribution of mastery ( $\beta = 0.119; p < 0.001$ ) and performance-avoidance ( $\beta = -0.075; p < 0.05$ ) climate slightly decreased, and performance-approach climate was not significant anymore ( $\beta = 0.02; p > 0.05$ ), suggesting that goal orientations mediates the relationship between students' perceptions of the learning environment and their attitude toward PE. The most significant predictors for explaining the total variance of students' attitude toward PE were the three achievement goals, respectively, mastery ( $\beta = 0.427; p < 0.001$ ), performance-avoidance ( $\beta = -0.205; p < 0.001$ ) and performance-approach orientation ( $\beta = 0.142; p < 0.001$ ), followed by the perception of a mastery-oriented motivation climate. **Discussion:** These findings highlight that a strong mastery-oriented climate and a strong mastery orientation, as well as a low performance-avoidance orientation, may have positive effects on students' attitudes towards PE. Furthermore, they underline the necessity of research on causal relationship between motivational climate, achievement goals, attitude toward PE and PA participation. **References:** Papaioannou et al. (2007). *Journal of Teaching in Physical Education*, 26, 236-259. **Acknowledgments:** This study was supported by FCT.

## PSYCHOSOCIAL PROCESSES IN SPORTS AS DRIVER FOR SOCIO-EMOTIONAL DEVELOPMENT

Hilhorst, J.E.C.1,2,3, Steenbergen, B.2, Theeboom, M.1

1: Vrije Universiteit Brussel (Brussels, Belgium), 2: Radboud University Nijmegen (Nijmegen, the Netherlands), 3: Kennispraktijk (Nijmegen, the Netherlands)

**Introduction** Participation in sports can result in positive or negative behavioural outcomes for youth. Researchers increasingly stress the psychosocial processes and contextual factors in sports that may mediate socio-emotional development (Bailey, 2005; Coalter, 2007). In the present study we reviewed the literature on sports and socio-emotional development and determine the state of the art with respect to this topic. Guidelines and implications for future are subsequently provided. **Methods** First, a systematic literature search of studies on sports and social-emotional development was performed. Second, we used the PPCT model (Bronfenbrenner, 1995) in which a distinction is made between processes, personal characteristics, contextual factors and time factors, to categorize relevant mediators for the relation sports and socio-emotional development. **Results** Eighteen studies were selected and analyzed. Mediators of sports and socio-emotional development were identified and categorized to determine what kind of mediators it are and to give an overall picture of the categories. In thirteen studies were processes identified, in sixteen studies personal characteristics, in all studies contextual factors and in five studies time factors. **Discussion** The analysis showed that three clusters with psychosocial processes seem crucial for socio-emotional development in sports: player-player interaction, player-adult interaction and self-regulatory mechanisms. However, to date hardly any study has scrutinized how these processes affect the potential effects on social-emotional development of youth. Furthermore, a majority of the studies focused on the interaction between the adult sport coach and the young athlete in the context of competitive sports. Finally, none of the studies described the mutual relations between processes, personal characteristics, contextual factors and time factors. **Future research** should focus on how the three clusters with psychosocial processes in sports affect socio-emotional development, within the whole ecological approach, to make practical recommendations for enhancing sport settings that promote socio-emotional development. **References** Bailey, R. (2005). Evaluating the relationship between physical education, sport and social inclusion. *Educational Review*, 71-90. Bronfenbrenner, U. (1995). *Developmental Ecology Through Space and Time: A Future Perspective*. In P. Moen, G. J. Elder, & K. Luscher, *Examining lives in context: Perspectives on the ecology of human development* (pp. 619-647). Washington, DC: American Psychological Association. Coalter, F. (2007). *A wider social role for sport: Who's keeping the score?* London: Routledge.

## THE CONTENT OF PHYSICAL EDUCATION IN SWEDEN AND SOUTH AFRICA

Kougioumtzis, K., Patriksson, G., Toriola, A., Amusa, L.

*University of Gothenburg*

**THE CONTENT OF PHYSICAL EDUCATION IN SWEDEN AND SOUTH AFRICA** Kougioumtzis, K.1, Patriksson, G.1, Toriola, A.2, Amusa, L.3 1: GU (Gothenburg, Sweden), 2: TUT (Pretoria, South Africa), 3: VU (Thohoyandou, South Africa) **Introduction** The aim of this study is to highlight physical education (PE) content in Swedish and South African schools utilizing nation-wide stratified random samples of pupils in each country. **Methods** A questionnaire has been developed measuring health promotion, social development, personal development, as well as physical development and movement. The questionnaire was administered to pupils in primary and lower secondary school. The final sample consisted of 2.495 Swedish and 3.748 South African individuals. The answers of Swedish (SWE) and South African (SAF) pupils have been analyzed using ANOVA. **Results** In relation to health promotion, pupils' awareness of health related benefits of physical activity was higher in South Africa than in Sweden,  $MSAF = 4.28(77)$ ,  $MSWE = 3.93(98)$ ,  $F(1,6136) = 253.9$ ,  $p < .05$ . Regarding social development, South African pupils reported socialization effects connected to PE to a higher degree than Swedish pupils did,  $MSAF = 4.18(.98)$ ,  $MSWE = 3.74(.92)$ ,  $F(1,6092) = 307.0$ ,  $p < .05$ . In terms of personal development, Swedish pupils reported a more positive climate during PE classes than South African pupils did,  $MSWE = 3.73(.94)$ ,  $MSAF = 3.67(1.15)$ ,  $F(1,6093) = 4.7$ ,  $p < .05$ . As far as physical development and movement are concerned, Swedish pupils reported that they enjoy a spectrum of physical activities that was broader than that reported by South African pupils,  $MSWE = 3.44(1.00)$ ,  $MSAF = 3.22(.92)$ ,  $F(1,6138) = 79.9$ ,  $p < .05$ . **Discussion** Health promotion and social development are characterizing PE content in South Africa to a higher degree than in Sweden. This is in line with the fact that South African PE is part of the Life Orientation learning area (Van Deventer, 2009). On the contrary, personal development as well as physical development and movement are more evident in Swedish than in South African schools. This is in line with the strong connections between PE and physical

activity in Sweden as well as the distinct efforts to empower pupils on the basis of their own capabilities and aspirations. References Toriola A, Patriksson G, Amusa L, Kougioumzis K (2010). *AJPERD*, 16, 327-345. Van Deventer K, (2009). *SAJE*, 29, 127-145.

### EFFECTIVENESS OF DUTCH SPECIAL SECONDARY SPORTS SCHOOLS

Hakkers, S.

*Mulier Institute*

**EFFECTIVENESS OF DUTCH SPECIAL SECONDARY SPORTS SCHOOLS** Authors: Stephan Hakkers, Niels Reijgersberg, Agnes Elling & Fleur van Rens (Mulier Institute, Utrecht) Contact: s.hakkers@mulierinstituut.nl Introduction Combining school and sport is difficult for many aspiring elite athletes, especially since elite sporting demands have increased over the past decades due to international developments. In most sports talented athletes are expected to train many hours a week from an early age. However, only a few sports talents will become actual elite athletes, of whom most also need to find a job after their sports careers ended. Therefore, it is important that talented athletes are given the opportunity to attain a level of secondary education which reflects their cognitive abilities. In order to maximize performance development of aspiring athletes both in sports and education, the first Topsport Talentschools (TTS) were founded in the Netherlands in 1991, similar to the international development of Elite Schools of Sport (Radtke & Coalter, 2007). Only those schools in the Netherlands have ministerial consent to grant exemptions to sport talented students. Given that the majority of talented athletes does not attend TTS but mainstream schools (Reijgersberg et al., 2010) – that also might offer support in optimizing the school-sport balance –, it is interesting to gain insight in the effectiveness of TTS. The purpose of this article is therefore to investigate whether attending a TTS indeed leads to the intended positive effects of optimizing achievements in sports (flow of sports talent to high-level athlete) and education (highest feasible degree in education)? Methods We conducted a retrospective study amongst young people who were identified as talents during the years 2004-2008 by seven selected national sports federations with a substantial number of talents attending TTS and having sufficient contact informations of former talents. The (former) talents received an invitation letter from their federation to participate in an online survey, for which they received a login code. The questionnaire contained questions about socio-demographic characteristics, school career, sports career, motivation, school facilities and satisfaction. Apart from former talents, current sports talents were also invited to participate in this study. They received a similar online questionnaire with more focus on the current forms of support they received from schools and their degree of satisfaction to combine sports and education. A total of 407 retrospective and 478 sport talents have completed the digital questionnaire. Results The preliminary results show that there are hardly differences in the sports and educational careers of former talents attending either a TTS or mainstream secondary school, when controlled for other possible influencing variables, like hours of training, age when identified as talents and sports/school motivation. TTS talents however, were regarded as necessary for those talents with high training demands at an early age and they also appear to be more satisfied with balancing school and sport during adolescence. References Reijgersberg, N., Gijsbers, M. & Elling, A. (2010). Dromen van de Top. Over investeringen van(ex-) status talenten en de invloed van topsportbeoefening op hun leven, 's-Hertogenbosch:W.J.H. Mulier Instituut. Radtke, S. & Coalter, F. (2007) Elite Sports Schools: An International review on policies and practices. Stirling: University of Stirling.

**09:50 - 11:20**

## Oral presentations

### OP-PM50 Sports Medicine 3

#### **PRESSURE PAIN MAPPING FOR THE INVESTIGATION OF MECHANICAL SENSITIVITY AMONG ELITE MALE FOOTBALL PLAYERS. EFFECTS OF TURF TYPE**

Domínguez-Marfín, M.A.1, López-Ruiz, F.1, Reyes-López, M.V.1, Valenza, G.1, Fernández-de-las-Penas, C.2,3, Madeleine, P.3

1: Universidad de Granada (Granada, Spain), 2: Universidad Rey Juan Carlos (Madrid, Spain) 3: Aalborg University (Aalborg, Denmark)

**Introduction** Differences in muscle restitution between artificial turf and natural grass could induce muscle fatigue and, hence increase the risk of injury among football players (Ekstrand et al., 2010). The mechanical sensitivity of muscle is changed in response to strenuous physical activity or training (Kawczynski et al. 2012). Thus, studies investigating deep structures sensitivity can be helpful to delineate differences among pitch surfaces. In this study, we investigated if artificial grass compared with natural grass would affect the pressure pain maps of the lower extremity in elite football players. **Methods** A total of 16 football players (mean age +/- SD: 22 +/- 2 years) for artificial turf and 13 football players (age: 22 +/- 3 years) for natural grass participated. Pressure pain thresholds (PPT) were measured bilaterally over 23 locations of the lower extremity, including the rectus femoris, tensor fasciae latae, vastus lateralis/medialis; external and internal hamstrings; tibialis anterior; peroneous; external and internal gastrocnemius, and soleus muscles, in a blinded design. **Results** The ANOVA detected significant differences in PPT between groups and measurement points ( $P < 0.001$ ), but not between sides ( $P = 0.804$ ). Football players playing on natural grass exhibited lower PPT as compared to those players playing on artificial turf ( $P < 0.05$ ). In addition, PPT over vastus medialis muscle was the lowest one (most sensitive) and significantly lower than PPT levels over the rectus femoris, external and internal hamstrings, tibialis anterior; peroneous, external and internal gastrocnemius, and soleus muscles ( $P < 0.01$ ); whereas PPT over the rectus femoris was the highest one (least sensitive) and significantly higher than PPT levels vastus lateralis and medialis, tibialis anterior, peroneous; external/internal gastrocnemius, and soleus muscles ( $P < 0.01$ ). **Discussion** We showed the ability of topographical mapping of pressure sensitivity to reveal heterogeneous distribution of mechanical sensitivity among football players in relation to turf type. The higher PPT levels found among elite male football players on artificial turf compared with natural grass underlining decreased mechanical pain sensitivity could be considered as a positive trend in agreement with (Ekstrand et al., 2010). However, such differences may also have adverse effects, i.e. less efficient protective mechanism and prospective studies are needed to confirm our findings. References Ekstrand J, Häggglund M, Fuller CW (2010). *Scand J Med Sci Sports*, doi: 10.1111/j.1600-0838.2010.01118.x. Kawczynski A, Samani A, Fernández-de-las-Peñas C, Chmura J, Madeleine P. (2011). *J Strength Cond Res*, doi: 10.1519/JSC.0b013e318234e589.

## THE RELATIONSHIP BETWEEN LUMBOPELVIC MOTOR CONTROL AND TWO-DIMENSIONAL VIDEO ANALYSIS OF THE VERTICAL JUMP IN ELITE FEMALE ATHLETES

Dingenen, B., Malfait, B., Verschueren, S., Staes, F.

*KU Leuven*

**Introduction** Screening athletes to assess lower extremity injury risk has become a hot topic in research and clinical practice. Functional tests, such as the drop vertical jump (DVJ) test, are recommended to evaluate lower extremity movement quality as poor dynamic alignment is believed to be associated with an increased injury risk. Two-dimensional (2D) video analysis is a valid and reliable method to assess this movement quality (Munro et al., 2011). The inability to properly perform functional tasks can be related to multiple factors within the kinetic chain. An impaired lumbopelvic motor control (LPMC) is suggested to lead to compensatory movements of the lower extremity, resulting in injuries. However, the relation between clinical LPMC tests and quality of movement, analyzed with a 2D video analysis method, has not yet been established. **Methods** A total of 63 elite female athletes (35 soccer, 16 handball and 12 volleyball) who were injury- and pain free were tested. Hip flexion (HF), knee valgus (KV), knee flexion (KF) and ankle dorsiflexion (ADF) angles were measured during the deepest landing phase of the DVJ test. LPMC was evaluated by a set of 6 tests, described by Luomajoki et al. (Luomajoki et al., 2007). Correlations between the 2D angles and the LPMC tests were calculated with the Spearman rank test. Results In the soccer players, KV of the dominant leg ( $r=-0.243$ ) and non-dominant leg ( $r=-0.012$ ), HF ( $r=-0.142$ ) and KF ( $r=0.006$ ) were not significantly correlated, but ADF ( $r=0.369$ ;  $p=0.029$ ) was significantly correlated with the LPMC tests. In the handball players, KV of the dominant leg ( $r=-0.250$ ) and non-dominant leg ( $r=-0.025$ ), HF ( $r=0.031$ ), KF ( $r=0.033$ ) and ADF ( $r=-0.042$ ) were not significantly correlated with the LPMC tests. In the volleyball players, KV of the dominant leg ( $r=-0.379$ ) and non-dominant leg ( $r=-0.350$ ), KF ( $r=0.412$ ) and ADF ( $r=0.206$ ) were not significantly correlated, but HF ( $r=0.589$ ;  $p=0.044$ ) was significantly correlated with the LPMC tests. **Discussion** The findings of the present study show that less ADF in soccer players and less HF in volleyball players are significantly associated with decreased LPMC. Furthermore, there is a non-significant trend that more KV and less KF in volleyball players are associated with decreased LPMC. The high number of non-significant correlations suggests that the quality of movement during the DVJ test is also related to other factors than low load LPMC. Furthermore, a differentiation between sports is warranted. **References** Luomajoki H, Kool J, de Bruin ED, Airaksinen O. (2007). *BMC Musculoskeletal Disord*, 8, 90. Munro A, Herrington L, Carolan M. (2012). *J Sport Rehabil*, 21, 7-11.

## NEUROMECHANICAL PROFILES OF THE TRICEPS SURAE MUSCLE-TENDON UNIT IN ATHLETES WITH AN ACHILLES REPAIR

Wang, H.K., Chiang, H., Lin, K.H., Chen, W.S., Shih, T.F., Huang, Y.C., Jiang, C.C.

*School and Graduate Institute of Physical Therapy, College of Medicine, National Taiwan University*

**Introduction** We compared the neuromechanical and functional characteristics of the legs of athletes with unilateral Achilles tendon repair at different postsurgery intervals and to determine any correlation between the characteristics. **Methods** There were 10, 8, and 8 athletes recruited into 3 groups:  $\geq 3$  and  $< 6$ ,  $\geq 6$  and  $< 9$ ,  $\geq 9$  and  $< 12$  months postsurgery, respectively [mean ( $\pm$ SD) age: 33.7 (4.5) years]. Bilateral measurements of activation strategy involving the triceps surae and tibialis anterior muscles and mechanical properties of the Achilles tendon and lower-extremity function were conducted. **Results** Compared to athletes in the other groups, results of those with repaired legs  $\geq 3$  and  $< 6$  months postsurgery showed lower activation (EMG and activation level) and altered antagonist coactivation (EMG ratio), less tendon stiffness, shorter hopping distance, and lower balance score ( $p < 0.015$ ). Compared to the controls, the repaired leg showed lower activation and antagonist co-activation in fast contractions, less tendon stiffness, greater tendon hysteresis, lower rate of force development, plantarflexion torques, active dorsiflexion range, shorter hopping distance, and lower balance score ( $p < 0.015$ ). Correlations between the neuromechanical profiles and performances were found ( $p < 0.05$ ). **Discussion** This study, performed on athletes after an Achilles repair, concluded bilateral and various neuromechanical deficits in the triceps surae muscle-tendon unit, including activation strategies and tendon mechanical properties, as well as performance reduction in the repaired and control legs within 1 year of surgery (Aagaard et al., 2002; Maffiuletti et al., 2002). Correlations between neuromechanical profiles and functional performance in these athletes indicate a requirement of 6 months of rehabilitation in athletes after Achilles repairs. **References:** Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P. (2002). *J Appl Physiol*, 93, 1318-1326. Maffiuletti NA, Pensini M, Martin A. (2002). *J Appl Physiol*, 2002, 92, 1383-1392.

## REDUCED POSTOPERATIVE PHYSICAL ACTIVITY OF CHILDREN WITH CONGENITAL HEART DISEASES

Reiner, N.1, Hess, J.2, Oberhoffer, R.1,2

*Technische Universität München (1), Klinik für Kinderkardiologie und angeborene Herzfehler - Deutsches Herzzentrum München (2)*

**BACKGROUND:** Children with congenital heart disease (CHD) have a reduced exercise capacity. Studies suggest that prolonged hospitalization might contribute to deconditioning in exercise capacity. This study examined the postoperative physical activity among children with CHD after a hospital stay. **PATIENTS and METHODS:** 34 children and adolescents with CHD (21 girls, 8.0 years [IQ: 6.0-11.0 years]) after open heart surgery or catheter intervention were included into the study. Directly after being discharged from hospital their physical activity was assessed with a GT3X accelerometer over the next consecutive 7 days. **RESULTS:** Physical activity was reduced to 58.5 minutes (IQ: 35-123 minutes) of at least moderate activity per day. Only the half of the examined children meet the actual guidelines of one hour of moderate to vigorous activity a day. There were no gender specific differences ( $p=.362$ ). There are differences between the various degrees of severity of congenital heart defects, but not significant ( $p=.784$ ) **CONCLUSION:** Children with CHD have a reduced physical activity after hospital discharge. Outpatient rehabilitation programs to increase physical activity should be aspired after hospital stay to prevent further deconditioning.

## GENERALIZED PREDICTION EQUATIONS FOR REGIONAL LEAN MASS IN PHYSICALLY ACTIVE ADULTS

Scafoglieri, A., Tresignie, J., Probyn, S., Marfell-Jones, M., Reilly, T., Bautmans, I., Clarys, J.P.

*Vrije Universiteit Brussel*

**Introduction** The ability to accurately estimate regional lean tissue masses in vivo is very important for applied and clinical applications such as muscle distribution and energy metabolism (Gallagher and Heymsfield, 1998; Müller et al., 2001). In literature, there is a limited number of anthropometry-based prediction equations for the estimation of regional lean tissue masses in adults (Arthurs and Andrews, 2009; Ritchie and Davidson, 2007; Holmes et al., 2005). Since it remains unknown whether anthropometry can be used to accurately

estimate lean tissue mass in all body regions, the aim of the present study was to develop and cross-validate anthropometrical prediction equations for regional lean tissue mass. Methods One hundred and seventeen physically active Caucasians (67 men and 50 women; mean age: 31.9±10.0y; BMI: 24.3±3.2kg/m<sup>2</sup>; sporting activities: 5.4±4.6hours/week) participated in the present study. Body mass (BM), stretch stature (SS), 14 circumferences (CC), 13 skinfolds (SF) and 4 bone breadths (BB) were used as anthropometric measurements. Regional lean tissue mass of both arms, trunk and both legs were measured by dual energy X-ray absorptiometry (DXA) as the criterion method. Results Three generalized prediction equations for regional lean mass were developed as follows: arms = 40.394(BM) + 169.836(CC arm-tensed) + 399.162(CC wrist) - 85.414(SF triceps) - 39.790(SF biceps) - 7289.190, where Adj.R<sup>2</sup>=0.97, p<0.001, and SEE=355g; trunk = 181.530(BM) + 155.037(SS) + 534.818(CC neck) + 175.638(CC chest) - 88.359(SF chest) - 147.232(SF supraspinale) - 46522.165, where Adj.R<sup>2</sup>=0.97, p<0.001, and SEE=1077g; and legs = 55.838(BM) + 88.356(SS) + 235.579(CC mid-thigh) + 278.595(CC calf) + 288.984(CC ankle) - 84.954(SF front-thigh) - 53.009(SF medial calf) - 28522.241, where Adj.R<sup>2</sup>=0.96, p<0.001, and SEE=724g. Cross-validation statistics showed no significant differences (p<0.05) between observed and predicted regional lean tissue mass. Root mean squared errors were smallest for arms (362g), followed by legs (820g) and trunk (1477g). Discussion The proposed anthropometric prediction equations can be used to safely and easily estimate regional lean tissue mass of the extremities and the trunk in groups of physically active adults, but estimation errors of 8 to 14% can occur in certain individuals. It needs to be reminded that DXA cannot distinguish between skeletal muscle and non-skeletal lean components such as skin, connective tissue and organs. Therefore conversion from lean mass to muscle mass is susceptible to significant error because we are dealing with two different models (Clarys et al., 2010). References Arthurs KL, Andrews DM (2009). *J Biomech*, 42, 389-394. Clarys JP et al. (2010). *Obesity*, 18, 1477-1485. Gallagher D, Heymsfield SB (1998). *Appl Radiat Isot*, 49, 733-734. Holmes JD et al. (2005). *J Appl Biomech*, 21, 371-382. Müller MJ et al. (2001). *Eur J Nutr*, 40, 93-97. Ritchie CB, Davidson RT (2007). *Nutr Metab*, 4, 29.

### THE EFFECT OF HORMONAL FLUCTUATION ON GROSS AND FINE MOTOR COMPETENCE

Ghani Zadeh Hesar, N.1,2, Witvrouw, E.1, Peersman, W.1, Roosen, P.1, Van Ginckel, A.1,3, Braems, G.4, Lenoir, M.1

1: *UGent (Belgium)*, 2: *Urmia University (Iran)*, 3: *FWO (Belgium)*, 4: *UZ Gent (Belgium)*

Introduction The hormonal variation during the menstrual cycle (MC) influences neurological function, motor skill and joint laxity (Hampson and Kimura, 1988; Park et al., 2009). These seem to support the notion that hormonal changes affect motor coordination by means of a central and peripheral mechanism. But, the exact mechanisms behind changes of neuromuscular function during the MC are not yet known. Methods Twenty healthy adult females with no use of any forms of hormonal contraceptive participated. Gross and fine motor competence, body balance, and joint position sense (JPS), were evaluated by the Körperkoordinationstest für Kinder (KTK), the Bruininks-Oseretsky test (BOTMP), Neurocom balance master (NBM) and Biodex 2 isokinetic dynamometer respectively. Blood samples were analyzed for estradiol and progesterone levels in three phases of the MC: menstrual phase (MP), follicular phase (FP), and luteal phase (LP). Results The jumping sideways (JS) test of KTK showed significantly better performance in the LP compared to the FP (P=0.014). Forward lunge (FL) scores of NBM were significantly better in the LP as compared to the FP. A tendency toward shorter contact time, greater impact index and better force impulse was detected during the LP. The results showed no significant differences for the BOTMP and JPS tests between the three phases of the MC. Discussion In the JS test, the subjects performed significantly better performance in the LP compared to the FP. In accordance, Friden et al. (2006) showed better performance in fast jumping tasks when estradiol level was high. In both leg, the force impulse was smaller for the LP than the FP indicating that in the LP subjects performed less work overall. In this study, functional ability of the lower extremities during the LP and greater stability of the knee joint at the LP on the JS test was corroborated by a decreased knee laxity in the luteal compared with the other phases in study of Park et al. (2009). In accordance with Abt et al. (2007) the results showed no differences between the three phases of the MC for fine motor coordination. The findings suggest that ovarian hormones play some role in gross motor competence via central and peripheral mechanism but not on fine motor competence. References Abt JP, Sell TC, Laudner KG, McCrory JL, Loucks TL, Berga SL, Lephart SM. (2007). *Knee Surg Sports Traumatol Arthrosc*, 15, 901-907. Friden C, Hirschberg AL, Saartok T, Renstrom P. (2006). *Knee Surg Sports Traumatol Arthrosc*, 14, 383-389. Hampson E, Kimura D. (1988). *Behav Neurosci*, 102, 456-459. Park SK, Stefanyshyn DJ, Ramage B, Hart DA, Ronsky JL. (2009). *Br J Sports Med*, 43, 174-179.

09:50 - 11:20

## Oral presentations

### OP-PM51 Training, testing and health

#### HIGH AND LOW LEVEL OF FLEXIBILITY IS NOT A PREDICTOR FOR SPEED AND EXPLOSIVENESS PERFORMANCE IN PROFESSIONAL SOCCER PLAYERS

Hadjicharalambous, M.1, Christou, M.1,2

1: *University of Nicosia (Nicosia, Cyprus)*, 2: *University of Cyprus (Nicosia, Cyprus)*

Introduction Flexibility has been considered to be an essential element of daily training programs in several sports (Magnusson and Restroom, 2006). It was suggested that increasing flexibility may contribute in improving exercise performance and preventing from injuries (Smith, 1994). However, no studies so far evaluated whether poor or good flexibility may influence fitness parameters in elite soccer-players. The purpose of the present study was to examine the effect of lower back and hamstrings' flexibility on several fitness parameters in elite soccer players. Methods Ninety four professional soccer players were initially evaluated, but, only seventy one (mean±SD) met the cut-off criteria and were included into the statistical analysis. These 71 players were separated into two groups based on their sit-and-reach flexibility score. The players whose reach score was less than 22cm developed the low-flexibility (low-Flex) group (n=28); and those whose reach score was above 28cm were included into the high-flexibility (high-Flex) group (n=43). A comparison between the two groups was performed following a series of anthropometric and fitness parameters evaluations. Results Sit-and-reach flexibility was significantly higher (p=0.0001) in high-Flex (31.4±3) compared with the low-Flex (17.4±6) group. No significant differences were observed on age, height, weight, body fat%, on several countermovement jumps and on 10 and 30 meters maximum speeds (p>0.05). Peak oxygen consumption (VO<sub>2peak</sub>) was significantly higher (p=0.004) in the high-Flex (56.03±3.2

ml/kg/min) compared with the low-Flex ( $VO_{2peak}$ : 53.87 $\pm$ 3.1 ml/kg/min) group. No statistical significant correlations were observed between flexibility score and any other depended variable measured in both groups. Discussion In conclusion, high level of sit-and-reach flexibility may contribute in enhancing aerobic capacity and/or low levels of sit-and-reach flexibility may diminish running economy in professional soccer players; but the exact mechanism responsible for this result still needs to be determined. However, neither high nor low levels of sit-and-reach flexibility should be considered as a limiting factor in speed and explosiveness performance but poor lower back and hamstrings' flexibility might be a limiting factor in achieving high endurance performance in soccer. References Magnusson P, Restroom P. (2006). The European College of Sports Sciences Position statement: The role of stretching exercises in sports. *European J Sports Science*, 6(2), 87-91. Smith CA. (1994). The warm-up procedure: to stretch or not to stretch. A brief review. *J Orthop Sports Phys Ther* 19, 12-17.

## **INLUENCE OF HEALTH STATUS, PHYSICAL ACTIVITY AND FITNESS IN AUTONOMY OF COMMUNITY-DWELLING OLD ADULTS OVER A FIVE YEAR PERIOD**

Pereira, C., Rebocho, L., Baptista, F.

*University of Évora*

INLUENCE OF HEALTH STATUS, PHYSICAL ACTIVITY AND FITNESS IN AUTONOMY OF COMMUNITY-DWELLING OLD ADULTS OVER A FIVE YEAR PERIOD Catarina L. Pereira<sup>1</sup>, Lurdes Rebocho<sup>2</sup>, Fátima Baptista<sup>2</sup>, <sup>1</sup>Department of Sports and Health, University of Évora, Portugal. <sup>2</sup>Exercise and Health Laboratory, Faculty of Human Movement, Technical University of Lisbon, Portugal Introduction As long as life expectancy increases, a significant number of people are likely to live longer while subject to infirmities and disabilities, and thus loss of autonomy. Studies focusing on disability and autonomy have been mainly cross-sectional and few studies have analyzed longitudinally predictors of health and physical functioning variables. Thus, the purpose of this study was to analyze the influence of health status, physical activity and fitness on the autonomy of community-dwelling old adults over a five year period. Methods Participants were 106 community-dwelling persons aged 60 years and older at baseline (67.4 $\pm$ 5.4 years). They were evaluated at baseline and after the 5-year follow-up period. Measures comprised autonomy/physical functioning, co-morbidities, physical activity, physical fitness including body composition, evaluated by the Composite Physical Function scale, International Physical Activity Questionnaire, Fullerton batteries and bioimpedance, respectively. Results Linear regression revealed that the main predictors of change in autonomy over a 5-year period were initial autonomy ( $\beta=0.032$ ,  $R^2=9.8\%$ ); health status (initial number of co-morbidities:  $\beta=-0.191$ ,  $R^2=6.3\%$ ; change in the number of co-morbidities:  $\beta=-0.244$ ,  $R^2=10.8\%$ ); and changes in agility ( $\beta=-0.288$ ,  $R^2=6.7\%$ ), aerobic endurance ( $\beta =0.007$ ,  $R^2=3.2\%$ ), and walking related energy expenditure ( $\beta =0.001$ ,  $R^2=5.1\%$ ), ( $P<0.05$ ). Conclusion Initial autonomy level and health status appear to influence autonomy change in community-dwelling old adults over a 5-year period, however physical activity (walking) and fitness (agility and aerobic endurance) also accounted for autonomy variability, justifying the promotion of intervention programs for the maintenance or improvement of these factors. Key words: Autonomy; Physical activity; Physical fitness; Elderly; Health Status

## **DOES HYDRATION STATUS AFTER TRAIL RUNNING INFLUENCE MUSCLE DAMAGE AND DOMS?**

Brooks, N.E., Esterhuizen, A., Myburgh, K.H.

*Stirling University,*

Introduction: The purpose of this study was to determine whether competitive trail running affects indices used to assess hydration status and muscle damage. We hypothesized that: i) body mass (BM) alone would not provide adequate assessment of hydration status after 23.4 km competitive trail running, ii) muscle damage would be accompanied by both pain and inflammation, even in well-trained competitive athletes and iii) an inability to maintain hydration status during the race may be associated with increased muscle damage and/or pain. Methods: Twelve endurance-trained male athletes (37 $\pm$ 2 yrs; BMI: 25.2 $\pm$ 0.8 kg/m<sup>2</sup>,  $VO_{2max}$ : 59.9 $\pm$ 1.9 ml/kg/min) completed a 23.4 km trail running race, the AfricanX Trail (South Africa). Urine samples, RPE, thirst and pain ratings were obtained pre- and post-race and 1 d post-race (d1post). Urine samples were analysed for urea, protein and creatinine [concentrations] and osmolality. Baseline and d1post blood samples were analysed for creatine kinase (CK) and lactate dehydrogenase (LDH) activities, myoglobin, C-reactive protein (CRP), [Na<sup>+</sup>], [K<sup>+</sup>], osmolality, creatinine content and [urea]. Results: Time to complete the race was 162 $\pm$ 9 min (average speed 8.93 $\pm$ 0.47 km/hr). RPE and thirst increased post-race ( $p<0.001$ ). Participants lost 2.7 $\pm$ 0.5% body mass during the race, but were fully rehydrated by d1post. [U-creatinine] increased post-race and remained elevated at d1post, whereas [U-protein] returned to baseline by d1post ( $p<0.05$ ). Serum osmolality and [creatinine] were similar between baseline and d1post. Blood [urea] and [K<sup>+</sup>] increased ( $p<0.001$ ) whereas [Na<sup>+</sup>] decreased d1 post. CK, LDH, [myoglobin] and [CRP] all increased d1post ( $p<0.05$ ). Standing pain increased post-race, but returned to baseline d1post while individual muscle group pain did not return to baseline ( $p<0.01$ ). Participants were separated into euhydrated (<3% BM loss during race; n=7) or dehydrated (>3% BM loss during race; n=4) groups. Dehydrated individuals reported higher RPE values ( $p=0.034$ ) and higher perception of pain after the race and d1post ( $p<0.05$ ). Discussion: As hypothesized, body mass alone provided a crude assessment of hydration status, whereas serum and urine measures of hydration status provided a more informative indication of the physiological response. Markers of muscle damage and perceived pain were elevated even in this cohort of well-trained athletes. Dehydration was causal for increasing post-race perception of effort and a higher perception of muscle pain post-race. Muscle soreness remained higher d1post and this effect does not appear to be mediated by greater muscle damage or inflammation since CK and CRP levels were similar in both euhydrated and dehydrated individuals.

## **EFFECTS OF THE FIFA 11+ INJURY PREVENTION PROGRAM ON NEUROMUSCULAR CONTROL, STRENGTH AND PERFORMANCE IN AMATEUR SOCCER PLAYERS: A RANDOMIZED CONTROLLED TRIAL**

Impellizzeri, F.M.1,2, Junge, A.1, Dvorak, J.1, Pellegrini, B.2, Schena, F.2, Bizzini, M.1

*1: Schulthess Clinic (Zurich, Switzerland); 2, CeRiSM, University of Verona (Rovereto, Italy).*

Introduction To develop an injury prevention program that can be easily implemented in the everyday training routine (especially at amateur level), the FIFA Medical Assessment and Research Centre (F-MARC) has developed an advanced version of a previous prevention program: "The 11+". A cluster randomized controlled trial has recently shown that "The 11+" is effective in reducing injuries (Soligard et al. 2008). "The 11+" is a warm-up routine designed for training some physical components: core stability, neuromuscular control and balance, eccentric training of the hamstrings, plyometric and agility. The aim of this study was to examine whether "The 11+" can improve neuromuscular control, strength and performance in amateur soccer players. Methods Eighty-four male amateur players from 6 teams participated to this parallel, two groups, pre-post, randomized controlled trial. They were allocated to "The 11+" (n=42) and control (n=39)

group using a restricted blocked randomization where each block corresponded to a team. The players had to complete the warm-up routines 3 times a week for 9 weeks. Outcome measures were: eccentric and concentric strength of flexors and extensors, star excursion balance test, time-to-stabilization, core-stability of the trunk, vertical jump, sprint, agility. Analysis was performed using mixed models and magnitude of inferences. Results No differences between groups were found in training load and training components (0.146 < p < 0.680). Both groups completed an average of 2.1 sessions a week. After controlling for confounders and baseline values, possible worthwhile differences (47 to 72%) in favor of the 11+ group were found for flexors concentric strength at 60°/s (3.2%, 95% CI 0.6 to 5.9%; ANCOVA p level=0.046) and 180°/s (4.6%, 95%CI 1.0 to 8.3%;p=0.038), flexors eccentric strength (3.8%, 95%CI 1.4 to 6.2%;p=0.010), sprint (-0.9%, 95%CI -1.9 to 0.1%;p=0.123), agility (-1.1%, 95%CI -2.6 to 0.1%;p=0.265). Likely worthwhile differences (93-95%) in favor of "the 11+" group were found for Time-to-stabilization (-2.8%, 95%CI -4.4 to -1.2%;p=0.005) and core-stability (-8.9%, 95%CI -15 to -3%;p=0.012). Discussion The results of this study showed that nine weeks implementing "The 11+" as a routine warm-up can induce substantial improvement in neuromuscular control and possible worthwhile changes in flexors strength. Therefore, the 11+ not only can prevent injuries but can also induce positive effects on important physical components in amateur players. References Soligard T, Myklebust G, Steffen K, Holme I, Silvers H, Bizzini M, et al. *BMJ* 2008;337:a2469

## INFLUENCE OF OBESITY ON EXCESS POST-EXERCISE OXYGEN CONSUMPTION AFTER DIFFERENT MODERATE AEROBIC EXERCISES

Galvani, C.1, Bruseghini, P.2, Casolo, F.2, Faina, C.1,3

*Applied Exercise Physiology Laboratory, Catholic University of the Sacred Heart*

ILaboratorio di fisiologia sperimentale, Scienze Motorie, Università Cattolica del Sacro Cuore, Milano, Italia 2Scienze Motorie, Università Cattolica del Sacro Cuore, Milano, Italia 3Istituto di medicina e scienza dello sport, CONI, Roma, Italia Introduction Excess post-exercise oxygen consumption (EPOC) increases caloric burn during the recovery period, to be considered in relation to energy balance and weight loss. The aim of this study was to evaluate the acute effects of various modes of aerobic exercise of moderate intensity on EPOC in a lean (NW) and obese (OB) female population. Methods A population of moderately active lean and obese female (NW: age, 24,3±0,6 yr; BMI, 23,1±2,1 kg/m<sup>2</sup>; OB: age, 36,3±4,5 yr; BMI, 31±5,4 kg/m<sup>2</sup>) participated in the study over a 3-week period. Subjects filled a Baecke questionnaire of habitual physical activity and undergone 3 incremental tests to exhaustion (V'O<sub>2</sub>peak at treadmill, cycle ergometer and arm ergometer). Thereafter they completed five bouts of 30 min of exercise separated by at least 48 hours of rest: treadmill walking\_TE, cycling\_CE, arm crank exercise\_AE, cross-training exercise combining walking, cycling and arm crank for 10 min each\_CTE (60% of V'O<sub>2</sub>peak) and daily living activities\_DLA (3-6 METs). Before (30 min pre) and after (2 hours post) each exercise bout a resting metabolic rate measurement was carried out in a sitting position (K4b2, Cosmed, Italy). A repeated measures ANOVA was used to analyse data. Results EPOC magnitude was not significantly different for the two groups, except for CTE (NW, 9±4,2 l; OB, 2,4±2,4 l; p<0,05), and accounted between 5% and 15% of total energy expenditure (TEE150min). V'O<sub>2</sub> during exercise (V'O<sub>2</sub>ex) and TEE150min were similar for both groups (NW: V'O<sub>2</sub>ex, 1,3±0,3 l/min; TEE150min, 320,4±57,1 kcal; OB: V'O<sub>2</sub>ex, 1,2±0,3 l/min; TEE150min, 306,6±45,9 kcal; p=ns). Respiratory exchange ratio was significantly lower for NW when compared with OB during exercise, allowing a greater fat utilization (NW: QR, 0,8±0,1; FAT, 95,1±43,3 kcal; OB: QR, 0,9±0,1; FAT, 59,1±32,5 kcal; p<0,05 and p<0,001, respectively). Discussion This study indicates that analysed aerobic exercises, included DLA, elicit similar EPOC responses. These findings confirm (i) the magnitude of EPOC (LaForgia, 2006), (ii) that women who are lean or obese respond similarly to aerobic exercise at similar relative intensities (Crommett, 2004; LeCheminant, 2008) and (iii) that exercise-induced fat oxidation is diminished in obese women, as it was already demonstrated for men (Wong, 2006). References Crommett. *J Strength Cond Res.* 2004 Aug;18(3):410-5. LaForgia. *J Sports Sci.* 2006 Dec;24(12):1247-64. Wong. *J Clin Endocrinol Metab.* 2006 Feb;91(2):678-86. LeCheminant. *Int J Sports Med.* 2008 Jan;29(1):53-8.

## THE ANTHROPOMETRIC AND PHYSIOLOGICAL CHARACTERISTICS OF FEMALE UNIVERSITY LEVEL NETBALL PLAYERS IN RELATIONSHIP TO PLAYING POSITION.

Orme, D., Duckworth, K., Relph, N.

*University of Cumbria*

Introduction: Netball is a non-contact, intermittent, invasion team game where seven players per team occupy a 30.5 x 15.25 metre court divided into three equal sections, each playing position has a specific area of the court to occupy. Physiological profiling is used within team sports to assess both the demands of the sport and provide evidence of position specific requirements (Geithner et al., 2006). Differences in positional demands have been found between playing positions within netball, the centre positions being the most active (McManus and Stevenson, 2007). To date there is limited data on the anthropometric or physiological characteristics of netball players. The aim of this study was to analyse the anthropometric and physical performance characteristics of university level netball players in three positional groups; attack (A), defence (D), and centre (C) players. Method: Twenty one university level netball players (mean (±SD) age 20.2 ± 1.6yr, height 1.68 ± 0.10m and body mass 63.61±8.62 kg). A battery of tests were used on each player, anthropometric tests; height, weight, sum of 7 skinfolds and physical performance tests; multistage fitness test, 20m sprint, 505 test, flexibility and counter-movement jump (CMJ). Differences between positional groups were determined using one-way ANOVAs and significance accepted at p<0.05. Results: There were no significant differences between positional groups for any variable. However, considering mean data alone, group D were tallest, 1.73 ± 0.06m, had greatest body mass, 66.13 ± 10.85kg, CMJ 3111.7 ± 879.6W, flexibility 22.2 ± 12.2cm and estimated maximum oxygen uptake, 39.1 ± 8.6ml.kg<sup>-1</sup>.min<sup>-1</sup>. Group C, had the greatest sum of skinfolds 122.61 ± 28.6mm, were fastest across split times at 5, 10m and overall 20m sprint time (1.16 ± 0.11, 2.00 ± 0.18, 3.53 ± 0.33s) and the 505 agility test (2.64 ± 0.12 and 2.75 ± 0.25s for left and right legs respectively). Conclusion: No significant differences were found between A, C or D playing positions. This study would suggest that there is no need for position specific training programs at this level in netball. References: Geithner, C.A., Lee, A.M., Braco, M.R., (2006). Physical and Performance Differences among Forwards, Defensemen and Goalies in Elite Women's Hockey. *J. Stren Cond Res.* 20(3). 500-505. McManus, A., and Stevenson, M., (2007). Quantifying the physical demands in netball to develop training guidelines that assess player preparation and reduce injury. *J. Sci Med Spo.* 10(1). 85.

09:50 - 11:20

## Oral presentations

### OP-PM52 Cardiovascular physiology 2

#### CHANGES IN RATE OF HEART RATE INCREASE AT ONSET OF CYCLING AT 100 WATTS PREDICTS CHANGES IN SUBSEQUENT EXERCISE PERFORMANCE

Buckley, J.D., Nelson, M.J., Thomson, R.L. Howe, P.R.C.

*University of South Australia*

**Introduction** Intense training leads to fatigue, which is associated with reduced parasympathetic autonomic tone. The rapid increase in heart rate (HR) at the onset of exercise is primarily mediated by parasympathetic withdrawal. We hypothesised that a reduction in exercise performance due to fatigue, and thus partial parasympathetic withdrawal, would be associated with a reduction in the rate of increase in HR at the onset of exercise. **Methods** In a randomised, counterbalanced, cross-over design, 18 competitive cyclists completed two weeks of heavy cycling training and two weeks of light cycling training. At the end of each training period, the maximum rate of increase in HR (Heart Rate Increase, HRI) during five minutes of cycling at a constant power output of 100 Watts (W) was determined, after which performance (work done) was assessed during a five minute maximal cycle time-trial. **Results** Compared with light training, heavy training reduced both time-trial performance ( $5.2 \pm 0.9\%$ ) and HRI ( $15.2 \pm 5.5\%$ ) ( $P < 0.02$ ). The percentage change in HRI was positively associated with the percentage change in time-trial performance ( $r^2 = 0.53$ ,  $P < 0.001$ ). **Discussion** Changes in HRI during standardized submaximal exercise are associated with changes in exercise performance and may be mediated by changes in vagal tone. HRI could be used by coaches and athletes to monitor the effects of training and competition programs to avoid excessive fatigue. **References** Iellamo F, Legramante J, Pigozzi F, Spataro A, Norbiato G, Lucini D, Pagani M. (2002). *Circulation*, 105, 2719-24. Robinson B, Epstein S, Beiser G, Braunwald E. (1966). *Circ Res*, 19, 400-11.

#### THE EFFECT OF ACUTE EXERCISE INDUCED FATIGUE ON THE RATE OF INCREASE IN HEART RATE AT THE ONSET OF SUBMAXIMAL CYCLING

Thomson, R.L., Rogers, D.K., Howe, P.R.C., Buckley, J.D.

*University of South Australia*

**Introduction** Previous studies have been unable to identify a reliable and convenient method for assessing fatigue status. Heart rate (HR) reflects the autonomic regulation of the heart which is influenced by fatigue. Fatigue is associated with reduced parasympathetic autonomic tone (Iellamo et al., 2002) and the rapid increase in HR at the onset of exercise is primarily mediated by parasympathetic withdrawal (Robinson et al., 1966). We hypothesised that a reduction in exercise performance due to acute exercise induced fatigue, and thus partial parasympathetic withdrawal, would be associated with a reduction in the maximal rate of increase in HR at the onset of exercise (HRI). **Methods** Fourteen healthy male triathletes completed a 2 hr run at 75-85% of maximum HR to induce acute fatigue. A 5 min standardised submaximal cycle test at 100 watts and a 5 min maximal cycling test were completed before and 1 hr after the run. HRI is the maximum rate of increase in HR and was calculated by fitting a sigmoidal curve to the HR during the submaximal cycle test. Performance was classified as the total work done (kJ) during the maximal cycling test. Pre-exercise HR (mean HR in the 30 seconds prior to starting the submaximal cycle test), HR recovery (change in HR in 2 min following end of performance test) and HR max (maximum HR value during the performance test) were also measured. **Results** Time trial performance was significantly reduced following the 2hr run ( $-6.7 \pm 2.8\%$ ,  $P < 0.001$ ). This was accompanied by a significant reduction in HRI ( $-47.0 \pm 25.6\%$ ,  $P < 0.001$ ). Pre-exercise HR was significantly higher before the submaximal cycle test following fatigue ( $73.0 \pm 8.4$  bpm v  $90.5 \pm 11.4$  bpm,  $P < 0.001$ ). When controlling for these change in pre-exercise HR following fatigue, there was a significant relationship between change in HRI and change in performance ( $r = 0.578$ ,  $P = 0.038$ ). No other HR indices measured were related to changes in performance ( $P < 0.6$ ). **Discussion** HRI at the onset of submaximal cycling slows in response to acute exercise-induced fatigue. The change in HRI (when controlling for differences in pre-exercise HR) was the only HR assessment measured that was associated with changes in cycling performance. HRI is able to predict changes in performance due to acute fatigue and could be used to predict an athlete's state of recovery and physiological readiness to perform. HRI is a potential tool for coaches and athletes to monitor the acute effects of training and competition to avoid overtraining. **References** Iellamo F, Legramante J, Pigozzi F, Spataro A, Norbiato G, Lucini D, Pagani M. (2002). *Circulation*, 105, 2719-24. Robinson B, Epstein S, Beiser G, Braunwald E. (1966). *Circ Res*, 19, 400-11.

#### RECOVERY HEART RATE IN DYNAMIC AND STATICS SPORTS

Beltran Contreras, S., Peinado, A.B.1, Butragueno, J.1, Rojo-Tirado, M.A.1, Benito, P.J.1, Calderón, F.J.1

*Facultad de Ciencias de la Actividad Física y del Deporte (INEF), Universidad Po*

**Introduction** The fall in heart rate (HR) immediately after dynamic exercise has been studied by some authors [1, 2]. This decrease is considered to be a function of the reactivation of the parasympathetic nervous system [1]. The aim of this study was to compare the rate of recovery of the HR in several sports classified as statics (S) and dynamics (D). **Methods** 294 Spanish athletes of international level, from statics ( $n=89$ ) and dynamics ( $n=205$ ) sports, were evaluated. Each subject performed an incremental test until exhaustion in treadmill or cicloergometer. The expired air was analyzed with a gas analyzer. The response of heart rate (HR) during the first 4 minutes of a passive recovery after maximum effort was analyzed. Recovery rate index (IR) was calculated using the equation proposed by Calderon (IR1) [3]. A Student's unpaired t test was used to compare the HR recovery and IR between S and D sports. The significance level was set at 0.05. **Results** The maximum HR was not different between groups ( $p > 0.05$ ) (D:  $195.6 \pm 9.9$  beats $\cdot$ min $^{-1}$  vs. E:  $194.7 \pm 10.4$  beats $\cdot$ min $^{-1}$ ). However, the basal HR in S group was higher than D sports ( $p < 0.05$ ) ( $60.5 \pm 11.6$  beats $\cdot$ min $^{-1}$  vs.  $57.2 \pm 9.4$  beats $\cdot$ min $^{-1}$ , respectively). The HR recovery in minute 4 during the passive recovery was not significantly higher in S ( $120 \pm 14.2$  beats $\cdot$ min $^{-1}$ ) than in D ( $117 \pm 14.6$  beats $\cdot$ min $^{-1}$ ). IR1 was not significantly higher in D (IR1 min4:  $56.8 \pm 8.6\%$ ) than in S sports (min4:  $55.4 \pm 7.4\%$ ). **Discussion** The recovery of HR in S and D sports was similar, showing that the type of training does not influence the rate of recovery of the HR [3]. The cardiac parasympathetic reactivation is the principal determinant of the immediate fall in HR when exercise ceases [1], and this mechanism seems to function



independently of the type of training. Indeed, we believe that use the IR proposed is more useful to study the HR recovery, since takes into account the HR reserve. References 1. Coote, J.H., Recovery of heart rate following intense dynamic exercise. *Exp Physiol*, 2010. 95(3): p. 431-40. 2. Nagashima, J., et al., Dynamic component of sports is an important determinant factor of heart rate recovery. *J Cardiol*, 2011. 58(2): p. 191-6. 3. Darr, K.C., et al., Effects of age and training status on heart rate recovery after peak exercise. *Am J Physiol*, 1988. 254(2 Pt 2): p. H340-3.

### CHARACTERISING THE PHYSIOLOGICAL RESPONSES TO VERTICAL TREADMILL EXERCISE

Jordan, A., Claxton, D., Fysh, M., Purvis, A.

*Sheffield Hallam University*

**Introduction** A vertical treadmill (VerT) is being developed for the physical conditioning or rehabilitation of athletes. It requires a running action in a recumbent position on a vertically hung, non-motorised treadmill whilst the limbs are supported with overhanging resistance cables. To compare VerT exercise with horizontal treadmill running, a Rate of Perceived Exertion (RPE) of 15 was chosen as it approximates Maximum Lactate Steady State (MLSS) which is the highest steady state intensity without a continual blood lactate accumulation (Dekerle et al., 2003). The aim of this study was to determine the acute physiological responses to VT exercise at an RPE of 15. **Methods** With institutional ethics approval, five males aged 26 (2) years, height 181.2 (6.1) m, body mass 76.3 (6.8) kg were recruited. The participants' maximum oxygen consumption (51.7 (2.7) mL/kg/min) and Respiratory Compensation Point (RCP) were determined on a horizontal treadmill. MLSS was predicted from RCP minus 10% when expressed as percentage of maximum oxygen uptake (Dekerle et al., 2003). VerT exercise was performed for three minutes at an RPE of 15 during which treadmill belt speed and pulmonary gas exchange were continuously measured. Blood lactate was measured at rest and immediately after VerT exercise. **Results** Predicted MLSS during horizontal treadmill running elicited an oxygen uptake equivalent to 73.9 (2.9)% of the maximum oxygen uptake and a corresponding heart rate of 93.3 (8.4)% of the maximum. At an RPE of 15 on the VerT (equivalent to MLSS intensity), oxygen uptake was 58.7 (8.6)% of the horizontal maximum oxygen uptake, heart rate was 74.5 (5.7)% of the maximum, blood lactate rose from 1.41 (0.41) mmol/L rested to 3.67 (1.6) mmol/L and VerT belt speed was 1.60 (0.25) m/s. **Discussion** VerT exercise elicits lower cardiovascular stress (HR and oxygen uptake) than horizontal running at the same perceived intensity. This might be explained by the participants in the current study being accustomed to, but not conditioned for VerT exercise as well as the effects of load bearing. During VerT exercise muscular force is required to draw the leg downwards against the resistance cables which adds to the postural effort. This might result in a contribution of type II fibres during VerT as evidenced by the 2.26 (1.53) mmol/L increase in blood lactate. Further research should make direct comparisons with RPE-matched horizontal running as a framework for characterising VerT. **References** Dekerle J, Baron B, Dupont L Vanvelcenaher J, Pelayo P. (2003). Maximal lactate steady state, respiratory compensation threshold and critical power. *Eur J Appl Physiol*. 89, 281-288.

### FLOW-MEDIATED VASODILATION DURING EXERCISE

Miura, H., Sugino, M., Maki, Y.

*University of Tokushima*

**Introduction** Arterial stiffness or compliance is widely used to evaluate arterial function in humans. Previous researches reported the improved arterial function after acute endurance exercise (Kingwell et al. 1997, Nickel et al. 2011). However, an individual's physical fitness level or recovery response usually influences the arterial function responses. In order to establish an optimal exercise prescription for improving arterial function, evaluating arterial function during exercise must be needed. Therefore, this study examined flow-mediated vasodilation (FMD) during acute endurance exercise. **Methods** Eight healthy recreationally active adult men participated in this study. They performed the 30 min-recumbent cycling at 25W. Upper arm cuff inflation to 50 mmHg over their systolic blood pressure (SBP) for 5 min and subsequent deflation was induced at rest, during exercise, and immediately after exercise while in the recumbent position. The measurements of the right brachial artery diameter were taken using high-resolution ultrasound device. FMD was then estimated as the percent change in the arterial diameter over the baseline value at maximal dilation during each reactive hyperemia. **Results** The 25W-cycling trial showed that FMD increased from 8.9±1.0% at rest to 10.2±1.8% during exercise, and returned to 9.1±1.4% immediately after exercise. There was a significant difference between rest and exercise ( $p<0.05$ ), and between exercise and recovery ( $p<0.05$ ). However, oxygen uptake, heart rate, and systolic/diastolic blood pressure remained stable through the trial. **Discussion** This study is the precious of its kind to evaluate the FMD response during exercise. Though it remained stable immediately after exercise, FMD increased during acute relative low intensity endurance exercise. Elevation of FMD during exercise is accounted for the increased shear stress by increment of cardiac output, and vasoactive substances including of catecholamine, atrial natriuretic peptide, adrenomedullin (Celermajer 1997, Krzemiński et al. 2006). These results suggested that FMD should be evaluated during exercise for identifying the arterial function and exercise intensity. Future measurements of FMD at various exercise intensities may therefore allow for the establishment of exercise guidelines for achieving an improved endothelial function. **References** Celermajer DS (1997). *J Am Coll Cardiol*, 30, 325-333. Kingwell BA, Berry KL, Cameron JD, Jennings GL, Dart AM (1997). *Am J Physiol*, 273, H2186-H2191. Krzemiński K, Mikulski T, Nazar K (2006). *J Physiol Pharmacol*, 57, 571-581. Nickel KJ, Acree LS, Gardner AW (2011). *Angiology*, 62, 33-37.

### SIMULATION OF THE EFFECTS OF DEHYDRATION AND HYPERHYDRATION ON RUNNING ECONOMY

Ler, H., Thompson, M.W., Ruell, P.

*Univeristy of Malaya*

**SIMULATION OF THE EFFECTS OF DEHYDRATION AND HYPERHYDRATION ON RUNNING ECONOMY** Ler, H.Y. 1, 2, 3 Thompson, M.W.1 Ruell, P.1 1: The University of Sydney (Australia); 2: University of Malaya (Malaysia); 3: Tunku Abdul Rahman College (Malaysia) **Introduction:** Elite athletes appear to drink a relatively small volume of fluid during prolonged severe exercise, culminating in a bodyweight deficit of 1-4% due to dehydration. While HR is known to be elevated when exercising in a dehydrated state, we know of no research linking dehydration with running economy (RE). Theoretically, the oxygen cost of running is related to bodyweight, and if bodyweight is reduced then ultimately RE should improve. Conversely, added weight (weight jacket with small sand bags) around the torso should increase the oxygen cost of running and HR. This study investigated the simulation of dehydration and hyperhydration on RE and the HR response to these conditions. **Methods:** Sixteen well trained male distance runners performed a control trial in a euhydrated state and undertook either 2 added weight (AW) trials (n=8; age: 44.3±4.2 yr; 71.1±6.0 kg; 174.3±6.9 cm; VO<sub>2</sub>max: 58.6±6.3mL/kg/min) or 2 dehydration (D) trials (n=8; 45.3±2.9 yr; 74.8±8.4 kg; 175.3±7.2 cm; VO<sub>2</sub>max: 58.2±6.6mL/kg/min). Each trial consisted of four different submaximal running speeds (65, 70, 75, 80% of VO<sub>2</sub>max; 4 min stages for each speed) on the treadmill in thermoneutral conditions (20°C; 40%rh).

Hyperhydration was simulated with added weight to the torso which was equivalent to 3% (AW3) and 4% (AW4) BW while 3% (D3) and 4% (D4) BW deficit was induced via an exercise-heat exposure protocol. Expired respiratory gas samples were collected over the final 60s at each speed using the Douglas bag technique. Heart rate (HR) values were recorded within the final 15s of each speed of running. Results: Subjects were well hydrated prior to all AW and D trials with urine specific gravity <1.010. RE at each speed was expressed as both oxygen uptake (VO<sub>2</sub>, mL/kg/min) and caloric unit cost (CR, kcal/kg/km). VO<sub>2</sub> significantly increased with speed ( $r=0.999$ ;  $p<0.001$ ); together with average CR ( $p=0.263$ ) in all trials. No significant difference was found between D and AW trials in both VO<sub>2</sub> (mL/kg/min) and CR (kcal/kg/km). HR increased linearly with each increment in speed for all trials and was significantly higher at 75 and 80% of VO<sub>2</sub>max in D3 and 65 to 80% of VO<sub>2</sub>max in D4 compared with AW3 and AW4 trials, respectively [(D3 vs. AW3: 147±5 vs. 140±5; 159±6 vs. 152±5); (D4 vs. AW4: 128±10 vs. 119±7; 140±8 vs. 129±6; 150±6 vs. 141±6, 161±5 vs. 152±5 bpm)] ( $p<0.05$ ). Discussion: RE at speeds ranging from 65 to 80% of VO<sub>2</sub>max was not affected by 3-4% of bodyweight deficit or added weight. One possible explanation for these results is that when added weight is evenly distributed around the torso the additional oxygen cost is minimised and offset by an added contribution from the series and parallel elastic component of muscles and tendons at no metabolic cost.

**09:50 - 11:20**

## Invited symposia

### IS-SH11 European Sports Tradition: Towards Unified Concepts and Policies

---

#### MOVEMENT CULTURES IN EUROPE: SIMILARITIES AND CONTROVERSIES

Pfister, G.

*University of Copenhagen*

Introduction: In the last decades, intensive debates about the "European Sport Model" emerged not only in sport sciences but also in the context of EU sport policies. Despite the controversies about its meanings and benefits, most participants in these discussions agreed that this sport system has its roots in the European civil societies and differs decisively from sport models in other regions of the world. Aims and content: In this paper, I will retrace the origins and developments of various "movement cultures" on the European continent and reconstruct in particular the development of German Gymnastics/Turnen, Swedish gymnastics and English sport. I will explain the emergence of these different concepts against the backdrop of the socio-cultural and political situation in their respective countries. Theory and method: In the second part of the paper, the role of modern sport and its impact on German and Swedish gymnastics will be the focus. Using the theoretical concept of "sportification", the conflicts between sport and gymnastics as well as the "sportification" of the different gymnastics systems will be analyzed and described. The sources for this analysis are in particular gymnastics and sports magazines as well as the books of the proponents of the different sports/gymnastics movements. With regard to the sportification process I refer to Guttman's paradigm "From ritual to record" as well as the articles and books discussing this work. Results: Current studies about the sport habits and tastes in various countries indicate that some of the sport and gymnastics traditions still have an influence on the European sports cultures. Guttman, A. (1978). *From ritual to record: The nature of modern sports*. New York: Columbia University Press

#### SPORT, ORGANIZATIONS AND CHANGE IN EUROPE

Porro, N.

*Facoltà di Scienze motorie all'Università di Cassino*

By a sociological point of view one must preliminarily distinguish between Voluntarism at large and Voluntary Action. Voluntarism is a social sub-system which can be described according to institutional and organizational theories. Voluntary action means a collective practice inspired to a philosophy of solidarity and to a value oriented ethics. In Europe the sports organizations, including the most of performance competitive activities, since the late 19th century historically grounded in both the sub-system of voluntarism and the culture of voluntary action. By an organizational perspective they represented the social backbone of the sports system at large. At present the most of European sports clubs are rooted in the non profit private domain, in the Third Sector organizational area and in the so called Social Economy. At the same time the culture and the practice of voluntary sport have been influenced by social changes and by the uprising of new lifestyles, attitudes, preferences and tastes. The so called European sports system is still strongly differentiated and reflects various and highly heterogeneous dynamics of formation and development which on turn refer to the profile of the Nation building, to specific forms of modernization, to the social stratification etc. In each country role, structure and regulation of the sport system depend on (i) different legal statuses assigned to sport; (ii) various typologies of acknowledgement of the non profit system at large; (iii) organizational histories, to be linked with specific experiences (regarding sports disciplines, network frames, influence of exogenous and endogenous factors), and on (iv) an emerging role exerted by over-national bodies like EU. To a closer analysis of its social, cultural and organizational landscape sport for all itself means as an umbrella formula in which are represented many fields of action, sometimes conflicting each other. One can describe it as a typical political arena according to the classic Benson's definition (1988), implying different actors, several stakeholders and specific priorities and motivations. According to our approach we can locate three main organizational identities: (i) grassroots movements, (ii) sport for citizenship associations and (iii) sport for everybody offer system. On turn, changes and trends in sports organizations will be analysed adopting on one hand a socio-historical approach and, on the other, an emerging sociological analysis of organizations. The presentation emphasizes the relationship between these conceptual and methodological contributions and the specific role of sport in producing social capital.

#### FOOTBALL RESEARCH IN AN ENLARGED EUROPE: A ROAD MAP FOR INNOVATIVE IDENTITY RESEARCH

Sonntag, A.

*ESSCA School of Management*

Introduction Researchers from the social sciences who work on football-related topics often face two major handicaps: not only do they often work in a rather isolated manner within the borders of their academic discipline, but they hardly ever have sufficient budgetary

means to test their hypotheses in large-scale surveys. This is particularly true for researchers dealing with issues like mutual perception patterns between different communities or the impact of international football on ongoing contemporary identity dynamics in the age of globalisation. Methods The paper presents a methodological road map for a large-scale collaborative research project on European football, which is carried out within the 7th European Framework Programme under the topic line "The Anthropology of European Integration". The project, which is entitled "FREE – Football Research in an Enlarged Europe" and scheduled to run from April 2012 to March 2015, is an attempt to overcome both the disciplinary and budgetary handicaps mentioned above and to realise a truly interdisciplinary synergy of research approaches with the help of a complex methodological architecture. Its perspective is distinctly European, working on transnational tendencies and commonalities rather than national prisms and case studies. Results/Discussion At the moment of the ECSS Congress, it will be too early to present first tangible results. It will, however, be possible to put to discussion the assumptions and hypotheses which underpin the project and open up a controversial debate. At the same time the paper will be an opportunity to invite interested scholars to contribute actively to this ongoing project. Issues discussed will include the social impact of European football competitions, football as a producer of collective memory, football and gender construction, identity formation from the local to the transnational, the European football community as a public sphere, as well as transnational movements of stakeholder empowerment in football governance. References Sonntag, A (2008), *Les identités du football européen*, Presses Universitaires de Grenoble.

09:50 - 11:20

## Invited symposia

### IS-BN09 Neuromechanics of Stretch Shortening Cycle: Application to Sports

#### ANYTHING SPECIFIC ABOUT THE FASCICLE- TENDON INTERACTION AMONG THE WORLD TOP LEVEL MARATHON RUNNERS?

Ishikawa, M.1, Sano, K.1, Nobue, A.1, Danno, Y.1, Akiyama, M.1, Oda, T.2, Ito, A.1, Nicol, C.3, Locatelli, E.4, Komi, P.5  
*Osaka University of Health and Sport Science (Osaka, Japan)*

1: Osaka University of Health and Sport Science (Osaka, Japan), 2: Hyogo University of Teacher Education (Hyogo, Japan), 3: University of the Mediterranean (Marseilles, France) 4: International Association of Athletics Federations (Monaco), 5) University of Jyväskylä (Jyväskylä, Finland) Recent years have demonstrated great success of African runners in general and that of the Kenyan runners in particular. The success of the Kenyan runners has been so dramatic that scientists and practitioners alike wondered, whether this success is not only as a result of superior training system and athletic selection but also due to the genetic make-up, specifically providing the runners with exceptional preconditions for high level performance. Contrasting the expectations, the reliable studies conducted on the Kenyan runners have not shown that they would be markedly different in many basic physiological parameters from their e.g. European counterparts. Nevertheless, they seem to have high maximal aerobic capacity associated with exceptionally good running economy (Saltin et al. 1995 a,b). This finding of high running economy could not be explained by any of the histochemical and/or biochemical parameters measured from the muscle biopsy samples. Consequently, it was a clear conclusion of these reports of Saltin et al (1995 a,b) that one of the possible reasons for the high mechanical efficiency (or running economy) could be the special biomechanical make up of these runners. The question can therefore be asked whether the Kenyan runners possess a particular type of triceps surae muscle-tendon complex, which could favor efficient storage and use of elastic energy in Achilles tendon during natural forms of locomotion. The present study was therefore focused on examining the anthropometric characteristics and the muscle-tendon interaction of the Kenyan runners belonging to the elite category of performance as measured by their success in international achievement as medal winners or running records. The present report will emphasize how the muscles of these athletes function efficiently during stretch-shortening cycle exercises References Saltin B et al. (1995a) *Scand J Med Sci Sports*. 5: 209-221. Saltin B et al. (1995b) *Scand J Med Sci Sports*. 5: 222-230.

#### IDENTIFICATION OF FASCICLE-TENDON INTERACTION DURING SSC IN SKIING TECHNIQUES

Lindinger, S.1, Ishikawa, M.2, Komi, P.V.3,4, Holmberg, H.C.5, Rapp, W.3,4, Müller, E.1, Linnamo, V.3,4  
*University of Salzburg*

Identification of fascicle-tendon interaction during SSC IN SKIING TECHNIQUES Stefan J. Lindinger<sup>1</sup>, Masaki Ishikawa<sup>2</sup>, Paavo V. Komi<sup>3</sup>, Hans-Christer Holmberg<sup>4</sup>, Walter Rapp<sup>3</sup>, Erich Müller<sup>1</sup>, Teemu Lemmettylä<sup>3</sup>, Stefan Gressenbauer<sup>1</sup> and Vesa Linnamo<sup>3</sup> <sup>1</sup>University of Salzburg, Austria, <sup>2</sup>Osaka University, Japan, <sup>3</sup>University of Jyväskylä, Finland, <sup>4</sup>Mid Sweden University, Östersund KEY WORDS: skiing, MTU, ultra sound Identification of stretch-shortening cycles (SSC) in cross-country skiing (XC) can be obtained using kinematics in combination with EMG of the respective muscles (indirect methods). Consequently a clear hypothesis was developed (Norman & Komi/Komi & Norman 1987) that XC benefits from a sequence of flexion-extension movements that contain SSC actions, shown in later studies (Vähäsöyrinki et al. 2008; Lindinger et al. 2009). Encouraged by these findings we wanted to identify the possible fascicle-tendon interaction also in different other XC techniques. While making progress in these series of studies it was decided to add also alpine skiing in the measurement protocol. Testing followed the basic models used in previous measurements obtained for XC skiing, but concentrated more on the double poling (DP) used on a treadmill. In free technique V2 skating was taken as a major object, and in Alpine skiing (AS) recordings were made for Slalom while in both on snow studies the unique nature of these measurements included the use of ultrasonography (Prosound C3cv, Aloka Japan) to observe the fascicle-tendon interaction during these performances. Goniometers/video was used for joint kinematics. So the fascicle-tendon interaction of selected muscles during the important functional phases of the performances, such as the ski and pole contact during skating and the preparation and action during slalom turns could be examined. The recorded muscles included shoulder and arm extensors for DP and leg extensors for skating and slalom. When applicable the sEMG was also recorded from all these muscles simultaneously with other systems also including pole and leg forces. Results of these series of studies confirm the occurrence of speed and subject dependent SSC in elbow and shoulder joints during DP. In skating as well as Slalom skiing (in particular the inside leg during turns) most of the measured muscle fascicles were stretched in the MTU stretching phase followed by shortening in the MTU shortening phase while the relative stretching and shortening amplitudes in both techniques were specific for each muscle. Although part of the analysis is still ongoing, the major conclusion can be reached to support the hypothesis that both XC and AS techniques contain important elements of SSC, which can be used to apply respective training techniques for further

improvement of performance. REFERENCES Lindinger et al. (2009), Changes in upper body muscle activity with increasing double poling velocities in elite cross-country skiing. *Eur J of Appl Physio.* 106(3):353-363.

## RELEVANCE OF SSC FUNCTION ON SPORT PERFORMANCE

Komi, P.V.1, Ishikawa, M.2, Linnamo, V.1

*Neuromuscular Research Center*

1: University of Jyväskylä (Jyväskylä, Finland), 2: Osaka University of Health and Sport Science (Osaka, Japan) In 1885 the French physiologists Marey and Demeny noted that when two vertical jumps are performed successively, the second one is higher than the first one. This potentiation effect was later called "wind-up" movement (Asmussen & Sorensen 1971) and currently called as stretch-shortening cycle (SSC) (Norman & Komi (1979)). SSC is the natural way the skeletal muscles function during locomotion, and can be easily identified in running, jumping and throwing. In the contact phase of running, for example, SSC refers to lengthening of the active muscle followed by its immediate shortening. The basis for the use of SSC instead of pure concentric muscle actions is simple: the neuromuscular system tries to perform movement as efficiently as possible. The fundamental characteristics of SSC have been examined quite extensively with isolated muscle models (e.g. Cavagna et al, 1965 and 1968) and also with human muscles (e.g. Bosco et al 1981; Komi, 1983). In SSC the active stretching (eccentric phase) allows storage of elastic energy which can be utilized partly in the subsequent shortening (concentric phase). The centrally controlled preactivation combined with the active eccentric phase prepare the muscle to receive the "impact" and store this elastic energy. The passive (non-active) muscle can only store a minimum amount of elastic energy. One important point in the discussion of SSC potentiation is the interaction between fascicles and tendon structures. The definition of SSC as given above, relates to the entire muscle-tendon unit (MTU) and can be considered too simple. The fascicles may not necessarily, and in some instances not at all, follow the stretch-shortening pattern of MTU. Depending on the imposed impact load the fascicles may show lengthening, which can be very short-lived and the possible reflex induced force potentiation may not be visible if ultrasound scanning frequency is low (Ishikawa & Komi, 2008). The present report will emphasize how this fascicle-tendon interaction will be influenced by the type of muscles, intensity of effort, aging process, fatigue and training. It is believed that considerable amount of information is already available to demonstrate how this interaction applies to various sport activities as well. References: Asmussen E & Sorensen N 1971. *Le Trev Hum* 34:147-156. Bosco C, Komi PV, Ito A 1981. *Acta Physiol Scand* 111:135-140. Cavagna GA, Saibene FP & Margaria R 1965. *J Appl Physiol* 20:157-158. Cavagna GA, Dusman B & Margaria R 1968. *J Appl Physiol* 24:21-32. Ishikawa M & Komi PV 2008. *Exerc Sport Sci Rev* 36:193-199. Komi PV 1983. (Ed.) Baumann W, *Biomechanics and Performance in Sport*. Schorndorf, Verlag Karl Hofman, 224-229.

**09:50 - 11:20**

## Invited symposia

### IS-PM15 Exercise in cancer patients (\*)

#### PHYSICAL EXERCISE IN CANCER PATIENTS

Velthuis, M.

*Comprehensive Cancer Centre the Netherlands*

As in many countries, the number of cancer survivors increases every year in the Netherlands: from 366.000 in the year 2000, to expected 692.000 in 2015. Physical exercise has been associated with benefits during and after cancer treatment, including reduction of treatment related side effects and improvements in physical and psychosocial outcomes. The presentation will focus on effects of physical exercise in cancer patients during and after rehabilitation with a curative intent and will be based on the Dutch evidence based guideline Cancer rehabilitation 1 and recently published studies 2, 3. The guideline Cancer rehabilitation 1 as well as Velthuis et al. 2 state that physical exercise during cancer treatment seems to be feasible, causes no additional health risk and seems to have promising effects, at least in breast cancer patients. Further studies are needed in other cancer diagnoses. The effects in patients diagnosed with colon cancer will be studied in de Physical Activity during Cancer Treatment (PACT) – study 4. The guideline Cancer rehabilitation recommends rehabilitation after cancer treatment has been finished that consists of aerobic and progressive resistance exercises. The rehabilitation programme should be determined per patient. Velthuis et al. 3 recommends to screen on fear of movement prior to the start of rehabilitation. The expectation is that cancer survivors with increased fear of movement might benefit from rehabilitation programmes focused on reducing fear of movement. While cancer survivors without fear of movement might benefit less from these programmes and can be offered regular physical exercise programmes. References 1Guideline Cancer rehabilitation. Comprehensive Cancer Centre the Netherlands, 2011. [www.oncoline.nl](http://www.oncoline.nl) 2Velthuis MJ, Agasi-Idenburg, SC, Aufdemkampe G, Wittink H. The effect of physical exercise on cancer-related fatigue during cancer treatment: a meta-analysis of randomised controlled trials. *Clin Oncol (R Coll Radiol)*. 2010 Apr;22(3):208-21. Epub 2010 Jan 27. 3Velthuis MJ, Peeters PHM, Gijsen BCM, van den Berg JP, Koppejan-Rensenbrink AG, Vlaeyen JWS, May AM. The role of fear of movement in cancer survivors participating in a rehabilitation programme. Accepted for publication in *Archives of Physical Medicine and Rehabilitation*. 4Velthuis MJ, May AM, Koppejan-Rensenbrink RA, Gijsen BC, van Breda E, de Wit GA, Schröder CD, Monnikhof EM, Lindeman E, van der Wall E, Peeters PH. Physical Activity during Cancer Treatment (PACT) Study: design of a randomised clinical trial. *BMC Cancer*. 2010 Jun 9;10:272.

#### EXERCISE AND CANCER— HOW TO PLAN AN EFFECTIVE INTERVENTION?

Nikander, R.

*Helsinki Metropolia University of Applied Sciences*

Over 20 million cancer patients worldwide are alive because of effective but demanding cancer treatments, and the number of survivors is increasing. More than half of survivors are over 65 years of age and they need to cope with cancer per se, in addition to the cancer treatment related lymphedema, weight gain or loss, premature menopause (women), fatigue, depression, and poor quality of life. Exercise as a planned and structured form of physical activity has been successfully used to improve the survivors' physiological and psycho-

social health, and it can even prevent relapses of the disease. Indeed, there is some evidence that exercise has small or moderate effect on survivors' cardiorespiratory fitness, physical functioning and quality of life in many cancer types, and it can help to cope with weight gain and fatigue in breast and prostate cancer survivors. There is little evidence of exercise on cancer patients' survival. Adverse effects of exercise such as lymphedema, shoulder tendonitis or joint pain have been quite rarely reported. Despite the beneficial evidence, the amount of exercise training is often low in cancer patients. Both supervised institutionalized and self-directed home exercise interventions lasting six to 26 weeks have been utilized in exercise interventions. These interventions have mostly consisted of aerobic exercise such as walking and cycling or resistance training. Exercise intensity has varied greatly due to various exercise modes. The frequency and duration have varied between 10 to 75 minutes per session and two to seven times a week. Adherence to exercise training has mostly been over 60%. Exercise training has several small positive effects for cancer survivors health.

### EXERCISING DURING CHEMOTHERAPY - POTENTIALS AND CONTRAINDICATIONS

Baumann, F.T.

*German Sport University Cologne*

Introduction: Cancer patients suffer not only because of illness and medical therapies but also due to lack of mobility during the phase of chemotherapy [Baumann 2009]. Immobility, which may result in muscle atrophy or pneumonia, can become life threatening [Bartsch 2000]. Between 70 and 100% of all cancer patients are suffering from fatigue during chemotherapy [Mock 2001, Jacobsson 1998, Irvine 1994]. In addition, the psychological burden is enormous. All of these factors have a detrimental effect on their quality of life, as several studies have shown. Results: In our studies we show a positive effect of endurance training on physical constitution and quality of life on leukemia and lymphoma patients during high dose chemotherapy. With breast cancer patients we made resistance training during chemotherapy. The level of resistance of the patients was maintained and even increased. The affected arm showed a significant increase in the maximum resistance. Regarding the outward rotation of the shoulder significant improvements were found for effort and performance. Regarding the assessment of quality of life, as significant improvement could be achieved in Fatigue. Discussion and Conclusion: Physical exercise programs still play only a minor role during the treatment of cancer inpatients. Only limited experience exists regarding resistance training with cancer patients [Courneya 2007]. No signs of complication were registered in our studies. Different therapeutic exercise interventions for the individual cancer entities are necessary due to varying medical treatments and side effects. Existing views that early exercise parallel to and immediately after medical therapy would pose a health risk to the patient and should only be introduced after a complete remission are incorrect. However, further studies have to be conducted, in order to better understand the exact effects of exercise and the different training intensities. Literature: Baumann et al. Bone marrow transplantation. 2010; 45 (2): 355-362 Bartsch et al. Onkologie 2000; 6: 44-51 Courneya et al.: JCO 2007; 25: 4396-4404 Dimeo et al.: Sup Care in Canc 2003; 11: 623-628 Irvine et al. Cancer Nurs 1994; 17: 367-378 Jacobsson et al.: J Pain Symptom Manage 1999;18 (4): 233-242 Mock. Cancer Suppl 2001; 92 (6): 1699-1707

09:50 - 11:20

## Oral presentations

### OP-PM53 Training and Testing: Fatigue

#### INFLUENCE OF FATIGUE ON UPPER LIMB MUSCLE ACTIVITY AND PERFORMANCE IN TENNIS

Rota, S., Morel, B., Rogowski, I., Hautier, C.

*University of Lyon 1*

INFLUENCE OF FATIGUE ON UPPER LIMB MUSCLE ACTIVITY AND PERFORMANCE IN TENNIS Rota, S.1, Morel, B.1, Rogowski, I.1, Hautier, C.1 1: CRIS (Lyon, France) Introduction Fatigue in tennis is multifactorial and influences the outcome of a match (Hornery et al., 2007). Indeed, fatigue can engender performance impairment, including mistimed strokes (velocity and precision), altered on-court movements (velocity, footwork and positioning to the ball) and incorrect tactical choices (Davey et al., 2002). The aim of this present study was to investigate the effect of a fatiguing tennis intermittent exercise on the upper-limb muscle electromyographic (EMG) activation level, ball velocity, stroke accuracy and consistency. Methods Height elite tennis players performed a fatiguing tennis exercise composed of 4 sets of 8 minutes maximal tennis hitting (serve and forehand). Before and after fatigue protocol, subjects performed isometric maximal voluntary contractions (IMVC) as well as forehand and serve skill tests. Heart rate, blood lactate concentration and rating of perceived exertion were monitored during the fatigue protocol. Force and EMG were recorded during IMVC for internal arm rotators, wrist flexors and wrist extensors. Ball velocity, stroke accuracy, error percentage of strokes and EMG of height upper-limb muscles were assessed during the skill tests. Results Mean heart rate, blood lactate and perceived exertion values attained respectively 176±9 beats/min, 5.7±2.5 mmol/L and 17.5±0.5 after fatigue. Significant decreases in serve velocity (3.2%) and forehand accuracy (21.1%) were observed after the fatiguing intermittent exercise. Error percentage of both strokes tended also to decline (p=0.056). EMG activation level for pectoralis major (PM) and flexor carpi radialis (FCR) significantly decreased during serve and forehand drives. EMG level of extensor carpi radialis activity decreased only during forehand drives. Force (-14%) and PM EMG amplitude declined during IMVC after fatigue. EMG activity for FCR was significantly lower in post-IMVC than in pre-IMVC while force stayed unchanged. Discussion This study demonstrates that a fatigue protocol can simulate physiological strain induces by intense rallies and that generates significant performance decrease during serve and forehand drives. Velocity and accuracy losses were accompanied by a significant EMG decrease observed during tennis strokes and IMVC for PM and FCR principally. As discussed by Welsh (2002), fatigue seems to be associated with a decrement in central control. Thus players have to decrease velocity in order to maintain a high degree of accuracy in serve whereas during forehand the preservation of velocity appeared to be detrimental on stroke accuracy. References Davey P.R, Thorpe R.D, Williams C. (2002). J Sports Sci, 20(4), 311-8. Hornery D.J, Farrow D, Mujika I, Young W. (2007). Sports Med, 37(3), 199-212. Welsh R.S, Davis J.M, Burke J.R et al. (2002). Med Sci Sports Exerc, 34 (4), 723-31

## ANALYSIS OF MECHANICAL PARAMETERS RELATED TO FATIGUE IN HIGH LEVEL SPRINTERS DURING SPRINT WORKOUTS

GARNACHO-CASTANO, M.V.1, CUADRADO-PENAFIEL, V.2, ORTEGA-BECERRA, M.A.3, MATÉ-MUNOZ, J.L.1, CONCEICAO, F.4, JIMÉNEZ-REYES, P.1,5

1: *Universidad Alfonso X El Sabio, UAX (MADRID, ESPAÑA)*, 2: *UCLM (CASTILLA LA MANCHA, ESPAÑA)*, 3: *UPO (SEVILLA, ESPAÑA)*, 4: *FADEUP (PORTO, PORTUGAL)*, 5: *UCAM (MURCIA, ESPAÑA)*

**Introduction** The ability to sprint is a key parameter in many sports and the focus of many training programs. Biomechanically sprint is composed of acceleration, maximum velocity and deceleration phases (Volkov & Lapin, 1979). Contact time, top speed and the moment in which this top speed is achieved in a sprint race are parameters influencing the performance in sprint running (Gajer et al, 1999). To our knowledge, no data exists that analyse the relationship between these parameters and phases of a sprint race. Thus, the aims of this study were: 1) to measure mechanical parameters during maximal sprint running in different distances, 2) to investigate relationships between those mechanical parameters and different phases for a sprint race, and 3) to quantify changes in these data due to fatigue induced by sprints repetition. **Methods** Nine high level sprinters (age  $23.1 \pm 4.4$ yr, body mass  $73.7 \pm 4.6$ kg, height  $177.6 \pm 5.9$ cm; body fat  $9.6 \pm 2.9\%$ ) participated in the study. They did sprints of 40, 60 and 80m at maximum speed possible up to lose 3% of the speed. Instantaneous running velocity ( $v$  in  $m \cdot s^{-1}$ ) over time and distance was recorded with a radar Stalker ATS System™ (Radar Sales, Mineapolis, MN, US). Contact time was analyzed by photogrametry with Kwon3D biomechanical analysis software (Vison, Cheolsan-dong, Korea). **Results** In this study, fatigue was induced by repeated maximal efforts, leading to a decrease in performance over the different distances respectively. Top speed and the moment which is achieved in the race significantly decreased ( $p < 0.001$ ); likewise contact time in the different phases significantly increased ( $p < 0.001$ ): values increased 2% for acceleration phase to 15% in deceleration phase. **Discussion** This study highlights the importance of Rate of Force Development (RFD) like one of the most important factors influencing performance in sprint. This is by the fact that the values of strength and power as the fatigue is necessary to be greater when the available time to apply force is lower (Hakkinen, 1989), and this is what happens during the maximum speed phase, in which the available time to apply force is lower than in the acceleration phase. Thus, the marked alterations observed in this study during repeated running sprints, which in turn is affected by fatigue and this on key parameters in sprint performance (i.e. contact time and top speed). Such data would provide new information on the mechanical manifestation of fatigue during repeated sprinting, which would then be used to design optimal training routines to improve athlete's sprint training session. **References** Gajer, Thépaut-Mathieu & Lehenaff. (1999) Evolution of stride and amplitude during course of the 100m event in athletics. *New Stud Athlet.*;14(1): 43-9. Hakkinen, K. (1989). Neuromuscular and hormonal adaptations during strength and power training. *J. Sports Med.* 29(1): 9-26. Volkov I and Lapin V. Analysis of the velocity curve in sprint running. *Med Sci Sports* 11: 322-327, 1979.

## EFFECTS OF INDUCED MENTAL FATIGUE ON PHYSICAL PERFORMANCE DURING PROLONGED INTERMITTENT SPRINTING

Coutts, A.J.1, Smith, M.1, Marcora, S.2

1: *UTS (Sydney, Australia)*, 2: *University of Kent (Medway, United Kingdom)*

**Introduction** Mental fatigue has been shown to impair performance during constant-power exercise, however its effects on performance during freely paced exercise are yet to be examined. The purpose of this study was to examine the influence of induced mental fatigue on performance during prolonged, intermittent sprinting. Furthermore, the study aimed to investigate the physiological and psychological factors that underpin any potential changes. **Methods** In this single blind, randomized, crossover study, eight team sport athletes (age:  $21 \pm 2$  y, stature:  $182 \pm 4$  cm, body mass:  $76 \pm 6$  kg,  $VO_{2max}$   $47 \pm 4$  ml/kg/min) completed a 45-min intermittent running protocol that simulated typical team activity demands on a non-motorised treadmill on two separate occasions, following either 90-min of demanding mental activity (mental fatigue) or 90-min of emotionally neutral documentaries (control). The 45-min protocol consisted of one 3-min block repeated 15 times to allow for data comparison. Velocity and distance were measured at a frequency of 10 Hz throughout the protocol and analysed in 3-min blocks. Heart rate (HR) and oxygen consumption were recorded as 5-s averages while blood glucose and lactate concentrations were measured every 9 min. All physiological variables were analysed in 9-min blocks. Rating of perceived exertion (RPE) was measured every 5-min using a CR-100 scale. The effects of condition on all variables were tested using two-way repeated-measures ANOVA. **Results** The demanding cognitive task increased mental fatigue ( $P < 0.05$ ), which caused a reduction in velocity of lower intensity activities (LIA) ( $P < 0.001$ ) while higher intensity activities and peak sprint velocity were not different between conditions. A condition  $\times$  time interaction effect was also observed for LIA velocity ( $P = 0.003$ ). Mean oxygen consumption and HR were lower in the mental fatigue condition (oxygen consumption:  $34 \pm 4.9$  ml/kg/min; HR:  $158 \pm 15.8$  bpm) when compared with the control condition (oxygen consumption:  $36 \pm 4.0$  ml/kg/min; HR:  $160 \pm 11.9$  bpm;  $P < 0.001$ ), while blood glucose and lactate concentrations were not affected by mental fatigue. When normalised to velocity, RPE was higher in the mental fatigue condition ( $P = 0.027$ ). **Discussion** Mental fatigue impairs performance during prolonged intermittent running. This is primarily observed as a reduction in LIA velocity. It appears that this reduction in performance is not mediated through physiological mechanisms but rather the athletes perceived exertion. Future studies should explore this relationship between mental fatigue and physical performance further.

## PASSIVE VERSUS ACTIVE COLD WATER IMMERSION POST-EXERCISE: CORE TEMPERATURE 'AFTER' AND SUBSEQUENT EXERCISE PERFORMANCE.

Crampton, D.

*Trinity College Dublin*

**PASSIVE VERSUS ACTIVE COLD WATER IMMERSION POST-EXERCISE: CORE TEMPERATURE 'AFTERDROP' AND SUBSEQUENT EXERCISE PERFORMANCE.** Crampton, D. 1, Donne, B. 1, Warmington, S.2, Egana, M.1 1: Physiology Department, Trinity College Dublin, Ireland, 2: Exercise and Nutrition Sciences, Deakin University, Melbourne, Australia. **Introduction** Cold water immersion (CWI) is a popular recovery intervention following high-intensity training and competition across a variety of sports. 'Afterdrop' is the decrease in core temperature ( $T_c$ ) occurring after prolonged CWI. This study investigated the magnitude of the afterdrop induced and sprint capacity following active and passive CWI. **Methods** Male triathletes ( $n=8$ ) completed sets of 3 by 30-s Wingate tests (4 min rest interval) on a Lode electromagnetic cycle ergometer pre- and post- randomised 30-min recovery periods. Passive hip-level CWI at  $15^\circ\text{C}$  (CW15) was compared with active CWI at  $15^\circ\text{C}$  (CW15-EX), active thermoneutral immersion at  $34^\circ\text{C}$  (TWI-EX) and active non-immersed control (CON-EX). The active component consisted of seated arm-cranking at 40%  $P_{max}$  on an adapted Monark cycle ergometer during the immersion phase. At 3 hour pre-

test volunteers ingested a gastrointestinal sensor (CorTemp); core temperature (T<sub>c</sub>) and blood lactate (BLa) data were assessed at regular intervals during exercise and recovery. Data were analysed using two-way repeated measures ANOVA, detected differences quantified using post-hoc Tukey tests ( $P < 0.05$ ) and presented as mean  $\pm$  SEM. Results Recovery delta T<sub>c</sub> (pre- to post-recovery) was significantly greater following CW15 (-0.8  $\pm$  0.2) compared with CW15-EX, TWI-EX and CON-EX (-0.2  $\pm$  0.1; -0.1  $\pm$  0.1; -0.2  $\pm$  0.1 °C, respectively;  $P < 0.05$ ). The initial post-immersion afterdrop (delta T<sub>c</sub>: end-recovery to start-exercise) was significantly greater following CW15-EX and CW15 (-0.4  $\pm$  0.1; -0.4  $\pm$  0.1) vs. TWI-EX and CON-EX (-0.1  $\pm$  0.1; 0.0  $\pm$  0.0 °C, respectively;  $P < 0.001$ ). Relative BLa post-recovery expressed as % remaining was greater following CW15 (58  $\pm$  2%) vs. CW15-EX, TWI-EX and CON-EX (39  $\pm$  2; 45  $\pm$  3; 39  $\pm$  2%, respectively;  $P < 0.001$ ) inferring reduced lactate clearance. Average mean power normalised to body mass was significantly lower following CW15 (7.3  $\pm$  0.1) vs. CW15-EX, TWI-EX and CON-EX (7.7  $\pm$  0.2; 8.0  $\pm$  0.2; 7.9  $\pm$  0.2 W.kg<sup>-1</sup>, respectively;  $P < 0.001$ ). In addition, average mean power normalised to body mass was significantly lower following CW15 and CW15-EX (7.3  $\pm$  0.1; 7.7  $\pm$  0.2) compared with pre-recovery data (7.9  $\pm$  0.2; 8.1  $\pm$  0.2 W.kg<sup>-1</sup>,  $P < 0.05$ ), however, following TWI-EX and CON-EX data were unchanged. Discussion Arm-cranking exercise (40% P<sub>max</sub>) limited the decrease in T<sub>c</sub> during CWI; however, both passive and active CWI resulted in a significant core temperature afterdrop effect post-immersion. Overall BLa clearance during CWI was significantly improved with the addition of low intensity arm exercise. Both passive and active CWI had a negative effect on subsequent sprint performance however this effect was greatest following passive CWI.

## THE EFFECT OF ICE SLURRY INGESTION ON PERCEIVED THERMAL STRESS AND FLUID INTAKE DURING A SIMULATED TRIATHLON

Dascombe, B.J., Stevens, C., Callister, R., Sculley, D.V., Boyko, A.

*University of Newcastle (Newcastle, Australia)*

**Introduction** The effect of internal pre-cooling strategies prior to exercise has been of research interest in recent times (Siegel and Laursen, 2012), however the efficacy of internal cooling strategies is largely unknown. Perceptions of thermal stress (PTS) and thirst (as measured through voluntary fluid intake (VFI)) assist in the regulation of endurance performance in the heat (Schlader et al. 2011). Therefore, this study investigated the effect of ice slurry ingestion on measures of PTS and VFI during the run leg of a simulated triathlon. **Methods** Nine well-trained male triathletes (29.1  $\pm$  3.6 yrs, 61.7  $\pm$  4.7 mL.kg<sup>-1</sup>.min<sup>-1</sup>, best ODT time: 02:10:37  $\pm$  00:08:32 hr) performed two randomised trials of a simulated triathlon in controlled hot conditions (32-34°C). The triathlon consisted of a paced 1.5 km swim (pool) and 1 hr cycle (ergometer), prior to a self-paced 10 km (treadmill) run. In the middle half of the cycle leg, participants consumed either 10 g.kg<sup>-1</sup> BM of ice slurry (ICE) or room temperature (CON) sports drink. Water intake was also allowed ad libitum throughout the cycle leg and at 2 km intervals in the run leg. Physiological and perceptual measures (100mm visual analogue scales) were taken during the cycle and run legs. Paired sample t-tests and two-way repeated-measures analysis of variance with Scheffe post hoc tests were used to determine the effects of ice slurry ingestion. **Results** Overall, self-paced 10 km run time significantly improved in the ICE condition (43.4  $\pm$  3.7 vs. 44.6  $\pm$  4 min;  $P = 0.03$ ). Voluntary fluid intake was significantly ( $P = 0.03$ ) lower in the ICE (1258  $\pm$  401 mL) compared to the CON (1393  $\pm$  356 mL). PTS was significantly lower at 5 km of the run leg in ICE (73  $\pm$  9 vs. 80  $\pm$  7 mm;  $P = 0.04$ ) and remained lower throughout the rest of the run leg. Importantly, the 5-10 km split was significantly different between conditions (21.3  $\pm$  1.9 vs. 22.1  $\pm$  2.4 min;  $P = 0.02$ ). Heart rate, sweat rate, and rating of perceived exertion were similar between conditions. **Discussion** These results demonstrate that ice slurry ingestion has a significant effect on triathlon performance, which may be a result of a reduction in the PTS during exercise. Alterations in PTS have been related to the self-selection of exercise intensity, with an increase in PTS having been shown to be related to a decrease in self-selected exercise intensity in the absence of an increased rectal temperature (Schlader et al. 2011). The reduction in VFI in the ICE condition may reflect an anticipatory response to an increase in body heat content (Sawka and Noakes, 2007). As such, the ingestion of ice slurry during endurance exercise appears to be effective in providing both physiological and perceptual thermoregulatory relief. **References** Siegel, R. and Laursen, P.B. (2012) *Sports Med.* 42(2), 89-98. Schlader, Z.J., Simmons, S.E., Stannard, S.R. and Mundel, T. (2011) *Physiol Behav.* 103, 217-224. Sawka, M.N. and Noakes, T. (2007) *Med Sci Sports Ex.* 39(8), 1209-1217.

## LIVE HIGH-TRAIN LOW IN THE HEAT: AN EFFICIENT NEW TRAINING MODEL?

Buchheit, M.1, Racinais, S.2, Bilsborough, J.3,4, Hocking, J.3, Mendez-Villanueva, A.1, Bourdon, P.1, Voss, S.1, Livingston, S.3, Cordy, J.3, Coutts, A.J.3,4

*ASPIRE*

1. ASPIRE, QATAR 2. Aspetar, QATAR 3. Carlton Football Club, AUSTRALIA 4. UTS, AUSTRALIA **Introduction** The purpose of the present study was to examine performance and physiological responses to a 14-day pre-season training camp combining heat exposure and hypoxia during sleeping (hypoxia) and training (hypoxia and heat) in 17 professional Australian Rules Football (ARF) players (22  $\pm$  2 yr). **Methods** Players participated in 10 outdoor ARF-specific skills (32  $\pm$  1°C, 39  $\pm$  5% RH, total=11.5 h) and 8 indoor strength (23  $\pm$  1°C, 57  $\pm$  2%) sessions. In addition, they slept (12 nights) and cycled indoors (22  $\pm$  1°C, 58  $\pm$  2%, 7 'interval cycling' sessions, total 4.3 h) in either normal air (NORM, n=8) or normobaric hypoxia (14  $\pm$  1 h/day, 2500-3000m, HYP, n=9). The camp was followed by a week of unloaded training (4 skills [ $\approx$ 29°C,  $\approx$ 55%] and 7 strength [indoor] sessions, 10.5 h) and 10 d of unsupervised training. Training load was monitored using session-RPE x duration. Players performed the Yo-Yo Intermittent Recovery level 2 (Yo-YoIR2) in temperate conditions (23  $\pm$  1°C, 57  $\pm$  2%, normal air) at pre, post and 3 weeks post camp. Hemoglobin mass (Hbmass) and blood volume (BV) were measured at similar time points. **Results** There was no clear difference in total training load between both groups during the camp (9786  $\pm$  286 vs. 9904  $\pm$  200 A.U. for HYP vs. NORM, respectively, -1% 90%CL (-3;1)) and the following weeks. Both groups showed very large improvements in Yo-YoIR2 post camp (+44% (38;50), ES = +2.3), with no between-group differences in the changes (-1%(-9;9) for HYP vs. NORM). Three weeks post camp, there was a possibly better Yo-YoIR2 performance maintenance in HYP (+6%(-2;15) for HYP vs. NORM). In HYP, Hbmass was likely (+3%(1;5), ES = 0.3) and very likely (+6%(2;10), ES = 0.7) increased post camp and 3 weeks after, respectively. Conversely, Hbmass did not change in NORM (0%(0;0) post camp). Post camp, both groups showed a likely (HYP, +4%(0;7), ES = 0.5) and very likely (NORM, +5%(2;9), ES = 0.8) increase in BV. Three weeks after, BV was very likely further increased in HYP (+7%(3;11) compared with pre-camp, ES = 1.3), while it tended to return to baseline in NORM (+2%(-5;9), difference rated as unclear). **Discussion** Large increases in BV and high-intensity, intermittent running performance were observed after only 2 weeks using the present training model, with no additional benefit of hypoxic exposure at this time. However, only players that were exposed to hypoxia maintained their physical performance 3 weeks post camp, which was associated with an increased Hbmass and BV. While heat exposure is likely to account for rapid and important (but transient) changes, hypoxic exposure may enable more consistent (but delayed) effects. **In conclusion**, in addition to the well-known heat and/or altitude acclimation effects, the combination of heat and hypoxic exposure during sleeping/training times might offer a promising 'conditioning cocktail' in team sports.

09:50 - 11:20

## Oral presentations

## OP-PM54 Physiology: Performance / Hypoxia

**ALLOMETRIC SCALING TO PREDICT TIME TRIAL PERFORMANCE AND MAXIMAL OXYGEN CONSUMPTION. DIFFERENCES BETWEEN MALE AND FEMALE CYCLISTS.**

Davidowitz, K.J.1, Lambert, M.I.1, Noakes, T.D.1, Lamberts, R.P.1

*1: UCT/MRC Research Unit for Exercise Science and Sports Medicine, Department of Human Biology, University of Cape Town, South Africa.*

Introduction A recent publication by Lambert et al (2012) showed allometric scaling of peak power output (PPO) was the most accurate method to predict 40km time trial (40km TT). This finding confirmed that the proposed allometric scaling method by Swain (1994) can, in addition to professional cyclists (Mujika et al, 1998), also be used in trained in well-trained male cyclist. However, as females have different body compositions than males, relatively higher body fat and lower muscle mass percentages, it is questionable if the same allometric scaling methods can also be used in female cyclists. Therefore the aim of this study was to determine if the same allometric scaling method used in male cyclists can also be used in female cyclists to predict 40km TT performance. Methods Twenty trained to well-trained female cyclists ( $287 \pm 25$  W;  $50.5 \pm 3.4$  ml/min/kg), between the ages of 18 and 45 years, completed a peak power output (PPO) test (including respiratory gas analysis (VO<sub>2</sub>max)) and a 40km flat time trial (TT). All tests were performed between days 7 to 21 of the participant's menstrual cycle to ensure that this had no effect on the measured performance parameters. After the tests, relationships between VO<sub>2</sub>max and 40km TT performance and absolute (W), relative (W/kg) and peak power output normalized for body mass to the exponent of 0.32 (W/kg<sup>0.32</sup>) were determined. Relationships found in the female cyclists were compared to a data set of 45 trained to well-trained male cyclists (Lamberts et al. 2012). Results In the female cyclists, strong relationships were found between PPO and VO<sub>2</sub>max. A similar relationship between male and female cyclists was found when PPO and VO<sub>2</sub>max were expressed absolutely (W and l/min, respectively). However when PPO and VO<sub>2</sub>max were expressed relatively (W/kg and ml/min/kg, respectively) a similar slope but different y-axis intercept was found ( $p < 0.0001$ ). In the female cyclists, 40km TT performance (s) also showed to have the strongest relationship with allometrically scaled PPO ( $r = -0.87$ , 95% CI - 0.95 to - 0.70,  $p < 0.0001$ ). When this relationship was compared to male cyclists, a different slope was found allometrically scaled PPO (W/kg<sup>0.32</sup>) and 40km TT performance (s) ( $p = 0.0005681$ ). Discussion As in males, the strongest relationship with 40km TT time in female cyclists was found with allometrically scaled PPO (W/kg<sup>0.32</sup>). However when comparing the relationship found in female cyclists to male cyclists significant slope differences were found, suggesting that additional weight in female cyclists is less of an advantage when performing a flat TT performance than in male cyclists. This can possibly be explained by difference in body composition between male and females, as additional weight in females consists of relatively more body fat and less muscle mass than in males. References Lamberts RP, Swart J, Lambert MI, Noakes TD. (2012). *Br. J. Sports Med.* 10, 33-44 Swain DP. (1994) *Med Sci Sports Exerc.* 26:58-63. Mujika I, Padilla S. (2001) *Sports Med* 31, 479-87.

**THE EFFECT OF WHOLE-BODY PRE-COOLING ON 30KM SELF-PACED CYCLING IN THERMONEUTRAL AND WARM ENVIRONMENT CONDITIONS**

Oliveira, G.G.A.1,2, Maia-Lima, A.1, Ramos, G.P.1, Pacheco, D.A.S.1, Goulart, K.N.O.1, Nunes-Leite, M.M.S.1, Amorim, F.T.4, Silami-Garcia, E.1, Gomes, E.C.1,3

*1 Exercise Physiology Laboratory, Federal University of Minas Gerais (UFMG), 2 Catholic University of Minas Gerais, Brazil; 3 Biochemistry and Immunology Department, UFMG, Brazil; 4 Exercise P*

Endurance exercise induces hyperthermia and increases physiological strain. When a warm environment is added these variables are further affected and so is performance. Nevertheless, the effects of pre-exercise cooling in these responses remain unclear, be it in a warm or thermoneutral environment. Therefore, the aim of this study was to investigate the effects of a pre-exercise whole-body cooling method on physiological strain and performance during a 30km time trial cycling in two environments. Methods: 8 male cyclists (mean $\pm$ SD: 28.8 $\pm$ 2.7 years; 72.7 $\pm$ 8.4 kg; 9.7 $\pm$ 2.4 % body fat; 58.2 $\pm$ 11.0mlO<sub>2</sub>/kg/min) performed, in a randomized balanced order, four 30km time trials in an environmental chamber set at: warm (35°C; 68%RH) and thermoneutral (24°C, 68%RH). In two trials, the exercise was preceded by a whole-body water immersion (24°C) until rectal temperature (Tre) decreased 0.4°C compared to rest value. The exercise was then performed either in the warm (PREC35) or the thermoneutral (PREC24) environment. The other two trials were the control conditions, and exercise was performed without the cooling procedure (CON24 and CON35). Throughout the exercise protocols the subjects' Tre, heart rate (HR) and thermal comfort were measured every 2km and they were allowed water ad libitum. Data was analyzed using a 3-way ANOVA with repeated measures and Tukey's post-hoc test (STATISTICAL 7.0 Program). Values are reported as mean $\pm$ SD. Results: Subjects' performance was significantly impaired in the heat ( $p < 0.05$ ), and was not affected by pre-cooling ( $p = 0.063$ ) (PREC24= 54.7 $\pm$ 4.4min; CON24= 56.0 $\pm$ 4.0min; PREC35= 59.6 $\pm$ 3.4min; CON35= 61.0 $\pm$ 3.4min). Tre was affected both by the environmental conditions and by the pre-cooling (PREC24= 36.4 $\pm$ 0.3°C at 0km; 38.7 $\pm$ 0.3°C at 30km; CON24 = 37.0 $\pm$ 0.2°C at 0km; 38.7 $\pm$ 0.4°C at 30km; PREC35=36.3 $\pm$ 0.5°C at 0km; 39.0 $\pm$ 0.4°C at 30km; CON35= 37.2 $\pm$ 0.2°C at 0km; 39.7 $\pm$ 0.5°C at 30km). HR was significantly lower pre-exercise in the pre-cooling conditions but was not affected by the environmental conditions. In the thermoneutral environment subjects' reported a better thermal comfort but this variable was not affected by the pre-cooling procedure. Conclusion: The pre-cooling method was not sufficient to improve performance on a 30km time trial cycling in a thermoneutral or warm environment conditions, despite the reduced Tre observed in the pre-exercise cooling conditions.

**WIND COOLING DURING A SELF-PACED CYCLING TIME TRIAL**

Teunissen, L., de Haan, A., de Koning, J., Daanen, H.

*VU University Amsterdam*

WIND COOLING DURING A SELF-PACED CYCLING TIME TRIAL Teunissen, L.1,2, de Haan, A.1,3, de Koning, J.1, Daanen, H.1,2 1: MOVE, VU University (Amsterdam, The Netherlands), 2: TNO (Soesterberg, The Netherlands), 3: MMU (Manchester, UK) Introduction Wind has been



shown to be an effective cooling method during fixed-paced exercise in the heat, decreasing thermal strain and increasing time to fatigue. However, it has been scarcely investigated in what way these observations translate to self-paced performance. So the aim of this experiment was to study how wind cooling affects thermal strain, thermal perception, pacing and performance during a 15 km cycling time trial in strenuous climatic conditions. Methods Ten male subjects performed two 15 km cycling time trials in a climatic chamber set at 28°C and 80% relative humidity. In one of the time trials, a wind tunnel unexpectedly provided head wind (~4 m/s) during the middle part of the race (3-12 km). Conditions (control: CO and wind: WI) were offered in balanced order with at least two days in between. Measurements included rectal temperature (Tre), average skin temperature (Tsk), heart rate (HR), fluid loss, rate of perceived exertion (RPE, each km), thermal sensation (TS, each 5 km), thermal comfort (TC, each 5 km), power output (PO) and finish time. Results WBGT was similar at the start of both trials (26.5±0.08°C) and dropped when wind was applied to 26.0±0.04°C. Overall, subjects had a higher PO in the WI-trial than the CO-trial (246±11 vs. 235±9 W), leading to a 75±24 s faster finish time. Per kilometer, PO differences between conditions were detected from km 4 to 14. These differences were largest in km 4 and km 11-14 (14-19 W). Tre was similar for CO and WI during each kilometer of the trial. However, wind application induced a clear difference in Tsk from km 4 to 15, being maximally 1.98±0.16°C lower for WI than for CO (km 12). This was reflected in lower RPE values during km 5-13 and improved TS and TC values at the 5 and 10 km mark of the WI-trial. HR was lower during km 10-15 of WI (about 4-6 bpm). No differences in fluid loss and fluid ingestion were observed. Discussion Despite a nearly similar WBGT value, wind application during self-paced exercise in a warm humid environment substantially reduced thermal strain and improved performance. Wind instantly induced a decrease in Tsk, attenuation of RPE and increase in power output. The higher PO was maintained throughout the wind interval at similar or lower Tre and HR values than during the CO-trial, with subjects feeling less exerted, cooler and more comfortable. This may have led to the slightly increased power profile in the last 5 km of the WI-trial (even though wind stopped blowing at 12 km), while PO in the CO-trial was not increased until the final kilometer. In conclusion, wind is an effective tool to provide immediate and constant benefits in thermal perception and performance during self-paced exercise in the heat.

### THE INFLUENCE OF HIGH ALTITUDE TRAINING ON CERTAIN IMMUNOLOGICAL AND HAEMATOLOGICAL COMPONENTS AS WELL AS ON THE PERFORMANCE OF MIDDLE AND LONG DISTANCE RUNNERS

Coetzee, B.

*North-West University*

Coetzee, B. 1: NWU (Potchefstroom, South Africa) Introduction A fair amount of controversy exist with regard to the benefits of altitude training for improved sea-level performance (Friedmann-Bette, 2008). Therefore, the purpose of this study was to determine what influence a three week long altitude training program at 3200m above sea-level have on certain haematological and immunological components as well as the distance and sprint running performance of middle and long distance athletes. Methods Nine middle and long distance runners of the university's athletics team were recruited to participate in the study. On the first pre-test day athletes completed a questionnaire after which their body weight and stature were taken. After a warm-up period, blood samples were taken (pre 1), followed by the execution of either a 2- or 5-min distance-in-time-test. Blood samples were again taken after completion of the test (pre 2). A rest period of 5 minutes followed after which a 300m-sprint test was completed and more blood samples taken (pre 3). The athletes then participated in a training camp for three weeks at an altitude of 3200m above sea level. Following the three weeks, each of the athletes were again subjected to the last mentioned tests (post 1, post 2 and post 3). The blood samples were analysed for the following haematological and immunological components: blood lactate, whole blood cell count (WBC), red blood cell count (RBC), haemoglobin blood content (HGB), hematocrit blood count (HCT), mean cell volume (MCV), mean cell haemoglobin volume (MCH), mean cell haemoglobin concentration volume (MCHC), red cell distribution width (RDW), platelet count (PLT), neutrophil (NE), lymphocyte (LY), eosinophil (EO), basophil (BA) and monocyte (MO) blood cell count. Results Only blood lactate (pre 3 to post 3), RBC (pre 1, 2, 3 to post 1, 2, 3), HGB (pre 1, 2, 3 to post 1, 2, 3), HCT (pre 1, 2, 3 to post 1, 2, 3), MCHC (pre 1, 2 to post 1, 2), PLT (pre 1 to post 1) and MPV (pre 3 to post 3) revealed large practical significant differences between the measurements for the pre- and post-altitude training periods when the effect sizes were determined. None of the other haematological and immunological components or performance related variables obtained large practical significant values in terms of the pre- and post-altitude training differences. Discussion In conclusion, these results show that a three week long altitude training program at 3200m above sea-level was sufficient in enhancing haematological components which are related to the oxygen carrying capacity of the blood, but insufficient in changing the immunological components and to improve the distance and sprint running performances of middle and long distance athletes. Sport scientists, therefore, need to investigate the efficacy of altitude training programs, especially in view of the financial implications of these programs. References Friedmann-Bette, B. (2008). Classical altitude training. *Scandinavian Journal of Medicine and Science in Sports*, 18(1), 11-20.

### THE EFFECTS OF NORMOBARIC HYPOXIA ON MITOCHONDRIAL RESPIRATION IN HUMANS.

Bishop, D.J., Ferri, A., Granata, C., Oliveira, R.S.F., Hedges, C., Miserocchi, G., Lima-Silva, A.E.

*Victoria University*

Introduction In response to stays at high altitude, contrasting mitochondrial changes have been reported. An early study reported increases in cytochrome c oxidase, while more recent research has observed decreases in oxidative capacity [1]. Consistent with this latter study, researchers have also observed decreases in mitochondrial volume, which were accompanied by increases in lipofuscin [1]. However, none of these studies directly measured mitochondrial respiration. We have recently observed an increase in maximal ADP-stimulated mitochondrial respiration in rats after 30 days of normobaric hypoxia (10% O<sub>2</sub>). The purpose of this study was to investigate the effects of 19 days of normobaric hypoxia on mitochondrial respiration in humans. Methods Five untrained men lived at altitude (3500 m), 24 h/day, for 19 consecutive days. Muscle biopsies were taken from the vastus lateralis muscle before and immediately following the stay at altitude. Maximal (5 mM ADP) ADP-stimulated mitochondrial respiration was determined on permeabilised muscle fibers. Both daily physical activity and caloric intake were monitored before entering the altitude hotel, and were subsequently maintained at these levels for the duration of the stay. Results There was a 10% increase in maximal ADP-stimulated respiration for both complex I and the combination of complex I and II following 19 days of living at 3500 m. There was no change in non-coupled respiration, but a 20% increase in complex IV reserve respiration. Interestingly, ADP sensitivity (0.1 mM ADP) showed no significant change. Discussion We have shown for the first time that there is an increase in mitochondrial respiration in humans after exposure to 19 days of hypoxia. This increase is similar to that found in a previous study in rats (16%, ns) [2], and also to our unpublished data with rats. Our results indicate that mitochondrial adaptations are complex, and that prolonged exposure to high altitude (3500 m) promotes increases in mitochondrial respiration despite previous reports of decreases in mitochondrial volume. References 1. Hoppeler, H. and M. Vogt, *Muscle tissue adap-*

tations to hypoxia. *J. Exp. Biol.*, 2001. 204: p. 3133-3139. 2. Novel-Chaté, V., et al., Chronic Exposure of Rats to Hypoxic Environment Alters the Mechanism of Energy Transfer in Myocardium. *Journal of Molecular and Cellular Cardiology*, 1998. 30(7): p. 1295-1303.

### PROLONGED EXERCISE IN HYPOXIA INDUCES TISSUE-SPECIFIC OXYGENATION PROFILES

RUPP, T.1, JUBEAU, M.1,2,3, WUYAM, B.1, MILLET, G.Y.1,3, PERREY, S.4, VERGES, S.1

1. HP2 (Grenoble, France), 2. MIP (Nantes, France), 3. LPE (Saint-Etienne, France), 4. M2H (Montpellier, France)

Introduction: Tissue oxygenation, assessed by near-infrared spectroscopy, is altered during hypoxia at rest and during exercise (1). However, it remains still debated, depending on hypoxia severity and exercise characteristics, whether the tissue oxygenation perturbations are similar between sites especially within cerebral areas implicated in motor output (2). Also, it is unknown how far systemic arterial desaturation impacts muscle and cerebral oxygenation during exercise in hypoxia. The purpose of our study was to compare arterial and tissue oxygenation on multiple sites during prolonged submaximal cycling in hypoxia. Methods: Twelve healthy males completed three experimental conditions. After a 4-h wash-in period, either in normoxia (NE,  $FiO_2=21\%$ ) or hypoxia (HE,  $FiO_2=11\%$ ), subjects performed a 80-min cycling exercise at 45% of their maximal aerobic power. A 3rd control condition, in hypoxia, consisted on a 80-min resting period in which the arterial saturation ( $SpO_2$ ) reached during HE was matched by adjusting  $FiO_2$  (HR,  $FiO_2=9\%$ ). Quadriceps, prefrontal (PFC) and motor cortices oxy[HbO<sub>2</sub>]- deoxy[Hb] and total[THb]-haemoglobin concentration changes were continuously investigated using near-infrared sensors to assess tissue oxygenation status. Results: HR and HE resulted in similar  $SpO_2$  reduction ( $\approx -20\%$ ). For the quadriceps, exercise-induced [Hb] rises were associated with increased and unchanged [THb] in NE and HE, respectively, while [THb] dropped significantly in HR. PFC showed a large [THb] increase at exercise with a four-fold [HbO<sub>2</sub>] increase compared to [HHb] in NE versus a four-fold [Hb] increase compared to [HbO<sub>2</sub>] in HE. Motor cortex showed similar [HbO<sub>2</sub>] decrease and [HHb] increase than PFC in HR but not at exercise. Indeed, motor cortex [THb] was stable in HE and NE while [HbO<sub>2</sub>] decreased and [HHb] increased in NE, these latter changes being significantly accentuated in HE. Discussion: This study quantifies for the first time the respective effects of prolonged cycling exercise and systemic arterial desaturation in muscle and cerebral oxygenation responses in hypoxia. These results demonstrate that specific responses to prolonged exercise and/or hypoxia are found between tissues and between cortical sites implicated in physical exercise, as shown by concomitant CPF hyperoxygenation and motor cortex deoxygenation in NE. References: 1. Verges S, Rupp T, Jubeau M, Wuyam B, Esteve F, Perrey S, Millet GY, In Press, *Am J Physiol Regul Integr Comp Physiol*. 2. Subudhi AW, Miramon BR, Granger ME, Roach RC, 2009, *J Appl Physiol* 106(4): 1153-8.

11:30 - 12:45

## Plenary sessions

### PS-PL04 Sport Science in the Heart of Europe (\*)

#### PHYSICAL ACTIVITY, FITNESS, AND HEALTH

Ainsworth, B.

*Arizona State University*

In 1985, Professor Claude Bouchard provided a model showing the relationships between heredity, health-related fitness, physical activity, health, and multi-level factors. Health-related fitness includes morphological, muscular, motor, cardiorespiratory, and metabolic conditions. Health outcomes include wellness, morbidity, and mortality. Physical activity domains include leisure, occupation, transport, and home activities. Multi-level factors include lifestyle behaviors, personal attributes, physical environment, and the social environment. This presentation provides an overview of the model and highlights key research to support and extend the reach of Bouchard's model as a research paradigm for understanding the importance of physical activity on health and longevity.

13:45 - 14:45

## Poster presentations

### PP-PM58 Physiology 14

#### HEMORHEOLOGICAL ALTERATIONS IN YOUNG SUBJECTS DUE TO ACUTE EXERCISE.

Alis, R.1, Romagnoli, M.1, Ibanez, S.1, Vaya, A.2

*Universidad Catolica de Valencia*

Hemorheological alterations in young subjects due to acute exercise. Alis, R.1; Romagnoli M.1; Ibañez, S.1, Vaya, A.2 1 Catholic University Valencia (Valencia, Spain). 2 La Fe University Hospital (Valencia, Spain) Introduction: Acute exercise causes changes in red blood cells (RBC) and blood flow characteristics [1]. In this study we explore the alterations in RBC rheology and blood flow during exhaustive exercise in young subjects. Methods: 10 young subjects ( $13,90 \pm 1,60$  years, 1 male 9 female) performed an incremental maximal treadmill test in fasting conditions. Blood samples were collected before and just after cessation of exercise from antecubital vein. Samples were analyzed in the first hour after extraction. RBC deformability at 12, 30 and 60 Pa (Rheodyn SSD, Myrenne, Germany), plasma fibrinogen (ACL-TOP autoanalyzer), native blood viscosity (NBV) and corrected at 45% hematocrit at 230 s<sup>-1</sup> (Brookfield DV III; Brookfield Engineering Laboratories, Inc., Stoughton, MA, USA), plasma viscosity at 37°C (PV) (Fresenius GmbH, Germany) and basic hematological parameters were analyzed. RBC aggregation measures were performed using an erythrocyte aggregometer (Myrenne GmbH Germany) at stasis and at low shear rate, and using a SEFAM erythro-aggregometer which determines the aggregation time, the aggregation index at 10 s

and the disaggregation threshold. Differences between pre and post measures were assessed using multiple analyses of variance (MANOVA). When data weren't normally distributed non parametric tests were used. p values <0.05 were considered as statistically significant. All values as mean±sd. Results: All deformability indexes decreased significantly (p<0.001). Hematocrit augmented significantly (pre: 40,40±2,84 %, post: 41,84±2,85 %, p<0,05). PV increased with exercise (pre: 1,22±0,04 mPa•s, post: 1,27±0,05 mPa•s, p<0,05). All aggregation parameters present a not significantly decrease with exercise. NBV augmented but not significantly (pre: 4,02±0,66 mPa•s, post: 4,20±0,47 mPa•s, p=0,378). Discussion As observed in other studies [1] acute exercise has effects on RBC rheology parameters in young subjects. Native blood viscosity increased but not significantly although RBC deformability and plasma viscosity were augmented. Blood viscosity is a function of plasma viscosity, RBC aggregation, RBC concentration and RBC deformability [2]. At high shear rates aggregation doesn't occurs and blood viscosity is inversely related to RBC deformability [2]. Our data points that the observed increase in hematocrit and plasma viscosity and the decrease in RBC deformability although significantly, are not enough to cause a significant increase in blood viscosity due to acute exercise in young subjects. References 1. Brun, J.-F., et al., Hemorheological alterations related to training and overtraining. *Biorheology*, 2010. 47(2): p. 95-115. 2. Chien S, et al., Blood viscosity: influence of erythrocyte aggregation. *Science*, 1967. 157: p. 829-831.

### GREATER COMPLIANCE IN SUPERFICIAL THAN DEEP VEIN DURING RESTING AND SYMPATHOEXCITATION

Ooue, A., Sato, K., Hirasawa, A., Sadamoto, T.

*Japan Women's College of Physical Education*

Introduction Venous compliance of the extremities is a major determinant of venous pooling that contributes to return blood to central region during physiological stress. Extremities have deep and superficial veins, which return blood from muscle and skin, respectively. But superficial venous compliance has not been measured. The superficial vein has a rich innervation of sympathetic nerves compared to the deep vein and plays an important role in the thermoregulation by pooling blood and facilitating heat loss. Thus, it is hypothesized that 1) the superficial vein has a greater compliance than deep vein and 2) sympathoexcitation has a greater effect on the superficial vein than deep vein. To clarify hypotheses we compared superficial and deep venous compliance during resting and sympathoexcitation. Methods Fifteen young subjects participated in this study. Cuff on upper arm was inflated to 60 mmHg for 8 min, and the cuff pressure reduced at 1 mmHg/s from 60 to 0 mmHg (Control condition: CON). Static exercise (EXE) and cold pressor test (CPT) were used as sympathoexcitatory maneuvers. Cross sectional area (CSA) of basilic (superficial) and brachial (deep) vein of the upper arm was measured by ultrasound technique. The compliance was calculated from the equation; compliance =  $\beta_1 + 2\beta_2 \times (\text{cuff pressure})$ , in which  $\beta_1$  and  $\beta_2$  were given by the pressure-CSA curve described by Halliwill et al (1999). In addition, compliance at an arbitrary pressure of 20mmHg (C20mmHg) was determined as  $C_{20\text{mmHg}} = \beta_1 + 2\beta_2 \times 0$ . Results C20mmHg in superficial vein was greater than deep vein (CON: 0.13±0.02 vs. 0.06±0.01 mm<sup>2</sup>/mmHg, P < 0.05; EXE: 0.12±0.02 vs. 0.09±0.01 mm<sup>2</sup>/mmHg, P < 0.05; CPT: 0.14±0.02 vs. 0.08±0.01 mm<sup>2</sup>/mmHg, P < 0.05). The sympathoexcitation of EXE and CPT did not change compliance in superficial vein, but produced a higher compliance in deep vein compared to CON (P < 0.05). Discussion The higher compliance in the superficial vein than that in the deep vein was probably due to a lower external pressure to the superficial vessel. In contrast to the hypothesis, the sympathoexcitation of EXE and CPT only increased the compliance in deep vein but had no effects on the superficial vein. Since the EXE and CPT selectively reduces the arterial blood flow in the skeletal muscle, the reduction in the blood volume contained within the deep vein occurred and thereby increase in the compliance in deep vein during EXE and CPT. On the contrary, the EXE and CPT did not alter the arterial blood flow in skin area and the containing blood volume in the superficial vein and thereby producing the unchanged compliance. References Halliwill JR, Minson CT, Joyner MJ. (1999) *J Appl Physiol*, 87, 1555-1563

### METABOREFLEX CONTRIBUTION TO THE BLOOD PRESSURE CONTROL DURING ISOMETRIC EXERCISE IN BOYS AND MEN

Papadopoulos, S.I, Dipla, K.I, Zafeiridis, A.I, Kyparos, A.I, Nikolaidis, G.M.I, Vrabas, S.I.I

*Aristotle University of Thessaloniki*

METABOREFLEX CONTRIBUTION TO THE BLOOD PRESSURE CONTROL DURING ISOMETRIC EXERCISE IN BOYS AND MEN Papadopoulos, S.I, Dipla, K.I, Zafeiridis, A.I, Kyparos, A.I, Nikolaidis, G.M.,I Vrabas, S.I. 1. DPSS-AUTH(Serres, Greece) Introduction During exercise, the 'central command', the 'exercise pressor reflex' (mechanoreflex and metaboreflex), and baroreceptors integrate total peripheral resistance and cardiac output, resulting in an effective elevation of blood pressure (Kaufman et al. 1983; O'Leary, 1996; Ogoh et al. 2007). Whether the metaboreflex contribution to the arterial pressure control during isometric exercise is different in children and in adults has not been investigated. Therefore, the aim of this study was to assess in boys and men the hemodynamic parameters that control arterial pressure during the activation of the muscle metaboreflex. Methods Twelve pre-adolescent boys and twelve men performed a testing protocol involving a 3-min baseline, 3-min isometric handgrip exercise (at 30% of maximal voluntary contraction), 3-min post-exercise circulatory occlusion, and 3-min recovery. The same protocol was repeated without occlusion. Beat to beat AP was measured by finger photoplethysmography (Finometer). Results During baseline, boys had lower arterial pressure, higher heart rate, and lower low/high frequency ratio of heart rate variability (p<0.05). During exercise, heart rate was the key contributor to the arterial pressure response in adults, whereas in boys, the lower percent increase in heart rate was counterbalanced by an increase in stroke volume, resulting in similar percent increase in mean arterial pressure to adults. Post-exercise occlusion resulted in a similar elevation in blood pressure in both age groups (by ~15mmHg); however, during this period, boys exhibited a lower (p<0.05) increase in peripheral resistance and a greater bradycardic response than adults. Discussion During the isolated metaboreflex, the magnitude of the blood pressure response was similar in boys and in men. However, the interplay of the mechanisms controlling the rise in mean arterial pressure was not similar between the two groups. References Kaufman MP, Longhurst JC, Rybicki KJ, Wallach JH, Mitchell JH. (1983) *J Appl Physiol*, 55, 105-112. O'Leary DS. (1996). *Med Sci Sports Exerc*, 28, 210-217. Ogoh S, Fisher JP, Raven PB, and Fadel PJ. (2007). *Am J Physiol Heart Circ Physiol*, 293, H2202-H2209.

## HAEMOGLOBIN MASS MEASUREMENTS IN PROFESSIONAL CYCLISTS DURING A LONG STAGE RACE: THE GIRO D'ITALIA

Artuso, P., Bosio, A., Guardascione, C., Pecci, C., Riggio, M., Rampinini, E.

*Mapei Sport Research Centre*

HAEMOGLOBIN MASS MEASUREMENTS IN PROFESSIONAL CYCLISTS DURING A LONG STAGE RACE: THE GIRO D'ITALIA Artuso P.1, Bosio A.1, Guardascione C.2, Pecci C.1, Riggio M.1, Rampinini E.1,3 1: HPL, MAPEI Sport (Castellanza, Italy) 2: Team Lampre ISD (Heiden, Switzerland) 3: Faculty of Exercise and Sports Sciences, Università degli Studi di Milano (Milan, Italy) Introduction The total amount of haemoglobin in the blood (Hbmass) is an important determinant for VO<sub>2</sub>max (Heinicke et al., 2001). Schmdit and Prommer (2005) proposed an optimised CO re-breathing method for Hbmass determination. In two studies it was demonstrated that Hbmass is stable during short stage races (4 and 6 days long) in Under 23 male and top level female cyclists (Schumacher et al., 2008; Garvican et al., 2010). No study investigated Hbmass changes during a long stage race in top level professional cyclists. The aim of the present study was verify the influence of three weeks of race on Hbmass values of professional athletes. Methods Nine professional cyclists (age 31±5.5 yrs, heights 178.7±5.1 cm and body mass 67.7±5.9 kg) of the same team were involved in the study. Using a simplify CO re-breathing method (Schmdit and Prommer, 2005), Hbmass of each individual was determined before (PRE, 2 days before the start), during (MID, at day 14) and after (POST, 1 day after the race) the Giro d'Italia 2011. Three athletes did not finish the race. Data of the 6 cyclists who completed the race was used for statistical analysis. The differences in Hbmass were determined using a one way ANOVA repeated measure. Results Hbmass of the six athletes remained stable (p=0.308) during the three-week stage race (PRE, 1080±86 g; MID, 1098±66 g; POST 1100±80 g). Discussion The main finding is that the strain induced by a long stage race like the Giro d'Italia, does not seem able to determine a decrease in Hbmass of the athletes. The results of the present study confirm other information collected during shorter stage races in different population of cyclists (Schumacher et al., 2008; Garvican et al., 2010). Since the Hbmass seems to be very stable even during the stage races, the CO re-breathing may be a useful tool to detect the use of blood doping made during the competition. The results seems to confirm also that hematocrit and haemoglobin blood concentration decreases previously reported during a long stage race are probably due to plasma volume expansion in the blood (Morkeberg et al., 2009). References Garvican LA, Eastwood A, Martin M, Ross MLR, Gripper A, Gore CJ (2010). Clin J Sport Med (20):200-204. Heinicke K, Wolfarth B, Winchenbach, P, Biermann B, Schmid, A, Huber, B, Friedman B, Schmidt W (2001). Int J Sports Med (22):504-512. Morkeberg JS, Belhage B, Damsgaard R (2009). Int J Sports Med (2):130-8. Schmdit W, Prommer N (2005) Eur J Appl Physiol (95):486-495. Schumacher YO, Pottglessler T, Ahlgrim, C, Ruthardt, S, Dickhuth, HH, Roecker K (2008). Int J Sport Med (29):372-378.

## SEASONAL VARIATION OF HAEMOGLOBIN MASS IN PROFESSIONAL AND UNDER 23 CYCLISTS

Tornaghi, M., Bosio, A., Guardascione, C., Pecci, C., Connolly, D., Rampinini, E.

*Sport Service Mapei S.r.l.*

SEASONAL VARIATION OF HAEMOGLOBIN MASS IN PROFESSIONAL AND UNDER 23 CYCLISTS Tornaghi M.1, Bosio A.1, Guardascione C.2, Pecci C.1, Connolly D.1, Rampinini E.1,3 1 HPL, MAPEI Sport (Castellanza, Italy) 2 Team Lampre ISD (Milan, Italy) 3 Faculty of Exercise and Sports Sciences, Università degli Studi di Milano (Milan, Italy) Introduction Maximum oxygen uptake (VO<sub>2</sub>max) is a good indicator of the aerobic systems efficiency and it has been found to be related to Haemoglobin mass (Hbmass) (Heinicke et al., 2001). VO<sub>2</sub>max may increase after a period of intense training while Hbmass appears to remain stable during a season in endurance athletes (Prommer et al., 2008). No study has verified seasonal changes in both VO<sub>2</sub>max and Hbmass in competitive cyclists. The aim of this study was to verify seasonal changes of VO<sub>2</sub>max and Hbmass in professional (PRO) and Under 23 (U23) cyclists. Methods Ten male PRO cyclists (age 28±4 yrs, heights 176±5 cm and body mass 66.0±5.0 kg) performed an incremental test to establish VO<sub>2</sub>max and peak power output (PPO), and Hbmass was measured using an optimised CO re-breathing method (Schmdit and Prommer, 2005). Each test was performed three times during the season (November-December, pre-preseason period START; January-February, before the competitive season, PRE and March-August, during the competitive season, MID). In addition, 12 male U23 cyclists (age 20±1, heights 180±7 and body mass 73.2±10.1 kg) underwent the same evaluations twice a year (January, PRE1 and PRE2 and May, MID1 and MID2) for 2 consecutive seasons. Results In PRO cyclists absolute and relative VO<sub>2</sub>max and PPO significantly increased (all p<0.023) during the season (VO<sub>2</sub>max: 70.0±4.5, 73.7±3.4 and 73.1±4.1 ml/kg/min at START, PRE and MID, respectively and PPO: 433±52, 456±28 and 460±24 W at START, PRE and MID, respectively). Hbmass remained stable (1034±133, 1026±95 and 1025±99 g at START, PRE and MID, respectively, p=0.805). U23 cyclists absolute and relative VO<sub>2</sub>max and PPO significantly increased (all p<0.022) during the two years (VO<sub>2</sub>max: 65.7±4.7, 67.3±4.9, 69.4±4.5 and 71.1±5.1 ml/kg/min at PRE1, MID1, PRE2 and MID2, respectively and PPO: 436±37, 456±39, 453±39 and 463±33 W at PRE1, MID1, PRE2 and MID2, respectively). Hbmass remained stable (1007±169, 996±146, 1019±163 and 1003±159 g for PRE1, MID1, PRE2 and MID2, respectively, p=0.225). Discussion This study confirmed that a preparation period increases aerobic efficiency, while demonstrating that Hbmass is stable in both PRO and U23 cyclists. Other physiological factors like cardiac output or plasma volume expansion must account for the VO<sub>2</sub>max increases observed. Given that Hbmass appears to be stable across competitive seasons, the CO re-breathing method may be a useful tool to detect the use of blood doping. References Heinicke K, Wolfarth B, Winchenbach, P, Biermann B, Schmid, A, Huber, B, Friedman B, Schmidt W (2001). Int J Sports Med (22):504-512. Schmdit W, Prommer N (2005) Eur J Appl Physiol (95):486-495.

## VASCULAR FUNCTION, ATHEROSCLEROSIS AND INFLAMMATION OF NEPHRECTOMISED APOLIPOPROTEIN E KNOCK-OUT MICE IN RESPONSE TO VOLUNTARY EXERCISE OR TOCOPHEROL SUPPLEMENTATION

Coombes, J.S.1, Fasset, R.G.2, Peake, J.I, Shing, C.M.3

1: University of Queensland (Brisbane, Australia) 2: Royal Brisbane and Women's Hospital Brisbane (Brisbane, Australia), 3: University of Tasmania (Launceston, Australia)

Introduction: Elevated levels of oxidative stress, inflammation and endothelial dysfunction are believed to contribute to the development of cardiovascular disease, which begins in the initial stages of CKD. Antioxidant therapy and exercise have the potential to reduce oxidative stress, inflammation and endothelial dysfunction. The aim of this study was to investigate the effects of 12 weeks of voluntary exercise or tocopherol supplementation on vascular function, aortic plaque and inflammation using the apoE<sup>-/-</sup> mouse with 5/6 nephrectomy (NX). Methods: Following NX or sham surgery apoE<sup>-/-</sup> mice were allocated to one of six groups: 1) sham (n=8); 2) NX (n=8); 3) sham undertaking voluntary exercise (sham Ex) (n=8); 4) NX undertaking voluntary exercise (NX Ex) (n=8); 5) NX and α-tocopherol supplemented diet (n=10); 6) NX and mixed tocopherol supplemented diet (n=10). In vitro aortic smooth muscle contraction was assessed by the dose response to noradrenaline (NA) (10<sup>-9</sup> to 10<sup>-5</sup>M). Acetylcholine (ACh) and sodium nitroprusside (SNP) induced relaxation assessed endotheli-

al-dependent and endothelial-independent relaxation, respectively. Plasma cytokine and creatinine concentrations and aortic plaque area were determined at sacrifice. Results: Average running distance was not significantly different between NX Ex and sham Ex groups ( $p > 0.05$ ). NX was associated with significantly higher plasma creatinine concentration when compared to the sham operated group ( $p < 0.05$ ). NA induced aortic vasoconstriction and SNP induced relaxation were not significantly different between NX, sham and exercise groups ( $p > 0.05$ ). Relaxation in response to Ach was significantly impaired in NX group when compared to the sham group ( $p < 0.05$ ). NX significantly impaired relaxation in response to SNP when compared to both NX tocopherol supplemented groups ( $p < 0.05$ ). Mixed tocopherol supplementation following NX significantly enhanced vasoconstriction in response to NA when compared to sham, NX and  $\alpha$ -tocopherol supplemented mice ( $p < 0.05$ ). Plasma concentrations of IL-6, TNF- $\alpha$  and MCP-1 were significantly elevated in the NX group when compared to the sham group ( $P < 0.05$ ), while voluntary exercise with NX was associated with significantly lower plasma IL-6 concentration when compared to the NX group ( $p < 0.01$ ). There were no significant differences in cytokine concentrations between the NX and NX tocopherol supplemented groups. Voluntary exercise ( $p < 0.05$ ) and  $\alpha$ -tocopherol supplementation ( $p < 0.01$ ) significantly reduced aortic plaque area of NX mice. Discussion: Vascular relaxation in apoE<sup>-/-</sup> mice is impaired following NX while mixed tocopherol supplementation enhances aortic vasoconstriction. Voluntary exercise reduces the NX induced increase in plasma IL-6 concentrations, while voluntary exercise and  $\alpha$ -tocopherol supplementation are effective in reducing aortic plaque area following NX.

### EFFECTS OF BLOOD FLOW RESTRICTION DURING LOW-INTENSITY RESISTANCE EXERCISE ON HIGH-ENERGY PHOSPHATE METABOLISM AND TISSUE OXYGENATION IN SKELETAL MUSCLES

Yanagisawa, O., SANOMURA, M., FUKUBAYASHI, T.

*Waseda university*

[Introduction] Previous studies have reported that low-intensity resistance training with blood flow restriction (BFR) dramatically leads to muscle hypertrophy and strength gain [1, 2]. These adaptations may be attributed to the greater metabolic stress during low-intensity resistance exercise with BFR, but the exact mechanism has not yet been clarified. The purpose of this study was to evaluate the effects of low-intensity resistance exercise with BFR on high-energy phosphate metabolism and oxygenation in human skeletal muscles. [Methods] Seven men performed dynamic ankle plantar flexion exercise (30% one repetition maximum) using a non-magnetic, custom-made device for 4 min (30 repetitions/min) with and without BFR (130% of systolic blood pressure) inside the bore of a 1.5T magnetic resonance device. Inorganic phosphate-to-phosphocreatine (Pi/PCr) ratio and intracellular pH in the medial gastrocnemius before, during, and after the exercise were determined using <sup>31</sup>P-magnetic resonance spectroscopy. Concentration changes in oxygenated, deoxygenated, and total hemoglobin/myoglobin (Hb/Mb) in the medial gastrocnemius were determined using near-infrared spectroscopy. Moreover, rating of perceived exertion (RPE; Borg 6-20 scale) was obtained in each exercise condition. [Results] Pi/PCr ratio significantly increased at 1-4 min in both the exercise conditions, with the BFR-condition values being greater than the control-condition values. Intracellular pH significantly decreased during exercise in the BFR condition but remained unchanged in the control condition. In addition, the BFR condition showed markedly decreased oxygenated and increased deoxygenated Hb/Mb concentration during the exercise compared with the control condition. Moreover, this condition resulted in increased oxygenated and total Hb/Mb in exercised muscle after exercise. The BFR condition ( $17.1 \pm 1.3$ ) exhibited significantly greater RPE value than the control condition ( $12.6 \pm 1.0$ ). [Conclusion] Low-intensity resistance exercise with BFR places greater stress on high-energy phosphate metabolism and oxygenation in muscles than exercise with normal blood flow. In addition, this exercise causes an increase in blood volume in exercised muscle after exercise. [References] 1. Takarada Y, Takazawa H, Sato Y, et al. Effects of resistance exercise combined with moderate vascular occlusion on muscular function in humans. *J Appl Physiol.* 88: 2097-2106, 2000. 2. Moore DR, Burgomaster KA, Schofield LM, et al. Neuromuscular adaptations in human muscle following low intensity resistance training with vascular occlusion. *Eur J Appl Physiol.* 92: 399-406, 2004.

### THE EFFECT OF 3-WEEK UPPER LIMB IMMOBILIZATION ON BRACHIAL ARTERY STRUCTURE AND FUNCTION

Nakamura, F., Hamaoka, T., Nirengi, S., Esaki, K.

*Community Health Promotion Center*

Introduction Vascular dysfunction associated with physical inactivity is a risk factor for cardiovascular diseases (Thijssen et al, 2010). Therefore, it is important to find an intervention method for preserving structural and functional vascular deterioration due to the muscle disuse. However, the knowledge of vascular adaptations that occur as result of inactivity in humans is less clear. Therefore, the purpose of this study was to examine the effect of disuse using 3-week upper limb immobilization on the structure and function of the conduit artery at rest and after cuff occlusion. Methods Eight male volunteers (19.5 years on average) participated in the experiment after having been approved by the institutional ethical committee and obtained a written informed consent. Non-dominant arm was immobilized with a cast for 3 weeks. At first, resting brachial artery diameter and blood velocity were measured in a prone position. After resting period of 5 min, the cuff around the upper arm was inflated for 5 min, followed by measurements of hyperemic blood flow (BF) and diameter. The blood velocity and vessel diameter (D) of the brachial artery were measured using ultrasound Doppler and B-mode methods at rest and after cuff occlusion. BF was calculated from the blood velocity and D. Change in hyperemic diameter was calculated using the equation: (hyperemic diameter-resting diameter)/ resting diameter \* 100. Muscle oxygenation was also measured using near-infrared spectroscopy. Results A significant ( $p < 0.05$ ) decrease was found in the vessel diameter at rest pre- and post- immobilization (-3.5%). Brachial artery blood velocity and BF at rest showed no significant interaction pre- and post- immobilization. A significant ( $p < 0.05$ ) decrease was found in the peak vessel diameter after cuff occlusion before and after immobilization (-7.2%). Brachial artery blood velocity and BF after cuff occlusion showed no significant interaction before and after immobilization. The change in the peak hyperemic diameter was significant decreased ( $p < 0.05$ ) before and after immobilization (-40 %). Conclusion The vessel diameter of the conduit artery at rest and after cuff occlusion was decreased, indicating the arterial remodeling and endothelial dysfunction by the 3-week upper limb immobilization. Reference Thijssen et al. (2007) *Arterioscler Thromb Vasc Biol* 27:325-331

### THE EFFECT OF ERGOMETER-SPECIFIC EXERCISE MODALITIES ON BLOOD COAGULATION IN NON-ELITE FOOTBALL PLAYERS

Omar, A.S., El-Sayed, M.S., Hadida, E.M.

*Faculty of physical education and sport sciences*

THE EFFECT OF ERGOMETER-SPECIFIC EXERCISE MODALITIES ON BLOOD COAGULATION IN NON-ELITE FOOTBALL PLAYERS Omar. AS, El-Sayed. MS and Hadida EM. Tripoli University, Faculty of Physical Education and Sport Sciences, Tripoli-Libya Introduction: Previous re-

search indicated that cardiovascular, respiratory, and metabolic responses are significantly different between cycling and running when performed at the same overall metabolic rate. Although blood coagulation and fibrinolysis have been extensively studied and reviewed, the effect of ergometer-specific exercise modalities on blood coagulation is not known (El-Sayed et al. 2011). Therefore the present study was designed to assess the effect of exercise modes (cycling versus running) at 60% VO<sub>2</sub>max for 45-min on blood coagulation in non-elite football players. Aim of the study: 1) To ascertain the influence of ergometer-specific on blood coagulation indices in non-elite football players. Methods: Venous blood samples were removed from ten non-elite football players before and immediately after two separate ergometer-specific cycling and running test trials performed at 60% VO<sub>2</sub>max for 45-min. Blood were assayed for lactate, haematocrit (Hct) and haemoglobin (Hb); while citrated plasma was analyzed for prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT), factor VIII activity (VIIIa), fibrinogen (Fb), and thrombin antithrombin complexes (TAT). Results and Discussion: Cycling and running exercise induced similar activation of blood coagulation as reflected by a significant (P<0.05) shortening in APTT, and nearly 2.5 fold rise (P<0.05) in VIIIa. Although plasma fibrinogen increased significantly (P<0.05) following exercise trials, no significant interaction was found between exercise modality and plasma fibrinogen responses. In accordance with fibrin formation and activation of blood coagulation, we observed an increase (P<0.05) of TAT which was found in all subjects after the cycling and running test trials. Exercise was not associated with any demonstrable change (P>0.05) in TT or PT. The increase in TAT complexes may suggest that the generated thrombin was inactivated by antithrombin III and therefore did not lead to the formation of fibrin. Conclusions: This investigation demonstrates that ergometer-specific exercise trials performed at 60% VO<sub>2</sub>max for 45-min are associated with similar activation of blood coagulation system and the increase in TAT complexes highlights the importance of antithrombin III in the control of fibrin formation in vivo. References: El-Sayed,MS, Ali N, Omar A. (2011) Clin Hemorrh and Microcirculation (in Press).

**13:45 - 14:45**

## Poster presentations

### PP-PM59 Physiology 15

#### EFFECTS OF COMPRESSION CLOTHING IN ELITE FEMALE ICE SPEED SKATERS

Born, D.P.1, Herlitz, B.1, Zinner, C.2, Richter, K.1, Lefter, M.1, Sperlich, B.1

1: University of Wuppertal, Department of Sport Science (Germany), 2: German Sport University Cologne, Institute of Training Science and Sport Informatics (Germany)

Introduction Compression clothing has become increasingly popular in particular in endurance sports due to the evidence of improved performance in running and cycling (Bernhardt et al. 2005, Chatard et al. 2004). While compression is a possible mean to increase venous return (Ibegbuna et al. 2003) there are conflicting results regarding the use of compression on blood lactate concentration and oxygen uptake (Ali et al. 2010, Berry et al. 1987, Bringard et al. 2006, Rimaud et al. 2010). Since elite speed skaters produce a high muscle force during the long gliding phases with restricted intramuscular blood flow (Foster et al. 1999) elite speed skaters could benefit of compression due to 1) improved blood flow, 2) increased muscle oxygenation, 3) less blood lactate accumulation and 4) increased performance. Therefore, the aim of the study was to evaluate the effect of lower body compression clothing on performance and cardio-respiratory as well as metabolic parameters in female elite ice speed skaters. Methods 6 female elite German ice speed skaters volunteered for this study (60.5±7.3kg, 168±6cm, 19.8±3.3%, VO<sub>2</sub>max 57.8±5.9 ml/min/kg). All participants performed two on-ice 3000m trails with and without lower-body compression clothing in a random order and an incremental test to determine VO<sub>2</sub>max. During the trails VE, VO<sub>2</sub>, VCO<sub>2</sub> and HR were measured continuously with a portable spirometer (Cortex Metamax & Polar). Tissue saturation index (TSI) and blood volume (tHb) were determined by the concentrations of oxy-, deoxy- and total haemoglobin measured with near-infrared spectroscopy (NIRS, Portamon). Capillary blood samples were collected before, immediately after, 10 and 30 minutes after the exercise and analysed using amperometric-enzymatic determination of lactate (Eppendorf). Additionally, the subjects rated their perceived exertion (BORG's scale) before and after both trails. Results The application of lower-body compression clothing did not show any benefits on performance determined by the time to complete 3000m. Furthermore, no differences were observed in respiratory measurements (VE, VO<sub>2</sub>, RER), HR, La, NIRS data (TSI, tHb) or RPE (p > 0.05). Discussion & Conclusion The results show no detectable effects of compression on performance or any physiological measurements in female elite ice speed skaters. These results go in line with earlier studies showing no benefits of compression in well-trained endurance athletes (Ali et al. 2010, Sperlich et al. 2011).

#### THE RELATIONSHIP BETWEEN ENERGY COST OF TURN MOVEMENTS AND RUNNING SPEEDS

Hatamoto, Y., Yamada, Y., Sagayama, H., Ueno, S., Ichikawa, M., Higaki, Y., Kiyonaga, A., Tanaka, H.

Fukuoka University

Introduction When evaluating the energetic demands of a ball game, both the distance covered as well as the energy cost of other movements (e.g. jumping, dribbling and tackling) should be considered. Bloomfield et al. (2007) reported an average of 700 changes of direction ("turn movement") per match in English Premier League soccer, and Bradley et al. (2009) found that soccer players performed high intensity running (>14 km/h) more than 250 times in a match. Extra energy is expended during a turn movement because of the extra muscle activity involved. However, there is limited research on the physiological demands of turn movements. We developed the "Different Frequency Accumulation Method (DFAM)" for evaluating the instantaneous physiological demands of turn movements during running. The purpose of the present study was to measure the physiological demands of turn movements at different running speeds using the DFAM. Methods Eight healthy young men (aged 18-22 years) participated in the study. Five trials were performed where the subjects were required to run at different speeds (3, 4, 5, 6, and 7 km/h). Each trial included four incremental stages of turn frequency (13, 18, 24 and 30 per minute), with each stage lasting 3 minutes. Each trial required the subject to run along a line and perform 180° turn movements at the required speed and turn frequency. The oxygen consumption during the trial was determined using respiratory gas analysis. The oxygen consumption of a turn at each speed was calculated from the slope of the regression for oxygen consumption against the turn frequencies using the DFAM. Heart rate (HR), post-trial blood lactate, and ratings of perceived exertion (RPE) were also measured. Results The oxygen consumption values, for a turn movement at 3, 4, 5, 6 and 7 km/h, were 0.26 ± 0.04, 0.35 ± 0.05, 0.46 ± 0.11, 0.68 ± 0.09, and 0.89 ± 0.13 ml/kg/min, respectively. ANOVA revealed that the oxygen consumption of a turn movement increased

as the running speed increased ( $P < 0.001$ ). HR, blood lactate and RPE increased with each running speed and increase in turn frequency. Conclusion We suggested the equation describing the relationship between running speeds and the oxygen consumption of a turn movement would be in accordance with the well-known formula for kinetic energy,  $E = 1/2 mv^2$ , where  $m$  is the body mass and  $v$  is the speed, with the oxygen consumption of a turn movement possibly proportional to  $v^2$ . This information could possibly be used for estimating the energy cost of a ball game. References Bloomfield, J. et al. (2007). Physical demands of different positions in FA Premier League soccer. *Journal of Sports Science and Medicine*, 6:63-70. Bradley, P. S., et al. (2009). High-intensity running in English FA Premier League soccer matches. *Journal of Sports Sciences*, 27(2):159-168.

## REPEATABILITY OF PERFORMANCE GAINS IN A 1000 KJ CYCLING TIME TRIAL FOLLOWING SODIUM PHOSPHATE SUPPLEMENTATION

Brewer, C.P., Dawson, B., Wallman, K.E., Guelfi, K.J.

*University of Western Australia*

**Introduction** Sodium phosphate supplementation has been shown to improve endurance exercise performance (Czuba et al., 2009; Kreider et al., 1992) and maximal oxygen uptake in well-trained athletes when 3-4 g per day is ingested for 3-6 days (Cade et al., 1984; Czuba et al., 2009; Kreider et al., 1992). The purpose of this study was to determine whether sodium phosphate ingestion had a repeatable effect on exercise performance if supplementation was repeated. **Methods** Nine well-trained male cyclists ( $\dot{V}O_{2peak}$   $65.2 \pm 4.8$  ml•kg<sup>-1</sup>•min<sup>-1</sup>; mean  $\pm$  SD) participated in a randomised, repeated-measures, double-blind crossover study. First, each participant completed a baseline 1000 kJ cycling time trial, followed 48 hours later by an incremental exercise test to exhaustion to determine maximal oxygen consumption. Upon completion of these baseline trials, participants completed three 6 day loading phases of supplementation with either 50 mg•kg<sup>-1</sup>•FFM<sup>-1</sup>•day<sup>-1</sup> of tribasic sodium phosphate or a combined glucose and NaCl placebo (two phases involved supplementation with sodium phosphate and one phase with placebo in a randomised order). On the 7th day, participants again performed the 1000 kJ cycling time trial followed 48 hours later by the incremental exercise test to exhaustion. Time to completion, cycling power output, heart rate and lactate were assessed during the time trial, while oxygen consumption and lactate were determined for each stage of the incremental test. Participants had a 14 day washout period between finishing one loading phase and starting the next. **Results** There was no significant difference in time to completion of the 1000 kJ cycling time trial between sodium phosphate and placebo supplementation phases ( $p = 0.573$ ), however, there was a tendency for faster completion time (mean 1.9-2.7 % or 58-69 s) and mean power output (2.1-3.3 % or 4.9-6.8 W) with sodium phosphate supplementation when compared to baseline or placebo conditions. There was a significant increase ( $p < 0.01$ ) in maximal oxygen consumption after the first phase of phosphate loading compared with baseline and placebo conditions ( $p < 0.01$ , 3.5- 4.3 %), with further increases displayed in the second phase of phosphate loading compared with the first phosphate supplementation phase ( $p < 0.05$ , 7.5- 7.9 %). No differences in heart rate or lactate values were found between conditions. **Discussion** In summary, sodium phosphate supplementation resulted in increased maximal oxygen consumption, with further improvements found when sodium phosphate supplementation was repeated. Cycling time trial performance tended to be better after sodium phosphate supplementation, but was not significantly so. **References** Cade R, Conte M, Zauner C, Mars D, Peterson J, Lunne D, et al. (1984). *Med Sci Sport Exer*, 16(3), 263- 268. Czuba M, Zajac A, Poprzecki S, Cholewa J, & Woska S. (2009). *Journal of Sports Science and Medicine*, 8, 591-599. Kreider R B, Miller G W, Schenck D, Cortes C W, Miriel V, Somma C T, et al. (1992). *International Journal of Sports Nutrition*, 2(1), 20- 47.

## ESTIMATION OF VELOCITY AT VO2MAX IN WELL-TRAINED SWIMMERS

Almeida, T., Espada, M., Reis, J., Bernardo, R., Vleck, V., Alves, F.

*Faculty of Human Kinetics, Technical University of Lisbon*

**Introduction** Maximal oxygen uptake ( $\dot{V}O_{2max}$ ) has long been recognized as a poor performance determinant in high level competitive swimming. For specific training prescription,  $\dot{V}O_{2max}$  needs to be associated with performance parameters, particularly maximal aerobic velocity ( $v\dot{V}O_{2max}$ ), which serves as a basis for individualizing the relative intensity of training. The use of mean velocity during a 400 m freestyle event (S400), or more accurately, the central 300 m mean velocity (MAV), has been identified as a predictor of  $v\dot{V}O_{2max}$  (Lavoie & Montpetit, 1986), and used extensively in training and research. However, race pacing strategies and other contextual factors may hinder its usefulness. The aim of the present study was to ascertain the prediction power of S400 or MAV for the estimation of  $v\dot{V}O_{2max}$ , determined by a standard incremental protocol. **Methods** Fourteen competitive male swimmers completed an incremental test composed by 5x250 and 1x200 m front crawl for  $\dot{V}O_{2max}$  and  $v\dot{V}O_{2max}$  determination. Breath-by-breath gas exchange was measured throughout each test with a telemetric system (Cosmed K4b2, Rome, Italy), using the aquatrainer swimming snorkel® for expired gas collection.  $\dot{V}O_2$  data were averaged every 15 s. Before each test, the oxygen analyzer system was calibrated according to the manufacturer's instructions while the turbine flowmeter was calibrated using a 3-L syringe (Quinton Instruments, Wis., USA). The criteria used to define  $\dot{V}O_{2max}$  were a plateau in  $\dot{V}O_2$  despite an increase in swimming velocity (SV) and a heart rate in excess of 90% of the predicted maximal heart rate. In this protocol of incremental exercise,  $v\dot{V}O_{2max}$  was defined as the lowest SV at which  $\dot{V}O_{2max}$  occurred, according to Billat & Koralsztein (1996). 800 and 400 m performances in a swimming competitive event were recorded, the latter for determination of S400 and MAV. **Results** As expected,  $\dot{V}O_{2max}$  showed no association with performance, both in the 400 and the 800 m freestyle events. On the contrary,  $v\dot{V}O_{2max}$  could explain an important variation of performance at both distances ( $r = 0.66$ ,  $p < 0.01$  and  $r = 0.74$ ,  $p < 0.01$ , respectively).  $v\dot{V}O_{2max}$  ( $1.44 \pm 0.04$  m.s<sup>-1</sup>) was significantly different from S400 ( $1.48 \pm 0.04$  m.s<sup>-1</sup>), but not from MAV ( $1.45 \pm 0.04$  m.s<sup>-1</sup>). However, adjusted  $r^2$  was only 0.6, with a SEE of 0.025, in spite of standardized residuals remaining within the 95% confidence interval limits, indicating a fairly good estimation model. **Discussion**  $v\dot{V}O_{2max}$  can be estimated from MAV, but not from S400. The degree of accuracy of the model is acceptable for many training design and evaluation purposes. However, individual estimations should be done carefully. **References** Lavoie, J.M. & Montpetit, R.R. (1986). *Sports Med*; 3: 165-189. Billat, L.V. & Koralsztein, J.P. (1996). *Sports Med*; 22(2): 90-108.

## ENERGY EXPENDITURE DURING CONSTANT AND VARIABLE INTENSITY CYCLING: VALIDITY OF POWER BASED ESTIMATES

Haakonssen, E.1, Martin, D.1, Burke, L.1, Jenkins, D.2

1: AIS (Canberra, Australia), 2: UQ (Queensland, Australia)

**Introduction** Accurate estimates of exercise energy expenditure (EE) influence energy intake recommendations for elite athletes. Commercially available power meters (i.e., SRM Julich, Germany) are used to quantify training load and estimate cycling EE. The aim of this study was to measure gross efficiency (GE) during constant and variable intensity cycling to evaluate the accuracy of estimating EE with power meters. **Methods** Nine national team female cyclists (mean±stdev; 24.2±3.1 yrs, 57.7±5.1 kg, 64.2±4.0 ml·kg<sup>-1</sup>·min<sup>-1</sup> VO<sub>2</sub>pk, 287±23 W Maximum Aerobic Power (MAP)) were recruited. Cyclists completed a gross efficiency test (GE<sub>test</sub> = 4 min at ~45%, ~55%, ~65% and ~75% MAP) followed by 10.5 min of either constant or variable intensity cycling averaging ~55% MAP and then completed a second GE<sub>test</sub>. The variable power trial involved 1 min @ 45% MAP and 30sec @ 75% MAP repeated 7 times. Testing was performed on a high kinetic energy, wind-braked cycle ergometer instrumented with a SRM PowerMeter (Science Version, 8sg). Cadence was self selected. Expired gases were analysed by open circuit, indirect calorimetry using a custom built automated Douglas Bag system. During GE<sub>tests</sub>, Economy (W.L-1), VO<sub>2</sub> at 150 W (VO<sub>2</sub>@150W) and average Gross Efficiency (GE) were calculated. EE (kJ) for 1hr of constant and variable cycling was estimated using indirect calorimetry and compared to predicted EE based on power (SRM) and GE estimated for the group and for the individual. **Results** Typical error (Mean±90% CI) calculated from pre-GE<sub>tests</sub> log-transformed data reflect reliable measurements of Economy - 7.0±6.0%; VO<sub>2</sub>@150W - 2.4±2.1%; and GE - 2.1±1.8%. Individual GE ranged from 16.0–21.2%. Following constant and variable intensity cycling, there were small but consistent changes in Economy (~3–8%), GE (~2%) and VO<sub>2</sub>@150w (~3%). GE during constant (18.4±1.6%) and variable intensity cycling (18.6±1.1%) was similar. SRM based estimates of EE for 1hr of cycling using the average GE (18.5%) were within ~30 kJ (<1%) of EE estimated from indirect calorimetry. However, individual errors ranged from -15% to 14%. Using each individual's GE produced estimates of EE within ~10 kJ (<0.4%, range: -1% to 4%). **Discussion** The gross efficiency (GE) of cycling for national team female cyclists was ~19%. GE was similar for ~10 min of constant and variable intensity cycling. Findings support the use of calibrated SRM power meters for estimating cycling EE. For trained, competitive female road cyclists, total mechanical work (kJ) multiplied by 5.3 provides a valid estimation of total EE during constant and variable cycling <75% VO<sub>2</sub>pk. Combining SRM power meter data with each cyclist's individually assessed GE greatly improves the accuracy of estimates for EE (<4% error in all cases).

## PRELIMINARY ANALYSIS OF PACING STRATEGIES IN A PROFESSIONAL BASKETBALL

Kavaliuskas, M.

University of Worcester

**Introduction** Pacing is the distribution of muscular work rate during exercise (Foster et al., 2004). Although pacing has been studied extensively in individual endurance sports, little research has investigated the distribution of work rates within team sports. The aim of this preliminary investigation was to analyse workload distribution of an individual player over the course of a basketball game. **Methods** A professional male basketball player (small forward; age (years) – 24; height (cm) – 196; body mass (kg) – 85.2) from a British Basketball League team participated in this study. 1 digital video camera (Sony DRV900E) was used to film a home game which was replayed on SportsCode software for coding of activity patterns. Activities were coded based on five arbitrary locomotor categories in a horizontal direction (Dogramaci et al., 2011). Categories 0,1,2,3 and 4 corresponded to non-participation (i.e. substituted), stationary, walking, jogging, and sprinting respectively. Frequency of actions within each category were calculated for each quarter (Q1,2,3,4) of the match and the Coefficient of Variation (CV) was used to indicate the degree of variability in actions performed. **Results** The player was active during Q1, Q2, and Q3 but did not participate in Q4. The frequency of category 1, 2, and 3 actions was greatest in Q1, while the greatest frequency of category 4 activity (sprinting) occurred in Q2. Analysis of CV indicates that the degree of variability in total activity values decreased from 68.5%, to 46.5% and 45% through Q3, Q2 and Q3 respectively. **Discussion** Pacing changes were observed throughout the game with less heterogeneous patterns occurring in the second and third quarters, largely due to the high frequency of periods when the player was engaged in lower intensity (category 1 and 2) activities in Q1. However, no 'end-spurt' phenomenon could be identified since the player was substituted and did not play during Q4. Currently, there is little known about the exact mechanisms underpinning work rate distribution with a range of physiological, psychological and tactical factors potentially contributing to the selection and maintenance of different pacing strategies (St Clair Gibson et al., 2006). Match dynamics and positive emotional state may have affected the player's pacing strategy with no reduction in work-rate as the match progressed because the team was winning. Therefore, further research examining pacing strategies during basketball is warranted. **References** Dogramaci SN, Watsford ML, Murphy JA (2011). J Strength and Cond Res, 25 (3), 852-859. Foster C, de Koning JJ, Hellinga F, Lampen J, Dodge C, Bobbert M, Porcari JP (2004). Int J Sports Med, 25 (3), 198-204. St Clair Gibson A, Lambert EV, Rauch LHG, Tucker R, Baden DA, Foster C, Noakes DT (2006). Sports Medicine, 36 (8), 705-722.

## EFFECT OF DISPARITIES OF FEEDBACK ON PACING IN CYCLE TIME TRIALS

Nyberg, K., Jaime, S., Rodriguez-Marroyo, J., Condello, G., Casolino, E., Dodge, C., Mikat, R., Wright, G., Foster, C.

University of Wisconsin-La Crosse

**Introduction** The purpose of this study is to understand the effect of hypoxia during warm-up and competition on performance during cycle time trials. If the pre-exercise warm-up is manipulated by the use of hypoxia, when does the hypoxic challenge influence pacing during the time trial, performed under either normoxic or hypoxic conditions? **Methods** Seven well-trained subjects performed a VO<sub>2</sub> max test, two habituation trials, and four randomly ordered, single-blind 5 km time trials. Subjects performed HH (hypoxic WU/hypoxic TT), HN (hypoxic WU/normoxic TT), NH (normoxic WU/hypoxic TT), or NN (normoxic WU/hypoxic TT) with hypoxia (FIO<sub>2</sub> =0.15) and normoxia (FIO<sub>2</sub>=0.21). **Results** The hypoxic warm-up elicited a significant (p < .05) decrease in arterial saturation (hypoxic SaO<sub>2</sub>=86%, normoxic SaO<sub>2</sub>=97%) and increases in perceived exertion (RPE) and blood lactate (HLA). During the time trial significant differences in PO between hypoxic and normoxic time trials began at 1.0 km, continuing for the duration of the time trial (NN PO @ 1,2,3,4,5 km=271, 271, 260, 256, 304W. NH PO=251, 239, 219, 212, 247W. HN PO=259, 258, 257, 250, 294. HH PO=238, 215, 212, 205, 245). There was no significant difference in initial PO. **Discussion** Despite manipulating the pre-exercise template, PO is not reduced until physiological feedback occurs within the time trial. In this study physiological feedback modifications were evident after ~1.0 km with significant adjustments in PO based on the FIO<sub>2</sub>. It is essential for the athlete to prepare an effective pacing strategy and constantly be interpreting and responding to environmental and internal cues (Mauger et al., 2011; Tucker et al., 2009). Apparently, with changes in FIO<sub>2</sub> subjects cannot distinguish this change, even if a low FIO<sub>2</sub> is presented during warm-up, until physiological feedback mechanisms have time to act during the time



trial. Since initial PO was not significantly different, changes in pacing strategy occurred only after afferent feedback was received. References Mauger AR, Jones AM, Williams CA. (2011). *Br J Sports Med* 45:225-229. Tucker R, Noakes TD. (2009). *Br J Sports Med* 43(6):392-400.

### ASSOCIATION BETWEEN MUSCLE FORCE PRODUCTION DURING STEADY-SPEED RUNNING AND RUNNING ECONOMY IN COMPETITIVE ATHLETES

Di Michele, R.

*University of Bologna*

**ASSOCIATION BETWEEN MUSCLE FORCE PRODUCTION DURING STEADY-SPEED RUNNING AND RUNNING ECONOMY IN COMPETITIVE ATHLETES** Di Michele, R.1, Merni, F.1 1: Department of Histology, Embryology and Applied Biology, Faculty of Exercise and Sport Sciences, University of Bologna (Bologna, Italy) Introduction Running economy (RE) is a key determinant of performance in distance running, and it is of interest to understand how RE is associated to biomechanical characteristics of running gait. Previous studies showed that RE is proportional to the rate of muscle force production during running (Kram & Taylor, 1990; Pontzer 2007). In steady-speed running, the highest portion of muscle force is applied to support one's own body weight (Kram & Taylor, 1990; Chang & Kram, 1999), but a significant amount of force is used to accelerate the center of mass (Chang, 1999) and to swing the oscillating limb (Modica & Kram, 2005). Therefore, the purpose of this study was to analyze the association between RE and the overall rate of force production, as estimated using a mathematical model. Methods RE was measured in ten high-level athletes while running on a track at the steady speed of 14 km/h. Furthermore, ground reaction force (GRF) data were collected with a force plate while running at the same speed. A mathematical model, adapted from Pontzer (2007), was used to estimate the rate of force production during running as a combination of i) the rate of the vertical component of GRF, ii) the rate of the horizontal component of GRF, and iii) the average force required to swing the limb in a stride, determined using a specific equation. A linear regression was conducted to assess the proportion of variance in RE explained by the modeled force values. Results The mean rate of the vertical component of GRF, when considered alone, explained a large portion of variability in RE ( $R^2 = 0.71$ ). The explained variance increased when the horizontal component of GRF and the force required to swing the limb were included in the model ( $R^2 = 0.79$  and  $0.88$ , respectively). Discussion The present results confirm the previous conclusions that the force needed for supporting the runner's body weight is a major determinant of RE (Kram & Taylor, 1990). Furthermore, including the horizontal component of GRF and the force needed for swinging the limb allows to obtain an index of overall force production that is highly associated with RE in trained distance runners. This finding provides further support to the observation that RE is proportional to the rate of force produced during running. From an applied perspective, the model used here can provide a reasonably simple evaluation tool when analyzing an athlete's running mechanics with the goal to improve the economy of his/her running style. References Chang YM, Kram R (1999). *J Appl Physiol*, 86, 1657-1662. Kram R, Taylor CR (1990). *Nature*, 346, 265-267. Modica JR, Kram R (2005). *J Appl Physiol*, 98, 2126-2131. Pontzer H (2007). *J Exp Biol*, 210, 484-494.

### EFFECT OF ECCENTRIC CONTRACTIONS WITH A PRE-EXERCISE GLYCOGEN DEPLETION PROTOCOL ON METABOLIC RESPONSES DURING SUBMAXIMAL CYCLING

Gavin, J.P., Myers, S.D., Clements, R.E., Willems, M.E.T.

*University of Chichester*

**Introduction** Glycogen depletion following prolonged exercise is often associated with susceptibility to, and recovery from, exercise-induced muscle damage (EIMD). In a state of EIMD, cardiorespiratory responses may become compromised during subsequent moderate- and high-intensity cycling. Yet, the effects on metabolic and cardiorespiratory responses during low-intensity cycling are unclear. **Methods** Ten men ( $22 \pm 3$  yr,  $180 \pm 7$  cm,  $81 \pm 16$  kg) exercised at 60 rpm for 10-min on a cycle ergometer at 50% maximal oxygen uptake prior to, and 12-hr after completing 100 unilateral maximal voluntary eccentric contractions with knee extensors of each leg. The evening before the eccentric bout, a unilateral glycogen depleting protocol (Pilegaard et al., 2002) was performed to lower muscle glycogen in the right leg. Eccentric contractions were performed on an isokinetic dynamometer (Humac Norm, USA) from full knee extension to flexion ( $1.57 \text{ rad} \cdot \text{s}^{-1}$ ). Cardiorespiratory responses were recorded using a portable metabolic cart (Cosmed K4b2, Italy) during cycling, with fat and carbohydrate oxidation calculated using stoichiometry equations (Jeukendrup & Wallis, 2005). Changes in maximal isometric voluntary force (MVIF) were used to assess EIMD. Paired samples t-tests were used to detect difference in pre- and post-values for MVIF, and metabolic and cardiorespiratory measures during the last minute of exercise. Results Twelve hours post, EIMD was evidenced by MVIF reductions of: 7% (left leg;  $P=0.06$ ) and 8.3% (right leg;  $P=0.008$ ). Respiratory exchange ratio reduced from  $0.97 \pm 0.05$  to  $0.92 \pm 0.05$  ( $P=0.02$ ), while oxygen uptake ( $1.5 \pm 0.2$  to  $1.6 \pm 0.2 \text{ L} \cdot \text{min}^{-1}$ ,  $P=0.39$ ), carbon dioxide output ( $1.4 \pm 0.3$  to  $1.4 \pm 0.2 \text{ L} \cdot \text{min}^{-1}$ ,  $P=0.54$ ), minute ventilation ( $36.9 \pm 0.7$  to  $38.1 \pm 0.6 \text{ L} \cdot \text{min}^{-1}$ ,  $P=0.69$ ) and heart rate ( $110 \pm 2$  to  $111 \pm 2 \text{ beats} \cdot \text{min}^{-1}$ ,  $P=0.85$ ) were similar. Fat oxidation increased post from  $0.16 \pm 0.1$  to  $0.26 \pm 0.1 \text{ g} \cdot \text{min}^{-1}$  ( $P=0.05$ ), but carbohydrate oxidation was unchanged ( $1.6 \pm 0.3$  to  $1.4 \pm 0.4 \text{ g} \cdot \text{min}^{-1}$ ,  $P=0.36$ ). **Discussion** Eccentric exercise preceded by a unilateral glycogen depleting protocol altered metabolic responses during low-intensity cycling exercise. Increased fat oxidation may be due to impaired insulin action with EIMD; but this was not supported by cardiorespiratory responses. Such may be attributable to limited damage induced by the eccentric bout, the intensity of the cycling exercise or a combination of both. Regardless, the design may have utility in examining mechanisms underpinning the physiological responses to exercise in an EIMD state. References Jeukendrup AE, & Wallis GA. (2005). *Int J Sports Med*, 26, S28-S37. Pilegaard H, Keller C, Steensberg A, Helge JW, Pedersen BK, Saltin B, Neufer D. (2002). *J Physiol*, 541(1), 261-271.

### EXERCISE AS AN EXTERNAL CUE FOR MAINTAINING CIRCADIAN RHYTHM – RECTAL TEMPERATURE RECORDINGS VS A NEW NON-INVASIVE HEATFLUX TECHNOLOGY

Stahn, A.1, Mendt, S.1, Steinach, M.1, Opatz, O.1, Werner, A.1, Kunz, D.1, Belavy, D.2, Felsenberg, D.2, Sattler, F.3, Koch, J.3, Gunga, H.C.1

1: Charite, Center for Space Medicine (Berlin, Germany), 2: Charite, Center of Muscle and Bone Research (Berlin, Germany), 3: Draegerwerke (Luebeck, Germany)

**Introduction** Travelling across different time zones requires athletes to quickly adapt to altered day and night cycles. Athletes are therefore prone to suffer from jet lag due to desynchronization of their internal body clock. Exercise has recently been outlined as a potential countermeasure to promote the entrainment of the circadian timing system (CTS). Previous studies, however, have been limited in isolating the effects that can be purely attributed to exercise. In addition, an easy and non-invasive technology for assessing the CTS is lacking. The

aims of this study were therefore: (1) To investigate the effect of 60 days of bed-rest and different exercise protocols on circadian rhythm and (2) to assess whether rectal temperature recordings and a new heatflux sensor (Double Sensor) can be considered as interchangeable methods for determining circadian rhythm. Methods 24 healthy men were exposed to 60 days of 6-degree head-down tilt bed-rest as part of the Berlin Bed-rest Study 2 (BBR2-2). Subjects were randomly allocated to a resistance (RE), a combined resistance and vibration exercise (RVE), or a control (CTR) group. Core body temperature profiles for 36 h were determined every week weeks bed-rest using both rectal recordings and a recently developed Double Sensor positioned at the forehead. Cosinor analysis was employed to quantify circadian rhythm by mesor, acrophase, and amplitude. Results No significant differences could be observed between rectal recordings and the new non-invasive heat-flux technology for mesor, acrophase, and amplitude ( $P = 0.12$  to  $0.98$ ). The strong associations between the two methods was also confirmed by high correlations ( $r = 0.92$  to  $0.97$ ) between rectal and Double Sensor recordings. While RE and VRE showed no significant difference in circadian rhythm throughout the study, CTR exhibited a significant increase in acrophase from week 1 to week 7 ( $P = 0.016$ ). In addition, CTR was characterized higher variability in acrophase and mesor compared to RE and VRE. Discussion The present study confirms our previous findings indicating that circadian rhythm of core body temperature can be reliably and continuously determined using a new heatflux sensor (Double Sensor) located at the head. In addition, there was a tendency for exercise to offset some of the detrimental effects of bed-rest on the CTS, substantiating the use of exercise as a potential countermeasure against alterations of the CTS during transmeridian travel. It is concluded that the present Double Sensor technology might be useful in better understanding the impact of jet lag as well as improving respective adaptation strategies for optimizing individual performance of athletes. Finally, it is suggested that the Double Sensor technology might be a useful approach in better understanding the interaction between the CTS and thermoregulation during exercise.

### PHYSICAL CHARACTERISTICS AND PHYSIOLOGICAL ATTRIBUTES OF FEMALE VOLLEYBALL PLAYERS – THE NEED FOR INDIVIDUAL DATA

Nikolaidis, P.T.1, Ziv, G.2, Veniamakis, E.E.3, Arnon, M.2, Lidor, R.2

1: *Laboratory of Human Performance and Rehabilitation, Hellenic Army Academy (Athens, Greece)*, 2: *Wingate Institute (Netanya, Israel)* 3: *Department of Nutrition and Dietetics, Technological Education*

**Introduction** The purpose of this study was twofold: (a) to profile physical characteristics and physiological attributes of adolescent and adult Greek female volleyball players ( $n=61$ ) who were members of the A (the best league for female volleyball players) and B (the second- best league for female volleyball players) Series clubs in Greece, and (b) to examine the intra-individual variability among these players in all physical and physiological measurements that were undertaken in the study. **Methods** The participants were divided into three age groups - under 14, 14-18, and over 18 years. They underwent a series of physical (e.g., height, body mass, and percentage of body fat) and physiological (e.g., aerobic profile, flexibility, and vertical jumping ability) tests. **Results** Three main findings emerged from the data analysis: (a) differences in physical characteristics and physiological attributes existed between the three age groups. For example, fat free mass was lower in players under the age of 14 ( $41.6 \pm 6.1$  kg) compared to players between the ages of 14-18 ( $50.2 \pm 7.0$  kg) and players over the age of 18 ( $52.0 \pm 3.4$  kg). In addition, the relative peak power as measured in the WAnT was the highest in the over-18 group ( $9.72 \pm 0.65$  W.kg<sup>-1</sup>), lower in the 14-18 group ( $8.95 \pm 0.77$ ), and the lowest in the under-14 group ( $8.32 \pm 0.78$  W.kg<sup>-1</sup>), (b) large intra-individual variability existed in most physical characteristics and physiological attributes measured in the study, and (c) the intra-individual variability was observed in all three groups. **Conclusions** These findings emphasize the need for coaches to examine the intra-individual variability within the players on their teams, and to use this information when designing training programs and strength and conditioning programs.

### EFFECT OF VARYING WARM-UP INTENSITIES ON INTERMITTENT SPRINT PERFORMANCE

Wallman, K.

*The University of Western Australia*

**EFFECT OF VARYING WARM-UP INTENSITIES ON INTERMITTENT SPRINT PERFORMANCE** Anderson, P.1, Wallman, K.1, Landers, G.1 1: *The University of Western Australia* **Introduction:** Warm-up (WUP) is a well-accepted practice considered by many athletes to be an essential precursor to exercise. Physiologically, an active WUP is proposed to improve subsequent exercise performance as a result of numerous temperature and non-temperature related benefits (see reviews by Bishop, 2003a, Bishop 2003b). While a number of studies have investigated the effect of WUP on subsequent continuous exercise or single-sprint performance, few studies have assessed the effects of WUP, compared to no-WUP, on intermittent sprint performance, with results being equivocal (Bishop & Claudius, 2004; Mohr et al., 2004). Further, there has been minimal research that has assessed the effects of WUP on exercise where WUP intensities were based on individual lactate thresholds. Therefore the aim of this study was to investigate the effect of different WUP intensities, based on lactate accumulation, on 10-min of subsequent intermittent sprint performance, and to determine whether core temperature ( $T_c$ ) correlated with performance. **Methods:** Eleven male, team-sport athletes performed four experimental trials in a randomised, Latin-square, cross-over design, each separated by one week, consisting of an intermittent sprint protocol (15 x 20 m sprints, separated by 30 or 60-s) that followed either no-WUP or one of three 10-min WUP trials. WUP intensities were performed at either (1) half the difference between anaerobic threshold (AT) and lactate threshold (LT)  $[(AT-LT)/2]$  below the LT level = WUP 1; (2) mid-way between LT and AT level = WUP 2; (3) half the difference between LT and AT,  $[(AT-LT)/2]$  above AT level = WUP 3. **Results:** Individual sprint times showed a significant main effect for sprints ( $p = 0.001$ ) but not for trials ( $p = 0.434$ ), with sprint 4 being faster than sprint 3 and sprints 4, 5, 7 and 10 being faster than sprint 12 ( $p < 0.05$ ). Warm-up 3 resulted in faster individual sprint times for sprints 1, 2, 3, 5, 6, 8, 9, and 14 (Cohen's  $d = 0.51 - 1.13$ ), compared to WUP 1 and no-WUP, as well as faster accumulated sprint times for the entire 15-sprint protocol, with moderate to large effect sizes found for accumulated sprints 1 - 10 ( $d = 0.50 - 1.05$ ). There were no significant correlations between  $T_c$  assessed immediately after each WUP and any performance variable. **Conclusion:** A WUP performed half the difference between LT and AT above AT (i.e., WUP 3) resulted in faster intermittent sprint performance compared to lower intensity WUPs and no-WUP. Significant increases in  $T_c$  were not correlated with exercise performance. **References:** Bishop D. Warm Up 1 (2003a). *Sports Med*, ;33(6):439-54. Bishop D. Warm Up 2 (2003b). *Sports Med*, 33, 483-98. Bishop D & Claudius B. (2004). *Acta Kinesiol Univ Tartu*, 9,7-21. Mohr M, Krusturup P, Nybo L, et al. (2004). *Scand J Med Sci Sports*, 14, 156-62.

## 13:45 - 14:45

## Poster presentations

## PP-PM60 Training &amp; Testing 13

**PHYSIOLOGICAL AND ANTHROPOMETRICAL VARIABLES OF IRANIAN ELITE KAYAKERS**

Isanezhad, A.1, Aggha-Alinejad, H.3, Donyamali, A.2, Sohrabain, A.4, Tahmasbi, W.1

*tarbiat modares university*

Physiological and anthropometrical variables of Iranian elite kayakers Introduction: Anthropometric profiles of World-class athletes offer useful data for coaches when initially selecting talented individuals for development programs (Ackland et al., 2003). Sprint kayaking is characterized by exceptional demands on upper body performance (Michael et al., 2008). Olympic kayak paddlers not only need a high aerobic power, but the anaerobic contribution is also very important for successful performance (Bishop 2000). The aim of this study was investigated of physiological and anthropometrical profile of Iranian elite kayakers. Methods Eight Iranian male kayak athletes with mean age: 19.7±1.98 (year) were examined. Anthropometric measurements: A total of anthropometric variables were directly and indirectly measured according to the methods of standard International Society for the Advancement of Kinanthropometry (ISAK). Aspect of upper-body peak power and anaerobic capacity using the 30-second exhaustive Wingate Anaerobic Test (WAnT). An incremental test was used to determine . Breath-by-breath gas analysis was conducted throughout using an automated Jaeger Oxycon Pro system (cosmed, Finland). All physiological testing was conducted on a calibrated, wind-braked kayak ergometer (K1 Ergo, Garran, Australia). Descriptive statistics were performed on the group data using standard statistical procedures. (Mean±SD). Result: Anthropometrical and body composition measurements indicated that: age: 19.7±1.98(year), straight height: 184.21±5.27(cm), sitting height: 98.43±1.62(cm), arm span:189.21± 5.95(cm), body mass: 79.04± 4.66(kg), lean body mass:71.81±3.59(kg), body fat: 10.84±6.18(percent), BMI: 21.69± 4.7(kg/m<sup>2</sup>). Aerobic and anaerobic tests showed: Vo<sub>2</sub>max: 4.07±0.24 (L/min), Vo<sub>2</sub>max: 50.69±3.34 (ml/kg/min), Heart rate to Vo<sub>2</sub>max: 183.1± 7.4(lb/min), Mean power:395.45±23.46(W), Mean power: 4.5± 0.24(W/kg), Peak power: 882.54±120.36, Peak power: 11.00± 1.27. Discussion: Our result indicated that these kayakers have straight and sitting height near the average of world elite kayakers (Ackland et al 2003). Their relative VO<sub>2</sub> max was 50.69±3.34 (ml/kg/min) and its accordance with Ackland et al (2003) results. Anaerobic peak power and mean power it's near to elite kayakers. In conclusion these kayaker have a good state in anthropometrical and physiological variables. References: Bishop, D. Physiological predictors of flat-water kayak performance in women. *European Journal of Applied Physiology*. (2000) 82, 91-97. Ackland T.R., Ong K.B., Kerr D.A., Ridge B. Morphological characteristics of Olympic sprint canoe and kayak paddlers. *J Sci Med Sport*, 2003. 6:285-94. Michael J.S., Rooney K.B., Smith R. The metabolic demands of kayaking: a review. *J Sport Sci Med*, 2008. 7:1- 7.

**PASSIVE RECOVERY IS SUPERIOR TO ACTIVE RECOVERY DURING A HIGH INTENSITY SHOCK MICROCYCLE.**

Wahl, P.1,2,3, Zinner, C.1, Bloch, W.2,3, Mester, J.1,3

*German Sport University*

1: Institute of Training Science and Sport Informatics, German Sport University Cologne (Germany) 2: Department of Molecular and Cellular Sport Medicine, Institute of Cardiovascular Research and Sport Medicine, German Sport University Cologne (Germany) 3: The German Research Centre of Elite Sport, German Sport University Cologne (Germany) Introduction: In the last years there was a great scientific discussion about high intensity (interval) training (HIT). However few is known about the arrangement of interval training and its integration into the training cycle. In most cases active recovery is performed during high intensity interval training, in order to normalize lactate and pH-values and performance faster compared to passive recovery. However, recent investigations showed that lactate and pH act as signaling molecules inducing adaptations. Their time of exposure is decreased if active recovery is performed, may be leading to a decreased (metabolic) stimulus. The aim of the present study was to examine the effects of a two week high intensity shock microcycle on maximal oxygen consumption and parameters of exercise performance in junior triathletes on the one hand, and to compare the long term effects of active (A) vs. passive (P) recovery on the other hand. Methods: 16 healthy competitive junior triathletes from a local team (12 male, 4 female) participated in this study. For the assignment to the A- or P-group subjects were matched according to age and performance. Within two weeks, a total of 15 high-intensity interval sessions were performed within three 3-day training blocks. Before and one week after the last training session, athletes performed a ramp test to determine VO<sub>2</sub>max, a time trial (TT) and a Wingate-test. Furthermore total Hb-mass was determined. The results of the whole group, independent of the arrangement of recovery were analyzed at first; second the A- and P-groups were analyzed separately. Results: Peak power output (PPO) during ramp test and TT performance significantly increased in the whole group. The comparison of the two groups revealed increases for the mentioned parameters and for VO<sub>2</sub> and power output at VT<sub>2</sub> only for the P-group. VO<sub>2</sub>max did not change. Wingate performance increased in the A-group only. Total hemoglobin mass slightly decreased in the whole group. Discussion: The main finding of the present study was that a 14-day HIT shock microcycle is able to improve TT performance and PPO in junior triathletes in a short period of time. Furthermore, not only the intensity, but also the arrangement of interval training seems to be important as well, since only the P-group showed improvements in endurance performance, despite a slightly lower training volume. These findings might be relevant for future arrangements of high intensity interval training.

**DOES PRIOR HEAT EXPOSURE REDUCE CONSEQUENCES OF ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE?**

Easthope, C.S.1,2, Mavros, Y.1, Fatarone Singh, M.A.1, Brisswalter, J.2, Caillaud, C.1

*1: USYD (Sydney, Australia), 2: UNSA (Nice, France)*

Introduction Eccentric exercise-induced muscle damage (EIMD) is a well-described phenomenon, but the precise mechanisms leading to the attenuation through repeated bouts are still poorly understood. Stress proteins such as heat shock protein (HSP)-72 and -27 may protect against the development of EIMD (1). This study investigated if HSP-inducing passive heating would attenuate EIMD-related changes in voluntary muscle activation (VA), force production and pain over repeated exposure to EIMD. Methods EIMD was assessed by increases in self-reported pain, reduction in force and changes in VA of muscles following a downhill running model of eccentric exer-

cise. Healthy young subjects (n=35) are being recruited to run downhill (-15°) for 30 minutes at a speed corresponding to 70%VO<sub>2</sub>max on two occasions 3-5 weeks apart as a model of EIMD. Half of the subjects were randomly selected for passive heating (lower limb immersion, 75 min, 43°C) 48 hr before their first running session, controls had no prior treatment. Before, and then 1 hr, 24 hrs and 48 hrs after downhill running, all subjects completed isometric (70° knee flexion) and eccentric (100°/s) force tests with electrical twitch stimulation (ITT, 400V, 50us) and EMG (quadriceps fem. and biceps fem.). They then reported contra-lateral thigh muscle pain on an analog scale. Results Preliminary data indicate that during heating all subjects reached a core body temp of >39°C. Mean isometric force reduction 24hrs after downhill running was attenuated in heated subjects (-8±5%) after the first downhill running session when compared to control (-17±4%, p=0.04) but not after the second (p=0.29). Perceived muscle pain increased significantly at 24 hrs post downhill running (p>0.02) in both groups (p=0.42). Following downhill running, VA was depressed (p=0.04) and antagonistic co-activation was increased (p=0.03) with no group differences (p=0.5). Discussion Heating the muscle 48 hrs before eccentric exercise attenuates the force reduction related to EIMD, but does not alter the subsequent increases in pain or decreases in muscle activation or persist over repeated exposure to EIMD. These findings partially support the conclusions from earlier investigations (2), but require further study to elucidate the mechanisms and persistence of this potentially protective adaptation to limit muscle damage. References 1. Thompson HS, Clarkson PM, Scordilis SP. The repeated bout effect and heat shock proteins: intramuscular HSP27 and HSP70 expression following two bouts of eccentric exercise in humans. *Acta Physiol Scand* 2002;174(1):47-2. Nosaka K, Muthalib M, Lavender A, Laursen PB. Attenuation of muscle damage by preconditioning with muscle hyperthermia 1-day prior to eccentric exercise. *EJAP*. 2006; 99:183

### AVAILABILITY OF ORTHOSTATIC TEST FOR THE EVALIETION OF PHYSICAL CONDITION IN ACCLIMATIZIOM PROCESS OF HIGH ALTITUDE TRAINING

Hisashi, K., Hidetaka, T., Taro, S., Masaki, T.

*Doshisha University*

AVAILABILITY OF ORTHOSTATIC TEST FOR THE EVALIETION OF PHYSICAL CONDITION IN ACCLIMATIZIOM PROCESS OF HIGH ALTITUDE TRAINING Hisashi, K.I., Hidetaka, T.I., Taro, S.I., Masaki, T.I. 1: Doshisha University (Kyoto, Japan) Introduction It has been known that ascend to high altitude is associated with the down regulation in cardiac autonomic nervous activity as compared to sea level(Hainsworth et al. 2007; Iwasaki et al. 2006). These regulations seemed to be gradually approached to near sea level with high altitude acclimatization. The purpose of this study was to investigate the availability of orthostatic test reflecting cardiac autonomic nervous activity for the evaluation of physical condition in acclimatization process of high altitude training. Methods Cross-country skiing athletes (10 males, 6 females, 20.4±1.2) lived 1 day at sea level for collecting control data and lived and trained for 8 days at the ambient altitude approximately 1,600m above sea level. Heart rate (HR) during 10 minutes orthostatic test, HR, arterial blood oxygen saturation and blood lactate during 3 minutes step test, amylase in the saliva, urine specific gravity and subjective feeling of fatigue were measured at the every morning. Time trial of 1,500m running as an index of endurance performance was conducted at altitude in day 1, day 4 and day 8. To evaluate an influence of training loads on cardiovascular system, HR during training was recorded and calculated training impulse (TRIMP). Analysis of variance was used for the statistical evaluation. Results No significant changes were found in HR response during orthostatic test, HR response during 3 minutes step test, the other physiological parameters and 1,500 m running performance on a subject's mean level during 9 days. Because, there were individual differences in all variables, looking at subject's individual data, some of subjects revealed good response to acclimatization process of high altitude training. It showed gradually approached to near sea level with high altitude acclimatization. Discussion It is suggested that there is definite individual differences in the cardiac autonomic nervous activity response to high altitude acclimatization process. But some of subjects revealed good response to acclimatization process to high altitude training. Therefore, these responses imply that orthostatic test could be one of indexes reflecting physical condition during acclimatization process of high altitude training in endurance athletes. However, it is needed a further research to identify the individual differences of HR response. References Banister EW, Morton RH, Fitts-clarke J. (1992). *Ann. Physiol. Anthropol*, 11, 345-356 Hainsworth R, Drinkhill MJ, Rivera-Chira M. (2007). *Clin Auton Res*, 17, 13-19 Iwasaki K, Ogawa Y, Aoki K, Saitoh T, Otsubo A, Shibata S. (2006). *Aviation, Space, and Environmental Med*, 77(10), 1015-1019 Levine BD, Stray-gundersen J. (1997). *J. Appl. Physiol*, 83(1), 102-112

### EFFECTS OF MENSTRUAL CYCLE PHASE-BASED ENDURANCE TRAINING ON ENDURANCE PERFORMANCE IN FEMALES WITHOUT VERSUS FEMALES WITH ORAL CONTRACEPTION

Han, A.I, Sung, E.I, Hinrichs, T.I, Vorgerd, M.I, Platen, P.I

*Ruhr-University Bochum*

Purpose: The menstrual cycle is divided into 2 main phases, the follicular (FP) and the luteal phase (LP). Each phase is characterized by a certain profile of different hormones, including variations in anabolic hormones. Oral contraception (OC) alters the profile of these hormones. We could recently demonstrate that adaptation to strength training is slightly higher in females who mainly conduct their training in FP compared to LP. This study analyses the effects of menstrual cycle-based endurance training and compares the effects between non-OC users and OC users. Methods: 27 healthy females (n=13 non-OC users (25.1 ± 3.6 yrs, 164.8 ± 6.8 cm, 67.7 ± 17.7 kg) and 14 OC users (23.9 ± 3.1 yrs, 168.4 ± 6.9 cm, 61.9 ± 8.8 kg) completed an one-leg endurance training on a cycle ergometer for each leg for 3 months. Both groups trained one leg mainly in the 1st half of the menstrual cycle (follicular phase training (FT) and quasi-follicular phase training (qFT)) and the other leg mainly in the 2nd half of the cycle (luteal phase training (LT) and quasi-luteal phase training (qLT)). Concentrations of estradiol (E2), progesterone (P4), total testosterone (T) and free testosterone (free T) were analyzed in FP and LP. One-leg peak oxygen uptake (VO<sub>2</sub>peak), one-leg-maximal workload (Wmax), muscle fiber composition (F%area), fiber diameter (Fdm) and cell nuclei to fiber ratio (N/F) (biopsies of m. vastus lateralis, n=8) were analyzed prior to and after the training period for each leg separately. Results: Concentrations of E2, T and free T were significantly higher in non-OC users compared to OC users (p<0.05). Free T was higher in FP compared to LP and in qFP compared to qLP (p<0.05). P4 level was highest in LP compared to all other phases (p<0.05). Increase in Wmax was higher in FT (+34.8 W) compared to LT (+27.8 W) (p<0.05) and did not differ between qFT and qLT (+32.3 vs. +35.9 W), without any significant differences between non-OC and OC-users. VO<sub>2</sub>peak tended to increase after FT (+3.3 ml/min/kg) and LT (+2.8 ml/min/kg) and increased significantly after qFT (+5.7 ml/min/kg) and qLT (+5.3 ml/min/kg) without any differences between non-OC and OC-users. Muscle fiber parameters did not show any clear alterations after training. Conclusions: Despite clearly higher concentrations in anabolic hormones in non-OC users compared to OC-users, increase in aerobic performance and maximal workload did not differ between these groups. Within the respective groups, however, adaptation to aerobic training was slightly higher in FT and qFT compared to LT and qLT.

## THE EFFECT OF MODERATE ALTITUDE ON OBJECTIVE AND SUBJECTIVE SYSTEMS OF TRAINING LOAD QUANTIFICATION

Ferliche, B.1, Rodríguez, F.A.2, Iglesias, X.2, Calderón, C.3, Barrero, A.2, Pérez-Medina, I.2, Barrero, A.2, Vázquez, J.2, Ábalos, X.2, Rodríguez-Zamora, L.2, Truijens, M.4

1: FCAFD, University of Granada (Granada, Spain); 2: INEFC-Barcelona Sport Sciences Research Group, University of Barcelona (Barcelona, Spain); 3: CAR Sierra Nevada (Granada, Spain), 4: Royal Dutch Sw

**Introduction** Objective and subjective training load indicators, such as training impulses (TRIMPs) and ratings of perceived exertions (RPE) have been used to monitor elite swimmers under normoxic conditions (Wallace et al., 2009). However, their usefulness and validity under hypoxic conditions has not been studied to date. This study aims to analyse the effect of 3-weeks exposure to moderate altitude on the relationship between objective (TRIMPs) and subjective (s-RPE) systems of training load quantification in elite swimmers. **Methods** 40 elite swimmers were assigned to two groups: Lo, who lived and trained at sea level, and Hi, who lived and trained at moderate altitude (CAR Sierra Nevada, Spain, 2320 m above sea level). During three consecutive weeks all training sessions were monitored. Heart rate (HR) and time were recorded to compute TRIMPs (Banister & Hamilton, 1985). Session-RPE (s-RPE) based on the CR-10 scale (Foster et al. 2001) was self-administered within 30 min after each swimming (S1, S2) and dry-land (DI) training sessions. **Results** There were no differences in S1 and S2 training loads (TRIMPs) in any of both Hi and Lo groups. s-RPE showed differences between groups that were significantly smaller in the Hi group in S1 ( $p < 0.001$ ). In DI differences were noted between both groups in all training sessions ( $P < 0.05$ ). The association (Pearson's  $r$ ) between s-RPE and TRIMPs during swimming sessions was moderate both in S1 (Hi: 0.42; Lo: 0.76;  $p < 0.001$ ) and S2 (Hi: 0.69; Lo: 0.56;  $p < 0.001$ ). In DI sessions no association was found between methods (Hi: 0.02; Lo: 0.02;  $p > 0.05$ ). **Discussion** The relationship between TRIMPs and s-RPE training load indicators is low-moderate. Therefore, we consider they should not be used indiscriminately in altitude, at least during the acclimatization phase. s-RPE appears to be more sensitive to an increase in the intensity of the internal load than to a rise in training volume (Sweet et al., 2004). This is supported by our observation that there were differences in s-RPE between the Hi and the Lo groups in the first two weeks, but not in third week when training intensity tend to equalize. TRIMPs do not seem to constitute an appropriate quantification procedure for workload during dry-land sessions. **References.** Banister EW & Hamilton CL. (1985). *Eur J Appl Physiol*, 54, 16-23. Foster et al. (2001). *J Strength Cond Res*, 15, 109-115. Wallace et al. (2009). *J Strength Cond Res*, 23, 33-38. Sweet et al. (2004). *J Strength Cond Res*, 18, 796-802.

## RESEARCH OF EXTERNAL BREATH PARAMETERS OF GYMNASTS DURING PERFORMANCE OF THE MAIN GYMNASTIC EXERCISES

Shlyakhtov, V.

*Velikiye Luki State Academy of Physical Education and Sports*

**Introduction.** The modern artistic gymnastics is characterized by the intensity of competitive activity and training process, and also necessity of formation of stable and reliable technique skills. The key moment in the gymnasts' preparation is improvement of functional readiness. Unfortunately, till now, it was possible to measure the data of the gas exchange and external breath only in laboratory conditions during special testing of gymnasts. In this connection the value of research of breathing system functioning during performance of the gymnastic exercises in natural conditions raises substantially. The purpose of the present research was to consider the method of ergospirometry during performance of the main gymnastic exercises as giant circles (forward and back) on the horizontal bar, swings to the handstand on the parallel bars, and acrobatic forward handspring, and to use the received data at different stages of gymnasts' training. **Methods.** 6 gymnasts aged 12-14 took part in the research. To study the gymnast's external breath parameters during performance of the exercises the telemetric ergospirometry complex «Oxycon mobile» by VIASYS and specialized software package was used. The video shooting of performance of the exercises was simultaneously done and synchronized with parameters of external breath. **Results.** The average duration of performance of the exercises was: forward handspring 2.05 sec., forward giant circle 1.67 sec., back giant circle 1.26 sec., swings to the handstand 1.38 sec. The average parameters of the breath in (l/sec.) in this exercises were: forward handspring 2.25/1.3, forward giant circle 1.71/0.8, back giant circle 1.86/0.7, swings to the handstand 1.38/0.5. The average parameters of the breath out (l/sec.) were: forward handspring 2.18/0.7, forward giant circle 1.48/0.9, back giant circle 1.53/0.6, swings to the handstand 1.48/0.9. The short breath holding was also observed during performance of this exercises. **Discussion.** The received data testify that the gymnast use monotype respiratory system work that characterizes identity of its work during performance of the main gymnastic exercises as giant circles (forward and back) on the horizontal bar, swings to the handstand on the parallel bars when the breath out phase coincides with the main phase of the performance of this exercises. Performing forward handspring gymnasts use two different models of the breathing system functioning. The former – the main movements are made breathing out to strain the skeletal muscles, to reinforce the power of the performance. The latter – there is a short breath holding during the exercises to exclude extra involvement of the muscles, which leads to muscle work minimization.

## THERMAL IMAGING AS A TOOL OF DIFFERENT BREATHING EXERCISE CHARACTERIZATION: A CASE STUDY

Formenti, D., Ludwig, N., Gargano, M., Garaldi, M., Ongaro, L., Alberti, G.

*State University of Milan*

**INTRODUCTION** Specific respiratory muscle training improves athletes' performance particularly at high intensities (Esposito et al., 2010). The aim of this study was to evaluate two types of breathing, thoracic and diaphragmatic, used in respiratory training. **METHODS** An evaluation of different respiratory muscle training is possible by the use of IR thermography (AVIO, TVS-700), a non-invasive technique that visually represents the whole process during and after training (Merla et al., 2010). The subject performed the exercise with SpiroTiger® for 5 minutes, followed by a 5 minute recovery. The exercise was repeated 15 minutes after the end of recovery-time. Thoracic and diaphragmatic breathing exercises were performed using the same protocol in different days. Ten Regions of Interest (ROI) were selected following anatomical and functional correspondence with the muscles involved in breathing (Zaidi et al., 2007). The data were analyzed with specific thermal images software. **RESULTS** In order to check functional behaviour of respiratory muscles, we calculated the correlation coefficient (R) among thermal data of all the ROI and then grouped together ROI with strong correlation ( $R \geq 0.85$ ). In thoracic exercises, correlated ROI were grouped into 4 areas corresponding to: pectoral muscles, rectus abdominus, intercostal muscles, abdominal oblique. In diaphragmatic exercises we found a strong correlation ( $R \geq 0.96$ ) between thermal data of all the ROI. The temperature of the torso decreased by a few degrees during both trainings, but there was also an increase in pectoral muscles areas to be considered. **DISCUSSION** ROI of pectoral muscles in thoracic breathing are characterized by a linear heating during exercise and also a linear trend in

the cooling-down process during the recovery time. The heating-up is linked to the work of the superficial muscles located in the upper part of the trunk that characterized the thoracic breathing. In diaphragmatic breathing, which mainly uses internal musculature, temperature does not increase in pectoral muscles areas. There is in fact a lesser contribution of superficial muscles used in thoracic breathing. In diaphragmatic breathing, more muscles synergistically participate to carry out an action: this is the reason for the strong correlation between the thermal data of all the areas. REFERENCES Esposito F., Limonta E., Alberti G., Veicsteinas A., Ferretti G. (2010). *Respir. Physiol. Neurobiol.* 170:268-272. Merla, A., Mattei Peter A., Di Donato L., Romani G. (2010). *Ann. Biomed. Eng.* 38:158-163. Zaidi H., Taiar R., Fohanno S., Polidori G. (2007). *Acta Bioeng. Biomech.* 9:47-51.

### PREDICTION OF RELATIVE BODY FATNESS IN „WORLD GYMNAESTRADA“ PARTICIPANTS

Taeymans, J.1,2, Clijsen, R.3, Deriemaeker, P.2, Aerenhoudts, D.2, Cabri, J.4,5, Clarys, P.2

1: BUAS (Berne, Switzerland), 2: VUB (Brussels, Belgium), 3: THIM (Landquart, Switzerland), 4: NSSS (Oslo, Norway), 5: FMH-UTL (Lisboa, Portugal)

**Introduction** A low degree of relative body fatness (%BF) may be an important factor of success in sports with a high esthetic component such as gymnastics or dance. The aim of this study was to establish a prediction equation for %BF based on data gathered by an easy-to-conduct (kin-anthropometric test battery in male and female gymnasts. **Methods** Data were collected during the „World Gymnaestrada“ (Dornbirn, Austria, July 2007). From the 25'000 participating gymnasts, over 1400 volunteered in this study. In total, 818 participants agreed to conduct also a Bioelectrical-Impedance-Analysis (BIA) test. %BF was the dependent variable in the established equations in this study and was assessed using the BIA method (Tanita TBF-611, Tanita Inc., Tokyo, Japan). Kinanthropometric variables (such as Handgrip (HGR) and sum of 4 skinfolds (sum4SF) were measured using the ISAK guidelines (ISAK, 2002). Lifestyle habits under investigation were: smoking status, fruit and vegetables intake, physical activity (IPAQ), physical inactivity (minutes sitting per day) and years of gymnastic training. A backwards regression analysis was used to establish the prediction models. Significance was set at 5%. **Results** Participants from 31 different countries volunteered in this study. The best represented countries were Switzerland (35%), Germany (20%), Holland (5%) and Denmark (5%). All but 12 participants in the sample were Caucasian. Age of the active gymnasts ranged from age 12 to 82 years while mean years of training was about 28 years in the total sample. The best equation was established as:  $\{\%BF = -0.927 + (0.069 \times \text{sum4SF}) + (0.090 \times \text{HGR}) + (0.912 \times \text{BMI}) - (10.906 \times \text{GENDER})\}$  ( $p < 0.001$ ;  $R^2 = 0.700$ ;  $\text{RMSE} = 4.25\%$ ). If gender was removed from the prediction equation, the model remained significant ( $p < 0.001$ ), but its predictability ( $R^2 = 0.568$ ) and its precision decreased ( $\text{RMSE} = 5.11\%$ ). Removal of BMI from the model showed similar confounding effects ( $R^2 = 0.631$ ;  $\text{SEE} = 4.69$ ;  $p < 0.001$ ). However, removing HGR or sum4SF did not change the predictability nor the precision of the model. **Conclusion** This study presents a simple equation model including 4 predictor variables based on easy-to-conduct measurements to predict %BF in a sample of active gymnasts. Gender and BMI are confounders in the model. **References** International Society for the Advancement of Kinanthropometry, ISAK, 2002.

**13:45 - 14:45**

## Poster presentations

### PP-PM61 Health & Fitness: BMI 1

#### GROUP FITNESS ACTIVITIES ON ELDERLY: WHO IS ELIGIBLE AND WHO IS NOT?

Bianco, A.1, Patti, A.1, Centineo, V.1, Cataldo, M.C.2, Tabacchi, G.1, Mamma, C.1, Palma, A.1

1: University of Palermo. 2: Public Health District (ASP 6).

**Introduction** While it is impossible to prevent every injury, literature suggests that injury rates could be reduced by 25% if people took appropriate preventative action. On the other side, one major problem of Group Fitness Instructors is to find the right intensity/level suitable for every attendee during classes (e.g. ballroom dancing). Therefore, the aim of this study was to examine the opportunity to adopt already validated function ability tests on group fitness activities with the aim to prevent injuries and maintain or increase quality of life. **Methods** The study was conducted with a quasi-experimental design. The Berg Balance Scale (BBS) and the Barthel index (BI) were administered to an experimental group (EG) and a control group (CG) of elderly persons living in an inner city area of Palermo, Italy. EG was enrolled in three classes of ballroom dancing. Participants were assessed by BI and then submitted the BBS. The exclusion criteria were: 1) persons aged less than 58; 2) persons with a diagnosis of a disabling disease; 3) ex-professional athletes; 4) for EG, no more than 2 months of previous ballroom dancing experience. Means and SD were used to report preliminary descriptive results. For the purposes of our study a score of 70% for both scales (BBS-70% and BI-70%) was identified as the threshold value between a good and a poor performance. The STATISTICA software was adopted to perform the K-S normality test. **Results** One hundred twenty people participated to the study. We recruited 66 people as a CG (77.2 ± 6.4 yrs; 26.4 ± 4.4 BMI) and 54 people as EG (69.3 ± 8.3 yrs; 26.6 ± 4.4 BMI). The BI and BBS of CG were 76.51 ± 32 and 31.3 ± 13.2 respectively, while the BI and BBS of EG were 97.5 ± 7.7 and 51.2 ± 5.9, respectively. The BI of CG showed 0.33 K-S values while the same analysis for SG gave 0.47. We found the same trend on BBS values of CG (0.06) compared to EG (0.22). In EG, BBS-70% included 92.6% of cases compared with 24.2% of CG. The Barthel Index indicated a very similar profile: for EG BI-70% accounted for 98.1 of cases while BI-70% of CG 69.7%. **Discussion** BBS and BI promise to be able to predict who is eligible to start with Group Fitness and who is not. Indeed, the majority of the elderly persons belonging to EG reported higher BBS and BI values than the 70% threshold. Larger numbers and an accurate statistical analysis are necessary to confirm these findings. Preliminary results are very encouraging. **References** 1. Muir SW, Berg K, Chesworth BM, Klar N, Speechley M. Modifiable Risk Factors Identify People Who Transition from Non-fallers to Fallers in Community-Dwelling Older Adults: A Prospective Study. *Physiother Can* 2010; 62 (4): 358-67. 2. Hackney ME, Earhart GM. Effects of dance on movement control in Parkinson's disease: a comparison of Argentine tango and American ballroom. *J Rehabil Med* 2009; 41 (6): 475-81.

## METABOLIC, INFLAMMATORY AND FUNCTIONAL INDICATORS IN OBESE WOMEN SUBJECTED TO PILATES METHOD OF EXERCISE PROTOCOL: A PROPOSAL FOR THE PROMOTION OF HEALTH

Guimaraes, B.R.1, Neiva, C.1,2,3, Pimenta, L.D.1, Pessoa-Filho, D.M.2, Furukawa, M.3, Zaia, J.E.1

1: UNIFRAN (Franca, Brasil), 2: UNESP (Bauru, Brasil), 3: UPM (Madrid, España)

Introduction Obesity is recognized as a chronic disease of complex etiology, indicated by several authors as a worldwide epidemic, and also as one of the most important factors for the appearance of the chronic-degenerative diseases, being the main cause of morbidity and incapacity in the world. Among the most frequent problems associated with the pathology are the appearance of a chronic inflammatory state, the reduction of the basal energy expenditure, and the progressive loss of functionality. Currently, the adipose tissue is one of the main focuses of researches on obesity due to the evidence of its endocrine role in metabolic and physiologic processes that influence the pathogenesis of chronic diseases. Thus, the aim of this research was to assess the effects of an exercise program of Pilates method in promoting the general health of obese women through of modulation on inflammatory, metabolic and functional parameters. Methods Sixteen females, from 29 to 57 years old (average of 43,5 years old) were selected. The Pilates Training was executed for 8 weeks, three times a week. The plasmatic concentrations of inflammatory cytokines, the daily resting metabolic rate (RMR), and the functional capacity of the studied subjects were analyzed pre- and post-application of training period. Results The results obtained showed that physical fitness presented statistical difference between the pre and pos training period. With regard to the inflammatory cytokines studied in blood, the protocol does not promoted significant changes in the concentrations of IL6 and CRP. However, circulating CRP concentrations of 6 subjects were above normal in pre intervention featuring a subclinical inflammation State, and of these, 4 subject presented standardization of these values, after applying the training protocol. In relation to the analysis of RMR, the results obtained by the respiratory gasimetry revealed the efficiency of the protocol employed at elevation of metabolic expense (P 0.0001). Discussion The RMR is probably one of the most important factors in controlling and reducing the weight, may be strongly associated with improvement in inflammatory and functional profiles of the indicators. We conclude with the study that a Pilates training protocol can contribute greatly to improving the general health of obese women.

## INVERTED BMI VERSUS BMI AS PROXY-INDICATORS FOR ADIPOSITY DURING ADOLESCENT GROWTH

Leitao, R.1,2, Rodrigues, L.3,4, Neves, L.1, Carvalho, G.2

1: College of Education at Polytechnic Institute of Viana do Castelo (Portugal), 2: Research Centre on Child Studies at University of Minho (Portugal),

Introduction Inverted Body Mass Index (iBMI cm<sup>2</sup>/kg) has been recently proposed as a better adiposity indicator than body mass index (BMI kg/m<sup>2</sup>) based on data from a sample of healthy subjects aged 16 years and over (Nevill et al., 2011). The unstable relation between BMI and percentage body fat (%BF) during growth and its marked sex-differences are additional limitations of using BMI as an indicator of %BF in children and adolescents. Therefore, we investigated whether the inversion of BMI would result in an improvement of such limitations from a longitudinal perspective. Methods Data for the present analysis were derived from a previous study in which we have examined the individual trajectories of adiposity based on %BF in a cohort of 288 Portuguese children followed from age 9 (baseline) to age 15 (follow-up) at school setting (Leitão et al., 2011). Anthropometric parameters (Stature, weight, triceps and subscapular skinfold thickness) were measured using the standard procedures suggested by Lohman et al. (1988). BMI, iBMI and %BF derived from skinfolds (Slaughter's equations) were calculated. The non-normally distributed variables (BMI and %BF) were log transformed at both assessment time points. Pearson correlation coefficients between BMI and %BF, and between iBMI and %BF, were determined separately by sex and compared. Results Similarly to the results of the work by Nevill et al. (2011), iBMI also showed to be better approximated by the normal distribution at both age 9 and age 15. Pearson's correlation between iBMI and %BF was high at both 9 and 15 years, in boys and in girls. At baseline, r values were -0.89 (P=0.00) and -0.91(P=0.00) for boys and girls, respectively. At follow-up, r values were -0.81 (P=0.00) and -0.80 (P=0.00) for boys and girls, respectively. There were no significant differences between these values and those observed for the correlation between BMI and %BF (z-tests, P>0.05). Conclusion Although iBMI seems to correlate with %BF similarly to BMI during growth, it showed advantages for statistical applications. Further research is needed for a better understanding of the biological significance and clinical relevance of this candidate indicator of adiposity. References Leitão R, Rodrigues LP, Neves L, and Carvalho GS (2011). Changes in adiposity status from childhood to adolescence: A 6-year longitudinal study in Portuguese boys and girls. *Ann Hum Biol* 38 (4): 520-528. Nevill AM, Stavropoulos-Kalinoglou A, Metsios GS, Koutedakis Y, Holder RL, Kitas GD, and Mohammed MA (2011). Inverted BMI rather than BMI is a better proxy for percentage of body fat. *Ann of Hum Biol* 38 (6): 681-684.

## BODY COMPOSITION, MUSCLE STRENGTH AND REACTION TIME FOLLOWING THREE DAYS OF FOOD RESTRICTION IN MALES

Silalertdetkul, S.

*Srinakharinwirot University*

BODY COMPOSITION, MUSCLE STRENGTH AND REACTION TIME FOLLOWING THREE DAYS OF FOOD RESTRICTION IN MALES Silalertdetkul, S. Sport Science Department, Faculty of Physical Education, Srinakharinwirot University, Thailand. Introduction Body weight is regulated by the energy balance between energy intake and energy expenditure. A decreased energy intake might affect on body composition and physical performance. Therefore, the objective of this study was to investigate the effect of three days food restriction on body composition, muscle strength and reaction time in young males. Methods Eleven active males age between 19 and 22 years participated in this study, which had been approved by the local ethics committee (body mass index, 23 ± 1 kg/m<sup>2</sup>; percent body fat, 11 ± 2%; percent fat free mass, 89 ± 2%; resting heart rate, 64±7 beat/min; maximum oxygen consumption, 58 ± 3 ml/kg/min; mean ± SD). This experiment was cross-over design with two main trials separately by at least 14 days. Participants reduced their daily food intake approximately 50% for three days. Body composition (BioScan; Maltron, United Kingdom), muscle strength (TAKEI, Japan), reaction time (THAI PHAN, Thailand), subjective feeling of hunger as well as rating of perceived exertion were measured before and after in control and food restriction group. Fasting venous blood samples were taken at the same period of time. The data were analyzed using two way repeated measures ANOVA and paired t-test. Results Total body fat (before: 7.8±1.9 kg; after food restriction: 7.2±1.8 kg, P= 0.05), total body fat free mass (before: 59.6±4.0 kg; after food restriction: 58.8±3.8 kg, P= 0.05), protein (before: 14.4±1.0 kg; after food restriction: 14.1±1.1 kg, P= 0.03), glycogen (before: 542.2±77.6 g; after food restriction: 534.5±79.0 g, P= 0.04), body weight (after control: 67.2 ± 5.4; after food restriction: 66 ± 5.4 kg, P< 0.01), leg reaction time (before: 0.68±1.1; after food restriction: 0.56 ± 0.08 ms, P= 0.04) and fasting triglyceride concentrations (before: 70±22; after food restriction: 53 ± 20 mg/dL, P= 0.02) decreased significantly following 50% of food restriction. There was

no change in muscle strength, muscle mass, arm reaction time, subjective feeling of hunger and rating of perceived exertion. Discussion A decreased 50 percent of daily food intake for three days induced decreased in body composition but there was no affect on arm reaction time, muscle mass and muscle strength.

### THE ENERGY "GAP" AND RISK OF WEIGHT-LOSS RELAPSE: DIFFERENCES IN SELF-REPORTED VS MEASURED PHYSICAL ACTIVITY

Hume, D.J., Kroff, J., Carstens, M., Goedecke, J., Lambert, E.V.

*University of Cape Town*

**Introduction:** Relapse in the first 3-5 years following weight loss is a common problem in obesity management (Ross, 2009). The extent to which physiological (Jackman et al., 2008) vs behavioural adaptations contribute to weight loss relapse is not clearly understood. Moreover, there is some indication that an 'energy gap' or leading to positive energy balance and weight regain (Ross et al., 2000) may be related to lower levels of physical activity. The present study was designed to identify measurable differences in energy metabolism and substrate utilization (both at rest and during exercise, respiratory exchange and maximal rate of fat oxidation during exercise, Fatmax), as well as differences in self-reported energy and nutrient intake, reported and measured physical activity energy expenditure, in weight-stable (WS) and reduced-obese (RO) women, matched for body mass index and age. **Methods:** In a convenience sample of 44 women, body mass index, waist circumference, body composition (BIA), energy intake and nutrient intake, physical activity (Actigraph GT3X), and energy metabolism (resting respiratory exchange ratio and Fatmax) were measured. Questionnaires related to family history, demographics, physical activity (PA, Global Physical Activity Questionnaire), and eating and dieting behaviour were administered. **Results:** Mean age was 38 +/- 11 yrs and mean BMI was 24 +/- 2 kg/m<sup>2</sup>. No significant differences were found between the RW subjects and the WS group for weight, waist circumference, fat-free-mass (FFM) or body fat percentage. Group were different for highest adult weight (P = 0.00028), total weight lost and percent body weight lost (P < 0.00001). Groups were also similar with respect to dietary energy intake, resting energy expenditure and maximal rates of fat oxidation during exercise. Measured physical activity was not different between groups, however, self-reported moderate PA (270 vs 113 min/wk; P = 0.02) was higher in the RW group. **Discussion:** Eating behaviour, energy metabolism, and fat oxidation appear to remain unperturbed in women who experience reductions in body weight of 14+/- 5.4% or less. However, the RW women over-reported moderate PA by more than 100 min on average per week. This finding suggests that reduced weight women are at risk of weight regain due to errors in perception related to levels of physical activity, rather than weight loss-induced changes in physiology. **References:** Ross R. (2009). *CMAJ*, 180, 997-998. Jackman MR, Steig A, Higgins JA, Johnson GC, Fleming-Elder BK, Bessesen DH, MacLean PS. (2008). *Am. J. Physiol. Regul. Integr. Comp. Physiol.*, 294, R1117-R1129. Ross R, Dagnone D, Jones PJ, Smith H, Paddags A, Hudson R, Janssen I. (2000). *Ann Intern Med* 2000, 133, 92-103.

### SEASONAL VARIATION OF BODY COMPOSITION OF EACH BODY SEGMENTS IN JAPANESE FEMALE UNIVERSITY STUDENTS.

Yumigeta, R., Tsunoda, N., Horikawa, H.

*Showa university*

**SEASONAL VARIATION OF BODY COMPOSITION OF EACH BODY SEGMENTS IN JAPANESE FEMALE UNIVERSITY STUDENTS.** Yumigeta, R.1, Tsunoda, N.2, Horikawa, H.1 1:Showa University (Yamanashi, Japan), 2:Kokushikan University (Tokyo, Japan) **Introduction** It is important for keeping health to recognize the change in the body composition. In previous study, it is well known that seasonal variation of body composition in human body. However, whether the body fat and the muscle in which segments of the body were changed when the variation is seen in the body composition is not clear. The purpose of this study was to clarify the seasonal variation of body composition of each body segments in Japanese female university students. **Methods** The subjects were 139 healthy female university students who live in the dormitory for nine months. And also, the subjects were the almost the same life style. Their mean (SD) values of age, height and BMI were 18.2(0.5) yrs, 159.2(5.1) cm, 21.0(2.2), respectively. Body weight(BW), percentage of body fat in whole body(FWB), left arm(FLA), right arm(FRA), left leg(FLL), right leg(FRL) and trunk(FTK) and muscle volume in whole body(MWB), left arm(MLA), right arm(MRA), left leg(MLL), right leg(MRL) and trunk(MTK) were measured by bioelectrical impedance analysis method(TANITA, Japan). Each item was measured in spring(April), summer(July), autumn(October) and winter(November). And also, each item was measured that subjects get up and after urination as soon as possible. **Results** Significant increase for BW was showed from summer to autumn and autumn to winter. Significant decrease for FWB was showed from spring to summer. On the other hands, significant increase for FWB was showed from summer to autumn. Significant increase for MWB was showed from spring to summer and autumn to winter. FRA and FLA were significant increased from summer to autumn and autumn to winter. FRL, FLL and FTK were significant decreased from spring to summer. On the other hands, FRL, FLL and FTK were significant increased from summer to autumn. **Discussion** From these results, significant increased for BW from summer to autumn was caused to FWB. On the other hands, significant increased for BW from autumn to winter was caused to MWB. Significant decreased for FWB from spring to summer was caused the decrease of FRL, FLL and FTK. On the other hands, It was considered that a significant increase for FWB from summer to autumn was depended on the increase of FRA, FLA and FTK and the increase of FRL and FLL according to significant decrease of the MRL and MLL. **Reference** Abe, T., Tanaka, F., Kawakami, Y., Yoshikawa, K., and Fukunaga, T.(1996)*Med.Sci.Sports Exerc.*, 28, 908-912.

### INFLUENCE OF GENDER, AGE AND BMI OF ADOLESCENTS IN THEIR PHYSICAL ACTIVITY PATTERNS

Botelho, G., Ferrao, A., Aguiar, M.

*Coimbra College of Agriculture, Polytechnic Institute of Coimbra*

**INFLUENCE OF GENDER, AGE AND BMI OF ADOLESCENTS IN THEIR PHYSICAL ACTIVITY PATTERNS** Goreti Botelho<sup>1,2</sup>, António Ferrão<sup>3</sup> and Marco Aguiar<sup>3</sup> 1: Department of Food Science and Technology, Coimbra College of Agriculture, Polytechnic Institute of Coimbra, (Coimbra, Portugal), 2: CERNAS Research Unit, Coimbra College of Agriculture, (Coimbra, Portugal), 3: University of Trás-os-Montes and Alto Douro (Vila Real, Portugal). **Introduction** During adolescence, regularly practicing physical exercise promotes the harmonious development of the body and improves physical appearance which is very important. However, physical activity patterns in youth have changed as a result of an increase in time spent watching television, the advent of video games and the internet, and a decrease in the opportunities for physical activity in schools and/or communities. This study aimed to investigate relationships among gender, age, body mass index (BMI), and physical activity (PA) patterns of 9-14 years Portuguese adolescents. **Methods** A new questionnaire entitled "Questionnaire to Assess Physical Activity and Sedentarism, QAPAS" based on two previous questionnaires, QAPACE (Barbosa et al., 2007) and



HBSC (2001-02) was developed and applied. Participants of this school-based cross-sectional study were a random sample of 1403 students, 9-14 years (mean age:  $10.64 \pm 0.76$ , 50.0% males and 49.9% females, with 0.1% of no answer) from 7 public schools of the municipality of Viseu city (representing 86.9% of the total students population of these schools). BMI was calculated and the adolescents were categorized as underweight, normal weight, overweight and obese, according to CDC guidelines. Data analysis was performed using SPSS software v. 20.0. Results From BMI results, 4.4% of adolescents are underweight (2.0% males, 2.4% females), 68.1% show normal weight (32.5% males, 35.6% females), 18.6% are overweight (10.3% males, 8.3% females), and 8.6% are obese (5.2% males, 3.4% females). Discussion Analysing PA duration by age, statistically significant differences between students with different ages were found, only for the last seven days (30 min. per day). In general, the PA increases with age, from 9 to 14 years. Taking into account the influence of gender, a statistical significant difference of PA patterns was found, with male students showing more time spent with physical activities in the past seven days and in a normal week of the year. References Barbosa N, Sanchez C, Vera J, Perez W, Thalabard J, Rieu M (2007). *Journal of Sports Science and Medicine*, 6, 505-518. HBSC, US Department of Health and Human Services. *Health Behavior in School-Aged Children, 2001-2002* doi:10.3886/ICPSR04372.v2. Funding: CERNAS Research Unit is supported by National Funds through FCT - Foundation for Science and Technology under the project "PEst-OE/AGR/UI0681/2011".

### **BODY COMPOSITION DETERMINED BY BIA METHOD IN CHILDREN AND USE FOR OVERWEIGHT AND OBESITY ASSESSMENT.**

Bunc, V., Hráský, P., Balas, J., Skalská, M.

*Faculty of P.E. and Sports Charles University*

BODY COMPOSITION DETERMINED BY BIA METHOD IN CHILDREN AND USE FOR OVERWEIGHT AND OBESITY ASSESSMENT. Bunc, V., Hráský, P., Baláš, J., Skalská, M. Faculty of Physical Education and Sports Charles University Prague, Czech Republic Introduction The prevalence of overweight and obesity varies according to age, gender, race and socioeconomic classes. Body mass (BM) is a function of energy and nutrient balance over an extended period of time. Energy balance is determined by macronutrient intake, energy expenditure, and energy nutrient partitioning. The obesity management is strongly dependent on the methods that may be used for detection of early overweight or obesity. Increases in childhood overweight and obesity have emphasized the importance of accurate and accessible body composition (BC) assessment, especially in monitoring prevention and treatment effort. Using body mass index (BMI) is slightly simpler than using the prediction equations and can be used in big population studies, but the standards are strongly dependent on the population and age of evaluated subjects. BMI has achieved international acceptance because of being calculated from the subject's BM and body height that are easy to be individually measured. Bioimpedance analysis (BIA) seems to be one of the simple, safe, and inexpensive method for assessment of BC in children. Therefore we focus on verification of BIA method in children and thus on development of the obesity identification tool that are dependent on the gender, age and level of fitness, but also on fat distribution. Methods and Results Four-thousand-forty five children aged 6-14 years (2486 – 57.9% boys, and 1809 – 42.1% girls) were evaluated BC by multi-frequency bioimpedance analyser by using of adapted prediction equation for Czech children. The verification of predicted equation was realized with help of DEXA method. The mean value of %BF in all boys was  $19.79 \pm 2.37\%$ , and the same in girls was  $22.18 \pm 4.51\%$ . In age of 6 years we found in group of boys the mean %BF  $22.4 \pm 4.1\%$ , the  $8.0 \pm 1.0\%$  of boys was obese and  $15.0 \pm 3.1\%$  boys was overweight, in girls of the same age we found  $24.5 \pm 4.0\%$ ,  $8.0 \pm 1.5\%$  and  $16.0 \pm 2.1\%$ , the same data in boys of age 14 years were  $18.0 \pm 2.8\%$ ,  $11.0 \pm 2.0\%$ ,  $19.0 \pm 3.0\%$ , and the same in girls  $21.4 \pm 3.0\%$ ,  $12.0 \pm 1.7\%$ ,  $19.5 \pm 2.0\%$ . Linear regression analysis showed a significant positive relationship between %BF measured and BMI  $\%BF(\%) = 0.921 * BMI(kg.m^{-2}) - 4.292$ ,  $r = 0.858$ ,  $r^2 = 0.736$ ,  $SEE = 1.22\%$  in boys, and in girls  $\%BF(\%) = 1.284 * BMI(kg.m^{-2}) - 6.906$ ,  $r = 0.903$ ,  $r^2 = 0.815$ ,  $SEE = 1.05\%$ ,  $p < 0.0001$  in both cases. Conclusions The BIA method is a useful method for detecting BC in children and may be declared like a precise tool for measuring of BC in epidemiological studies in children. The decisive role for this using of this method plays the population oriented prediction equation and subject's hydration state. The study was implemented with support from Research Grant of Czech Ministry of Education MSM 0021620864.

### **DIFFERENTIATED APPROACH TO DEVELOPMENT OF PHYSICAL ACTIVITY PROGRAMS FOR WOMEN BASED ON THE PPARG AND ACE GENES POLYMORPHISMS**

Drozdovska, S., Andrieieva, E., Borovik, O.

*NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORT OF UKRAINE*

Introduction The differentiated approach allows improving the therapeutic effects, achieving the agreement of the aim and training effect as well as avoiding unwanted effects and complications. The modern methods of molecular genetics of physical activity make possible individualization of the training based on the genetic markers – the polymorphisms of the genes coding the metabolic and muscular tissue features in human (Bouchard C., 2001; Ahmetov I., 2006). Manifestation of the health improving effects of fitness exercises include the changes in the body composition. The objective of the study is to investigate the relationship between body composition and polymorphic variants of PPARG and ACE genes in people involved into exercise training. Methods The body composition of 44 women involved into different types of physical exercises was evaluated. DNA was isolated from the buccal epithelium. I/D polymorphism of ACE gene and Pro/Ala polymorphism of PPARG gene were studied using the method of polymerase chain reaction (PCR). The body composition was determined on TANITA device. Results The correlation between BMI, physical fitness index, body composition and polymorphisms of ACE and PPARG genes were determined in women aged 21-35 years. The polymorphism of PPARG gene had a definite effect on Pignet index value ( $p=0.031$ ). Pignet index was 2.1 higher in the group with Pro/Pro genotype than in the group of Ala allele carriers. BMI was 18.7% higher in the women with D/D genotype than in the group with I/D genotype. Strength training resulted in significant changes in the body composition with insignificant reduction of the body weight and girth measurements in the women aged 21-35 years with Pro/Ala and Ala/Ala genotype. The women with Pro/Pro genotype had more evident reduction of the body weight and girth measurements, but the body composition changed less significantly. Aerobic training resulted in 4.3% reduction of the body weight and 3.98% reduction of the fat content in the women with Pro/Pro genotype; in women with Pro/Ala and Ala/Ala genotype these parameters were reduced by 6% and 6.97%, respectively. Discussion Different types of physical exercises cause monodirectional changes of the morphofunctional parameters in the women aged 21-35 years with the different genetic traits. However, dependence of the parameter increase values on the molecular genetic features was observed. Their determination makes possible to identify the exercises most favorable for physical fitness improvement, to develop the appropriate training program and to avoid the risk of the unwanted consequences. The strength training was less effective for the weight reduction in the women with Pro/Ala and Ala/Ala genotype. The most effective changes in the body weight after strength training were recorded in the groups of the women with Pro/Pro genotype.

changes in BMI confirm this tendency. References Bouchard C. (2001). *Med Sci Sport Exerc*, V. 33., P. 446-451. Ahmetov I. (2006). *The 5th International Conference on Strength Training*, Odense, Denmark, P. 7.

**13:45 - 14:45**

## Poster presentations

### PP-PM62 Health & Fitness: BMI 2

#### DO BODY MASS INDEX, SEX, TREATMENT AND AGE INFLUENCE THE BODY WEIGHT LOSS?

Rojo-Tirado, M.A.1, Benito, P.J.1, Peinado, A.B.1

*Facultad de Ciencias de la Actividad Física y del Deporte (INEF), Universidad Politécnica de Madrid (Madrid, España)*

**Introduction** Most studies have described how the weight loss is when different treatments are compared (1-3), while others have also compared the weight loss by sex (4), or have taken into account psychosocial (5) and lifestyle (6, 7) variables. The aim of this study was to compare the body weight (BW) loss slope between overweight (OW) and obese (OB) people, taking into account the sex, treatment and age influences. **Methods** One hundred eighty people (84 OW and 96 OB, with BMI: 25-29.9 and 30-34.9 kg•m<sup>-2</sup>, respectively), aged from 18 to 50 years, participated in the study (36 and 49 males, and 48 and 50 females, respectively) during 6 months. Four types of treatments were randomly assigned: strength training (S, n=19 and 24), endurance training (E, n=25 and 26), combined S and E training (SE, n=22 and 24), and diet and physical recommendations (C, n=18 and 22). All participants followed a 25% calorie restriction diet. Slopes of the dynamics of weight loss were obtained through a linear equation, when initial and final BW was plotted on a graphic. A MANOVA was used to determine differences between slopes. Probability level for statistical significance was set at  $\alpha=0.05$ . Results The slope of OB (-0.804±0.041) was higher than OW (-0.555±0.044) (F<sub>1,134</sub>=17.143; p<0.001). When the slope was compared between groups, only S and E had higher slope in OB (-0.781±0.076 and -0.897±0.077, respectively) than in OW (-0.426±0.094 and -0.566±0.08, respectively) (p<0.05). When the slope was compared between sexes, men and women from OB had higher values (-0.825±0.058 and -0.783±0.057, respectively) than OW (-0.627±0.069 and -0.482±0.057) (p<0.05). When the slope was compared between age ranges, only the ranges 18 to 30 and 41 to 50 years of OB (-0.829±0.09 and -0.865±0.051, respectively) had higher values than OW (-0.491±0.095 and -0.622±0.062, respectively) (p<0.05). **Discussion** The slope of BW loss is higher for OB than OW. By groups, S and E in OB have higher slope than in OW. By age, 18 to 30 and 41 to 50 of OB have higher values than OW. Both sexes have higher slope in OB than in OW. **References** 1. Brochu M, et al. *J Clin Endocrinol Metab*. 2009 Sep;94(9):3226-33. 2. Del Corral P, et al. *J Clin Endocrinol Metab*. 2009 May;94(5):1602-7. 3. Larson-Meyer DE, et al. *Med Sci Sports Exerc*. 2010;42(1):152-9. 4. Hagan RD, et al. *Med Sci Sports Exerc*. 1986;18(1):87-94. 5. Teixeira PJ, et al. *Obesity (Silver Spring)*. 2010 Apr;18(4):725-35. 6. Bautista-Castano I, et al. *Int J Obes Relat Metab Disord*. 2004 May;28(5):697-705. 7. Worthy SL, et al. *Health Education Journal*. 2010;69(4):372-80.

#### ASSOCIATIONS BETWEEN BODY MASS INDEX AND OSTEOARTICULAR SYMPTOMS IN DIFFERENT BODY REGIONS AMONG WORKERS

Silva, I., Santos, R., Mota, J.

*FADEUP*

**Introduction:** Obesity rates are high among employed adults and have shown consistent increase over the past few decades. Musculoskeletal disorders related to work are a major cause of disability in working age individuals. Several studies have linked obesity with musculoskeletal disorders, the repetitive work can contribute significantly to the increase of these disorders in obese workers. The aim of this study was to verify the Associations Between Body Mass Index (BMI) and osteoarticular symptoms in different body regions among workers. **Methods:** The sample derived from worksite intervention with 212 factory workers (124 women), aged 37.6±8.2 years. Weight and height were measured with standardized protocols and BMI was calculated and participants were classified as normal weighted (BMI≤24.9kg/m<sup>2</sup>) or overweight/obese (BMI≥25kg/m<sup>2</sup>). Musculoskeletal pain was assessed with the Nordic Questionnaire of Osteoarticular Symptoms. **Result:** Baseline results from this worksite intervention show that overweight or obese participants were more likely to have Osteoarticular Symptoms in the shoulders (OR=2.203, p=0.009) and in the hand (OR=1.780, p=0.04). **Discussion/Conclusion:** Our results emphasise the need of worksite intervention to promote healthy weight as a way to prevent Osteoarticular Symptoms.

#### THE VERTICAL CHANGE OF THE CENTER OF GRAVITY BROUGHT BY THE INCREASED STEP LENGTH

Miyamoto, R.1,2, Muranaga, S.1, Ishige, Y.3, Osawa, Y.1, Ino, Y.1, Higashi, T.1

*1:Kameda Institute of Sports Sciences and Medicine(Chiba,Japan),*

**Introduction** One of the biggest factors to hinder the expansion of healthy life expectancy is a decline of the walking ability. Studenski have reported that there is a relationship between walking speed and life span. Muranaga et al developed a simple test, which is called "2 steps test", to measure walking ability easily. In our facility, we conduct the "2 step test" as an enlightenment activity to prevent falls in elderly population. The purpose of this study is to compare of body center of gravity in vertical direction measured by the "2 steps test". For reference, 2 steps value 0.8 is considered as a fall danger and its 1.5 is a normal. **Method** Subjects were 10 healthy males and 10 healthy females. (age:24.0±2.7year • 4.8±4.6years, height173.8±5.9cm • 162.4±4.6cm,weight65.8±5.4kg • 58.4±5.7kg ) Each subjects performed 2 trials and the 2steps value must be from 0.8 to 1.5. 29 landmarks on the subject's body were captured and analyzed by the motion capture system (Eva-RT, Motion Analysis, USA) and the ground reaction force was also measured during all trials. Musculoskeletal model (nMotion muscular, NAC, JAPAN) was used to calculate the body center of gravity. We compiled statistics on the 2 steps value from 0.8 to 1.5. They were processed through the one way analysis of variance and multiple comparisons. **Results** The averaged center of gravity in vertical direction displacement was 7cm. This was corresponded the 2 steps value 0.8, which was in dangerous level for falling. At its value 1.2, it showed 11.4cm in unstable gait level and showed 18.6cm in normal gait level at its value of 1.5. There were statistically significant difference between 2 steps level 0.8 and 1.2, 1.3, 1.4, 1.5 (P<0.05). **Conclusion** The result of this study showed that the averaged center of gravity in vertical displacement was 18.6cm corresponding to 2 steps value 1.5, which is in normal gait level. Furthermore, this

difference in the center of gravity was about 10cm when 2 steps value 0.8 was compared with its 1.5. Therefore, we considered that the muscle strength in lower extremity needed to be able to tolerate the vertical displacement in the center of gravity. In addition, the resemble strength is indispensable to improve in walking ability to prevent fallings. It is proven that an extended step length brought the greater vertical displacement in center of gravity. This suggests that walking with larger strides would become one of the useful training to develop the muscle strength in lower extremity. We plan on introducing muscle activation value measures by EMG and joint torque as our next step. References Studenski S et al, (2011) The Journal of the American Medical Association, 305(1) 50-58

### **'AN EXAMINATION OF SEDENTARY AND EATING ATTITUDES OF A SPANISH UNIVERSITY POPULATION: THE INFLUENCE OF STUDYING NURSERY ON ITS STUDENTS OWN BEHAVIOUR.'**

Varela, V., Cancela, J.M., Ayán, C.

*Vigo University*

Introduction: Future education and health professionals will be responsible for encouraging physical activity and correct eating habits among the general population. However, it has been noted that the period of undergraduate study is often a phase of change in terms of practice of PA, often reduced<sup>1</sup>, and indeed dietary habits curb to less healthy options<sup>2</sup>, notably among females university students. The aim of this study was to discover the prevalence of physical activity and the existence of eating disorders among Nursing, Physiotherapy and Education students. Materials and Methods: A transversal descriptive study through a combination of the International Physical Activity Questionnaire and the Eating Attitude Test 40 was directed to students that take part in the aforementioned degrees in the Pontevedra Campus at Vigo University. The data collection took place during a single day in the class with the most registered students for the selected course and academic year through an individual, anonymous and voluntary questionnaire on an "ad hoc" basis. Results: The data showed that 64% of Nursing students and 72% of Teaching students were qualified as sedentary individuals, while 19.5% and 15.3% of them respectively were likely to suffer from eating disorders. A significant association between physical activity performance and disturbed eating behaviours was observed among Education students. Discussion: The practice of PA has been identified as a risk factor linked with the existence of DEA3 among university students<sup>4</sup>, which coheres with the results of this particular study. However, this behaviour was only found to be significant among teaching students, albeit the results that showed that Nursery and Teaching students presented similar health patterns. As a result, it has been recognised that sedentary behaviour and poor dietary habits are linked to students within the vocations of health and education. References: 1. Keating XD, Guan J, Piñero JC, Bridges DM. A meta-analysis of college students' physical activity behaviors. *J Am Coll Health* 2005;54:116-25 2. Raich R, Mora M, Sánchez D, Torras J, Viladrich M, Zapater L, et al.. A cross-cultural study on eating attitudes and behaviours in two Spanish-speaking countries: Spain and Mexico. *Eur Eat Disorders Rev* 2001; 9, 53-63. 3. Jáuregui I, Tomillo S, Santiago M, Bolaños P. Body shape model, physical activity and eating behaviour. 4. Thome JL, Espelage DL. Obligatory exercise and eating pathology in college females: replication and development of a structural model. *Eat Behav* 2007;8:334-49.

### **BODY COMPOSITION AND PHYSICAL FITNESS AMONG ITALIAN POLICE OFFICER.**

MASSIDDA, M.1, ARGIOLAS, C.2, DIANA, A.3, CARBONI, D.2, CALO, C.M.1

*University of Cagliari and Italian State Police*

Introduction Police officers need to be physically fit, due to the potential need for officers to be able to exert maximum efforts and to undertake the role operationally. A review of the literature suggests that officers achieve an acceptable measure of physical fitness during academy training and before the fitness test for become a policeman. However, without fitness maintenance programs, these gains achieved are shortly lost (Lee, 2007). Purpose The aim of this study was to determine the impact of body weight on fitness tests among the personnel of an Italian State Police Department. Methods Twenty nine police officers (37.3 +/- 4.9 years; body mass index 26.1 +/- 1.9; body mass 78.4 +/- 8.2 kg; height 173.1 +/- 4.1 cm; body fat percentage 17.0 +/- 3.0; predicted VO<sub>2</sub> max 46.0 +/- 6.5 mls/kg/min) participated in this study. In order to evaluate the fitness level of the policeman, we applied a testing procedure that included measurements of 4 fitness tests and 9 body anthropometric tests. The body composition was analyzed by bioelectrical impedance analyses (Handy 3000, DS Medical), while the neuromuscular capacity was measured by Squat Jump, Counter Movement Jump and Bench press tests (Myotest PRO) and the aerobic capacity by Cooper test. Results A negative correlation was found between body fat parameters and Cooper test (Arm Fat Area, r=-0.63; Calf Fat Area, r=-0.62; Biceps thickness, r=-0.57; Triceps thickness, r=-0.67; Calf thickness, r=-0.64; Fat%, r=-0.58). Also a negative correlation was found between body fat percentage and VO<sub>2</sub>max (r = -0.58), while a positive correlation was found between the power and strength of upper limb and Arm Muscle Area (Power, r=0.76; Strength, r=0.74). Finally, a positive correlation was found between VO<sub>2</sub> max and lactate (LA) concentration measured during the second minute after Cooper test (r=0.58). Discussion The positive correlation between VO<sub>2</sub> max and LA concentration after exercise suggested that the policemen lactate tolerance is a benefit that combines the capacity of fatigue tolerance with the good value of VO<sub>2</sub> max. These two factors are essential for exert effort during particular situation, as apprehending the suspect. Finally, our results showed a great heterogeneity among the sample as far as aerobic capacity and fat parameters. It would be useful a reduction of this variability through a weight-management program realized with a structured physical activity protocol. This requires long-term physical activity program inside the policeman's everyday tasks. References Lee, J. (2007). Handbook of Police Administration, 289-303. Jim Ruiz and Don Hummer Eds.

### **VALIDITY AND ACCURACY OF THE OMRON WALKING STYLE PRO PEDOMETER – COMPARISON OF DIFFERENT WEARING LOCATIONS**

Hinrichs, T., Platte, K., Moschny, A., Platen, P.

*University of Bochum*

Introduction: As pedometers are inexpensive tools to measure walking, they are frequently used as motivational tools in walking interventions. To increase compliance with pedometer use, handling should be as easy and convenient as possible. According to the manufacturer, the Omron Walking Style Pro pedometer can be worn at various locations on the body. The aim of this study was to evaluate validity and accuracy of this pedometer when worn at different locations. Methods: Forty subjects (20 males, 20 females) aged 37.5 ± 14.7 years (body mass index 24.4 ± 3.8 kg/m<sup>2</sup>) participated in the study. All participants wore the Omron Walking Style Pro (HJ-720IT-E2; Omron Healthcare) pedometer on the left side of the body at the following locations: shirt's chest-pocket, waist belt, sling bag, and pant's front-pocket. One single instrument was used for all measurements to exclude any influence of inter-instrumental differences on the results. Every participant walked (self-paced) four times on an oval 400 meter outdoor track. The wearing location of the pedometer was

changed (in randomized order) after every lap. To determine the actual steps (AS) taken, every lap was videotaped and analyzed for number of steps and time. For every location the intra class correlation (ICC) between AS and steps measured by pedometer (PS) and the absolute percentage error [APE=(PS-AS)/AS\*100%] was calculated. Results: AS, walking speed, and stride length did not differ between the four wearing locations. ICC (95% confidence interval) between AS and PS was 0.990 (0.980; 0.995) for the shirt pocket, 0.989 (0.980; 0.994) for the waist belt, 0.988 (0.976; 0.994) for the sling bag, and 0.968 (0.941; 0.983) for the pant pocket. APE was  $-0.35 \pm 0.92\%$  for the shirt pocket,  $0.03 \pm 1.03\%$  for the waist belt,  $-0.35 \pm 0.99\%$  for the sling bag, and  $-0.22 \pm 1.80\%$  for the pant pocket. Conclusion: This study revealed a high validity and accuracy of the tested pedometer during self-paced walking when worn at different locations on the body.

#### **BIOELECTRICAL IMPEDANCE VECTORIAL ANALYSIS AND THE EVALUATION OF A BODY WEIGHT REDUCTION PROGRAM IN OBESE WOMEN.**

Lima Ribeiro, S., de Melo, C.M., Louzada, E., Tirapegui, J.

*University of São Paulo*

This study aimed to introduce bioelectrical impedance vectorial analysis (BIVA) for the evaluation of a body weight reduction program in obese women. Twenty-four women, aged 30 to 50 years old and BMI of 30 - 45 kg/m<sup>2</sup> were studied. The women were submitted to a nutritional education and a physical exercise program for four months, and were evaluated for: body mass index; body fat mass and fat free mass (DEXA-dual energy X-ray absorptiometry); bioelectrical impedance vectorial analysis-BIVA; serum albumin (by colorimetric method) and total body water (by deuterium). As main results, total body water presented normal range values at the end of the program; however, fat free mass and serum albumin were reduced. The data for BIVA suggest that water imbalance may contribute to the reduction in fat-free mass in some of the participants. As conclusion, BIVA analysis was found to be a promising tool to investigate body composition changes in low-grade obese women, but it should not be adopted as an exclusive analysis. In addition, individual analysis of results seems to be more appropriate than statistical comparison between groups.

#### **AGREEMENT BETWEEN ESTIMATED FAT MASS BY ANTHROPOMETRY AND BIOIMPEDANCE IN GIRLS AGED 11-15 YEARS**

Simoes, F.1, Rego, I.1, Machado-Rodrigues, A.1, Valente-dos-Santos, J.1, Leite, N.2, Ronque, E.3, Cyrino, E.S.3, Rama, L.1, Courteix, D.4, Coelho-e-Silva, M.J.1

*Universidade de Coimbra*

AGREEMENT BETWEEN ESTIMATED FAT MASS BY ANTHROPOMETRY AND BIOIMPEDANCE IN GIRLS AGED 11-15 YEARS Simões F1, Rêgo I1, Machado-Rodrigues A1, Valente-dos-Santos J1, Leite N2, Ronque E3, Cyrino E3, Rama L1, Courteix D4 Coelho-e-Silva MJ1 1Faculty of Sports Sciences and Physical Education, University of Coimbra, Coimbra, Portugal; 2State University of Londrina, Parana, Brazil; 3Federal University of Parana, Curitiba, Brazil; 4Laboratory of Biology of Physical Activity (EA 3533), University of Clermont Ferrand, France Introduction Percent of body fat mass estimated by anthropometry (Slaughter et al. 1988) is often used. The equations emerged from a sample of 136 females (16 prepubescent, 29 pubescent, 59 postpubescent, 32 adult) using the triceps and subscapular skinfolds [%BF<sub>TS</sub>=1.33\*(T+S)-0.013\*(T+S)<sup>2</sup>+2.5; when T+S<35 mm]. In contrast to males, equations were not specific for pubertal groups. The present study examined the agreement between estimates of FM by anthropometry and bioimpedance assessment (BIA). Methods Eighty-nine adolescent females participated in this study (11.0-15.7 years; 46.5 (7.9) kg; 157.1 (8.5) cm). Skinfolds were measured as described by Lohman et al (1988). Fat mass (FM) was assessed with a standard tetrapolar BIA technique (BIA 101 Impedance Analyzer; Akern, Florence, Italy). The normality was verified by Kolmogorov-Smirnov test, with Lilliefors' corrections and by visual inspection. Linear regression was used to examine the coefficient of determination (R<sup>2</sup>), standard error of estimation (SEE), slope, intercept and agreement between methods (Bland-Altman plots). Results Anthropometry underestimated FM when compared with BIA (R<sup>2</sup> = 0.78, 95% CI 0.68-0.85; SEE= 1.7 kg, 95% CI 1.5-2.0). The slope of the calibration equation was 1.1 (95% CI 0.97-1.2) suggesting no proportional error between methods. The intercept of the calibration equation was 1.6 (95% CI 0.33-2.8) which was significantly different from zero (p<0.05). Mean difference between estimates was 2.4 kg (SD=1.7 kg) and limits of agreement ranged from -0.9 kg to +5.8 kg. Meantime, stepwise linear regression, based on log transformed values, obtain a model that significantly predicts FM by BIA from FM by anthropometry, body mass, suprailiac and abdominal skinfolds (R<sup>2</sup> = 0.85 95% CI 0.79-0.89; SEE= 1.4, 95% CI 1.24-1.67). Discussion/Conclusion Although BIA is not a criterion method, its agreement with equations proposed by Slaughter and colleagues (1988) seemed to be improved when body mass and skinfolds are considered. Since body mass is moderately related with pubertal status and maturation, future research is needed to propose specific equation for pre-pubertal, pubertal and post-pubertal girls. References Slaughter et al (1988). Hum Biol, 60(5), 709-723 Lohman et al (1988) Anthropometric standardization reference manual. Champaign, IL: Human Kinetics Acknowledgment Fundação para a Ciência e a Tecnologia [SFRH/BD/78603/2011, SFRH/BD/64648/2009].

**13:45 - 14:45**

### **Poster presentations**

#### **PP-PM63 Neuromuscular physiology 4**

#### **COMPARING OF PEAK TORQUE ON LOWER LIMBS BETWEEN INDIVIDUALS WITH PARKINSON DISEASE AND HEALTHY INDIVIDUALS.**

Silva, M., Fonseca, R., Lima, R., Martins, W., Medeiros, F., Costa, J., Tolentino, G., Cruz, L., Oliveira, R.

*Universidade de Brasília - UnB*

Introduction Of the many motor symptoms associated with Parkinson's Disease (PD), the symptoms considered cardinal are: shaking palsy, bradykinesia or slowness of movement, rigidity and postural instability (Fahn, 2003). Muscle weakness also has been identified as one of the most important motor symptoms associated with PD, manifesting itself since the beginning of the disease, but there are not many studied about this (Cano-de-la-Cuerda et al, 2010; Corcos et al, 1996). Thus the present study aim is comparing the muscular

strength of lower limbs in individuals with PD and neurologically healthy individuals matched by age and gender. Methods Participated in this study 27 volunteers that were divided into Parkinson's group (PG - age: 63.5 SD 1.8 years, body weight: 74.7 SD 13 kg, height: 1.67 SD 0.08 m) and control group (CG - age: 61.5 SD 1.9 years, body weight: 76.2 SD 7.2 kg, height: 1.69 SD 0.06 m). Muscle strength was measured by the extent of knee isokinetic (Biodex System 3) at a speed of 90 ° per second and the highest value was determined as Peak of Torque (PT). T test was used to compare means between groups ( $p \leq 0.05$ ). Results The results showed no significant differences for the absolute peak torque of the lower limbs between PG (132.4 SD 41.8 N / min) and CG (140.2 SD 21.4 N / min). Discussion This study did not find significant differences between groups. These results may be consistent with the speed of movement in the motor disturbances resulting from Parkinson's Disease does not affect the execution of movements. Studies have shown a tendency to decrease in muscle strength with increasing speed of movement in individuals affected by PD (Pedersen et al, 1997; Nogaki et al 1999; Inkster et al., 2003, Paasuke et al., 2004). The motor symptoms associated with loss of strength in PD is known for Bradykinesia (Berardelli et al, 2001) and apparently moving speed protocol used in this study indicates the time that this motor symptom is not present. Fahn, S., 2003. Description of Parkinson's disease as a clinical syndrome. *Ann. N.Y. Acad. Sci.*, 991: 1-14. Corcos DM, Chen C-M, Quinn NP, McAuley J, Rothwell JC. Relationship of strength to rate of force in Parkinson's disease. *Ann Neurol* 1996;39:79-88 Cano-de-la-Cuerda R., et al. Is There Muscular Weakness in Parkinson's Disease? *Am. J. Phys. Med. Rehabil.* Vol. 89, No. 1, January 2010 Inkster LM, Eng JJ, MacIntyre DL, Stoessl AJ. Leg muscle strength is reduced in Parkinson's disease and related to the ability to rise from a chair. *Mov Disord* 2003;18:157-162.

## NEUROMUSCULAR FATIGUE DURING REPEATED MAXIMAL STATIC EXERTION IN INTERNATIONAL RUGBY UNION PLAYERS.

Lacome, M.1,2, Piscione, J.1, Bourdin, M.2

1. Research Department, F.F.R (Marcoussis, France) 2. University of Lyon, LBMC, (Lyon, France).

Introduction Rugby is an intermittent high intensity activity, which differs in nature with player position. Forwards are mainly involved in static exertion whereas backwards performed more sprints. Physiological and metabolic responses of repeated-sprint activities specific to field-based team sports had previously been well documented (e.g. (1)) but studies dealing with physiological consequences of repeated isometric activity were scarce. The aim of this study was to explore neuromuscular fatigue occurrence during repeated isometric maximal exercise simulating scrum effort. Methods The experiments were carried out on 9 French male international rugby union players (18.8 ± 0.4 years, 186 ± 5.5 cm, 100.8 ± 11.2 kg). Subjects were asked to perform, as hard as they can, twelve 5-s isometric static exertions against a scrum simulator (FFR-Thales Scrum Simulator) interspaced with 15-s rest. Strong verbal encouragement was provided to each subject during the entire testing procedure. During the test, all the forces expressed against the scrum simulator were recorded with 3 forces sensors MC5-10000 (AMTI inc, Waterdown, MA). EMG signal was treated using Root Mean Square (RMS) and Mean Power Frequency (MPF) methods for rectus femoris (RF), vastus medialis (VM) and vastus lateralis (VL). EMG RMS and MPF were normalized with respect to the value obtained for the first repetition. All data were synchronized using a Biopac MP150 (Biopac System inc, CA, USA). Results Preliminary results demonstrated that mean force decreased significantly ( $p < 0.05$ ) from the fourth repetition (1966.5 ± 336.4 N) to the last one (1819.2 ± 454.8 N). Normalized RMS of the VM was significantly lower from the fourth repetition ( $p < 0.05$ ). For RF and VL, normalized MPF decreased significantly from the fourth repetition (96.0 ± 4.2 and 95.7 ± 3.8 % respectively;  $p < 0.05$ ) but not for VM. Discussion In line with previous study about repeated sprint exercise (2), our preliminary results showed decline in performance during repeated maximal isometric exercise matched with neuromuscular fatigue. Decrease in RMS values for VM could be interpreted as change in coordination. Decrease in MPF values for VL and RF tended to demonstrate that peripheral fatigue occurs. It is interesting to note that decrease in force was less than these observed in repeated maximal running or cycling (2) for similar exhausting conditions. References 1. Spencer M, Bishop D, Dawson B, Goodman C. Physiological and metabolic responses of repeated-sprint activities: specific to field-based team sports. *Sports Med.* 2005;35(12):1025-1044. 2. Girard O, Mendez-Villanueva A, Bishop D. Repeated-sprint ability - part I: factors contributing to fatigue. *Sports Med.* 2011 Aug. 1;41(8):673-694.

## COMPARISON OF AN INTERMITTENT AND CONTINUOUS FOREARM MUSCLES FATIGUE PROTOCOL WITH MOTORCYCLE RIDERS AND CONTROL GROUP

Marina, M.1, Torrado, P.1, Angulo-Barroso, R.1, Busquets, A.1, Rios, J.G.2, Gasol, X.3, Turmo, T.3

1: INEFC (Barcelona, Spain); 2: Facultad Biología (UB); 3: CAR (San Cugat, Spain)

Introduction The motorcycle riders fatigue of the right forearm muscles is particularly relevant given their functional role in braking and accelerating. EMG frequency decrease and EMG amplitude increase during a sustained submaximal contraction until failure in a fatigue protocol are widely accepted. In contrast, EMG outcomes from an intermittent fatigue protocol are quite controversial (Clancy et al., 2008; Quaine et al., 2003). Methods Twenty road racing motorcycle riders participated as the experimental group whereas 39 subjects participated as a control group. Once obtained the maximal voluntary contractions (MVC) baseline value, 50% and 30% of MVC were calculated and normalised. All subjects performed an intermittent protocol (IP: composed by 25 rounds as maximum) and a continuous one (CP: 50% MVC until exhaustion). A forearm discomfort questionnaire was conducted with the riders. To measure the force exerted against the brake lever we used a unidirectional gauge. A ME6000 EMG system was used to register flexor digitorum superficialis (FS) and carpi radialis (CR) EMG signals (normalized RMS -NMRS- and median frequency-NMF-). Results In the CP, riders and control groups' average durations were not different ( $t=1.85$ ;  $p=0.07$ ). In the IP, the mean number of rounds per group was significantly different ( $p \leq 0.001$ ). The IP' NMVC was the same between the two groups but revealed a significant decrease across the relative rounds ( $p \leq 0.001$ ). Significant protocol and relative round main effects were observed (both  $p \leq 0.001$ ) for both EMG parameters (NMF and NRMS) and both muscle groups. No significant interactions or group main effects were found for NMF and NRMS of the FS. For the CR' NMRS, a significant 3-way interaction was found ( $p \leq 0.001$ ). A significant correlation was found between the forearm discomfort and the number of rounds accomplished in the IP ( $r = -0.92$ ;  $p \leq 0.001$ ). Discussion and conclusion The IP not only discriminate better the riders from the control group but has also a strong relationship with the level of forearm discomfort within the riders. Both protocols induce different EMG results, confirming a stronger fatigue round effect in the CP. The CR revealed more differences among groups and protocols than the FS. Because braking requires feeling and precision the riders possibly are more habituated to coactivate the CR. References Clancy, E. A., Bertolina, M. V., Merletti, R., & Farina, D. (2008). JEK, 18(5), 789-797. Quaine, F., Vigouroux, L., & Martin, L. (2003). *Int J Sports Med*, 24(6), 424-427.

### WHAT HAPPEN WITH THE CONTRACTION TIME AND THE HALF TIME TO RELAXATION OF THE FOREARM MUSCLES DURING AN INTERMITTENT FATIGUE PROTOCOL?

Marina, M.1, Torrado, P.1, Angulo-Barroso, R.1, Busquets, A.1, Rios, J.G.2, Gasol, X.3, Turmo, T.3

1: INEFC (Barcelona, Spain); 2: Facultad Biología (UB); 3: CAR (San Cugat, Spain)

**Introduction** After revision of the literature (Celichowski et al, 2006; Hubal et al., 2006), we hypothesized that contraction (CT) and relaxation time (RT) should increase because of fatigue. Nevertheless the use of different contraction modes such as voluntary contraction, evoked force or single twitches may certainly affect the results. **Material and Methods** 20 subjects carried out an intermittent protocol composed by 25 rounds as maximum. Each round was composed by two sections: 1) composed by six 5 s-voluntary contractions of 30% MVC, with resting periods of 5 s, 2) To mainly assess the effect of fatigue, composed of 3 s MVC followed by 1-min-resting period and a 50% MVC maintained during 10 s. The force exerted against the brake lever, time to MVC (CT) and half time to relaxation (1/2RT) were measured by a unidirectional gauge connected to a MuscleLab system. A ME6000 EMG system was used to register flexor digitorum superficialis (FS) and carpi radialis (CR) EMG signal during MVCs was RMS. The number of rounds of each subjects was normalized (Mamaghani et al., 2002). Each relative round (n=4) corresponds to the 25% of the test for each subject. Repeated measures ANOVAs and regression analysis were used to study changes in the NMVC, RMS, Ct and 1/2RT. Results Significant decrement of the NMVC and RMS' MVC of the Carpi radialis (CR) and flexor superficialis (FS) were observed ( $p \leq 0.001$ ). No significant differences were found for the CT ( $F(4,16)=2.69$ ;  $p=0.069$ ). Nevertheless, for the 1/2RT significant differences were observed ( $F(4,16)=13.51$ ;  $p \leq 0.001$ ). Post-hoc analysis revealed differences only between the basal 1/2RT value and the four relative rounds ( $p \leq 0.001$ ) whereas no significant trend was observed throughout the fatigue protocol ( $F(3,17)=1.88$ ;  $p=0.171$ ). Regression analysis showed a significant decrement ( $p \leq 0.05$ ) in 35% of the subjects with CT and 15% with 1/2RT. **Discussion** The decrement of NMVC and RMS' MVC confirm the occurrence of fatigue. From the very beginning of the fatigue protocol 1/2RT is longer in comparison to the non fatigued state of the basal assessment. This result confirm only partially previous authors (Celichowski et al, 2006; Hubal et al., 2006; Orizio et al., 1999) possibly because they used electrically evoked single twitches instead of MVC as in our study. **References:** Celichowski, J., Pogrzebna, M., & Krutki, P. (2006). Archives italiennes de biologie, 144(3-4), 159-171. Hubal, M. J., Rubinstein, S. R., & Clarkson, P. M. (2008). J Strength Cond R, 22(4), 1332-1338. Orizio, C., Diemont, B., Esposito, F., Alfonsi, E., Parrinello, G., Moglia, A., et al. (1999). Eur J Appl Physiol, 80(4), 276-284.

### EFFECT OF AGE ON NEUROMUSCULAR COORDINATION STRATEGIES DURING STABLE AND UNSTABLE ENVIRONMENTAL INTERACTIONS

Holl, N., Wübbenhorst, K., Behrens, M., Zschorlich, V.

Rostock University

**Introduction** We have previously identified adjustments in movement orchestration and neural control mechanisms following changes in environmental dynamics. These changes in mechanical interaction with the environment create different stability demands and were studied during performance of a unilateral ballistic force production task (Wübbenhorst & Zschorlich 2011; Holl & Zschorlich 2011). Here, we ask whether coordination patterns of involved muscles change in healthy elderly in comparison to young healthy adults. We predict that the elderly show a reduced ability of maximal force output accompanied by specific changes in temporal coordination patterns according to muscle function and environmental dynamics. **Methods** Six young healthy participants (YPs) (mean age: 23.8 years) and six aged healthy participants (APs) (mean age: 73.5 years) were asked to produce maximal force in a time-reaction paradigm. The task comprised a ballistic knee extension movement in our movement-sled influenced by one of three environmental conditions that differ in the degree of instability: 0 degrees of freedom (DoF), 1 and 3 DoF. Forces were recorded by use of a three dimensional KISTLER force transducer. Temporal coordination patterns were assessed by use of the cross-correlation technique of EMG-signals of eight different muscles: M. vastus medialis (VM), M. tibialis anterior, M. peroneus longus, M. rectus femoris, M. semitendinosus, M. soleus, M. gastrocnemius medialis and M. biceps femoris. For each correlation the VM served as reference muscle. **Results** Our results showed that the AP-group produced less maximal forces as compared to YPs when increasing the DoFs. As basic mechanisms of this decrease we identified altered coordination patterns in comparison of YPs and APs showing a significant effect of age and muscle ( $p=0.0057$ ). These adjustments in temporal coordination of individual muscles were specific for DoF-condition and age. Taken together, the changes between groups (APs vs. YPs) while increasing the DoFs of the task became manifest by either congruent (maintaining the same coordination strategy but shifted in time) or incongruent (temporal shifts based on differing strategies) strategies. **Discussion** The results indicate that the individual age-groups compensate for the loss of effective force transmission by adjusting temporal coordination strategies. Consequently, each group uses unique motor control mechanisms taking the individual physical preconditions that occur with aging into consideration. However, the changes in temporal neuromuscular control may contribute to increased risks of injury in the elderly. **References** Wübbenhorst K, Zschorlich V (2011). J Electromyogr Kinesiol 21: 340-347 Holl N, Zschorlich V (2011). Exp Br Res 210(2): 229-242

### MUSCLE ACTIVATION DURING EXPLOSIVE CONTRACTIONS EXCEEDS THAT AT MAXIMUM FORCE, AND HIGH INITIAL ACTIVATION APPEARS TO BE FOLLOWED BY AN INHIBITORY RESPONSE

Folland, J.P., Fry, A.

Loughborough University

**Introduction** There is considerable debate about the maximality of muscle activation during different types of contractions. The magnitude and pattern of muscle activation during explosive contractions has not been carefully documented and may exceed that achieved at maximum voluntary force (MVF) i.e. the rising vs plateau phase of isometric contraction. This study investigated the magnitude and pattern of muscle activation during explosive contractions compared to at MVF. **Methods** Healthy, untrained, young men (n=27) performed two identical trials of isometric contractions of the knee extensors at a knee joint angle of 120°, 7 days apart, with data averaged across both trials. A strain gauge perpendicular to the tibia measured force and double differential surface EMG was recorded from two sites over each of the three superficial agonist muscles (RF, VM, VL) to assess muscle activation. Participants performed: two series of four maximum voluntary contractions of 3-s duration in order to measure MVF and EMG amplitude (RMS of a 500-ms epoch around MVF, EMG@MVF); and 10 explosive contractions of ~1-s duration as 'fast and hard' as possible from rest. For the explosive contractions, force and EMG amplitude (moving 25-ms RMS window) were assessed from 50-ms before until 150-ms after force onset in order to describe their temporal pattern and determine peak EMG (EMGEXP-PK). **Results** Whole quadriceps EMGEXP-PK exceeded EMG@MVF ( $209 \pm 96$  vs  $178 \pm 84$   $\mu$ V;  $P < 0.001$ ), reaching  $122 \pm 18$  %EMG@MVF, and this was the case for all three agonist muscles (All,  $P < 0.01$ ; VM 130, VL 125 and RF 118 %EMG@MVF). Participants with a high (HIGH, n=8) vs low (LOW, n=8) capacity for activation (EMGEXP-PK) during explosive contrac-

tions showed a different EMG pattern and magnitude. For HIGH time aligned EMG peaked at  $138 \pm 12\%$  EMG@MVF (45-ms), followed a marked decline of  $>1/3$  to  $88 \pm 23\%$  EMG@MVF (99-ms) before returning to  $>96\%$  EMG@MVF (116-ms onwards). For LOW time aligned EMG peaked at  $92 \pm 11\%$  EMG@MVF (59ms;  $P < 0.01$  vs HIGH), and remained similar thereafter ( $83-91\%$  EMG@MVF). Furthermore in the whole group, EMGEXP-PK was strongly related to the subsequent decline in EMG for the whole quadriceps ( $R = 0.67$ ;  $P < 0.01$ ) and this effect was particularly strong for the vasti muscles (VM,  $R = 0.78$ ; VL,  $R = 0.75$ ; both  $P < 0.01$ ). Conclusion In these untrained individuals activation during explosive contractions substantially exceeded that at MVF, indicating that activation at MVF was not maximal. Individuals with high activation during explosive contractions showed even higher initial values, but this was followed by a rapid decline that was strongly related to the amplitude of the initial peak. This study provides novel evidence for an inhibitory response to these initial high levels of activation.

### COMPARISON BETWEEN TWO THRESHOLD METHODS RELATED-BASELINES FOR THE EMG ONSET DETECTION IN TRUNK MUSCLES DURING GOLF SWING

Silva, L.1, Vaz, J.1, Marta, S.1, Paula, A.1, Castro, M.A.2, Fernandes, O.3, Pezarat-Correia, P.1

1: FMH-UTL (Lisbon, POR), 2: ESTESC-IPC (Coimbra, POR) 3: ECT-UE (Évora, POR)

**Introduction** Several approaches have been proposed for EMG onset detection, but there is not a standardized method. Onset detection accuracy has been shown to be related with muscle baseline activity (Hodges & Bui, 1996; Allison, 2003). The aim of this study was to compare two threshold methods related-baselines for onset detection. **Methods** Eight golfers (handicap =  $15.7 \pm 3.2$ ; range 11-20) performed 10 shots with two different clubs (5 with pitch and 5 with 4-iron). 80 shots were used for analysis. Surface EMG on both sides of trunk was recorded from Rectus Abdominis (RA), External Oblique (EO) and Erector Spinae (ES). In method A threshold was calculated by the baseline activity recorded between two MVC. In Method B threshold was determined by the mean activity before the beginning of backswing [-1000: -500 ms]. The mean of 50 samples of a sliding window above threshold level was used for the onset detection. Visual inspection was also performed. **Results** ANOVA showed no significant interaction between clubs, muscles and methods. Significant differences were found between methods and muscles (left:  $F(1.432, 90.225) = 194.905, p \leq .01$  right:  $F(1.764, 119.985) = 124.137, p \leq .01$ ). Left and right RA showed a high correlation and agreement with the Bland-Altman mean of 0.7 ms [-10, 8.7] and 0.2 ms [-5.1, 4.5], respectively. The left and right EO had good correlation between the baselines, but less agreement than RA, showing a bias of 89 ms [-88, 265] and 38 ms [-162, 237], respectively. ES had a lower correlation between method A and B. **Discussion** During golf swing RA showed high correlation and agreement between methods which means that the chosen baseline method did not affect the onset parameter due to a high signal-to-noise ratio. The EO showed higher variability than the others muscles in peak timing, with high bias between methods for the left side. Due to its role on pre-swing posture maintenance the ES had high background activity that affects the agreement between methods. So, for this muscle it is not advisable to use the repetition baseline for threshold calculation. In that case, EMG activity could not be related to the motor skill (Vaisman et al., 2010). The choice of the parameters to be included in threshold methods seems to have influence on onset detection (Hodges and Bui, 1996). The appropriate threshold method to determine the EMG onset of trunk muscles during the golf swing depends on the studied muscle. **References** Allison GT (2003). J Electromyogr Kines 13: 209-216. Vaisman L et al. (2010). J Electromyogr Kines 20: 750-760. Hodges PW, Bui BH (1996). Electroen Clin Neuro 101: 511-519.

### APPLICATION OF INVERSE ANALYSIS AND FINITE ELEMENT METHOD FOR PROGRESSING OF SURFACE EMG ANALYSIS

SAITOU, K.1, INOUE, S.2, MIYAZAKI, M.3, ITOH, H.4

1 Nagoya Gakuin University (JAPAN), 2 Saga University (JAPAN), 3 Obirin University (JAPAN), 4 Nagoya Institute of Technology (JAPAN)

**Introduction** In order to extract the information about anatomy and physiology of motor units as the active source through the inverse analysis of surface EMG, valid surface EMG simulation that is considered about the inhomogeneous layer under skin is required. And, the model for the simulation must be as simple as possible. In this study, the potentials as surface EMG were calculated by finite element method (FEM) by using three-layer or four-layer model that were consisted of muscle tissue, subcutaneous tissue and skin. Furthermore, the effect of those potentials on the solutions through the inverse analysis was investigated. **Methods** Cylindrical model with 40 mm in radius and 300 mm in length was used in the calculation of FEM. These simulations with FEM were executed by varying the value of thickness and conductivity of each layer except for muscle region. The thickness of skin (dermis + epidermis) ranged from 0.75 to 3.0 mm and the conductivity of skin ranged from 0.2 to 1.2 S/m in the three layers model. The thickness of dermis ranged from 0.5 to 2.5 mm and the conductivity of dermis ranged from 0.3 to 1.2 S/m, and the thickness of epidermis ranged from 0.25 to 0.5 mm and the conductivity of epidermis ranged from 0.0001 to 0.0005 S/m. The thickness was 5.0 mm and the conductivity was 0.4 S/m of the subcutaneous tissue in both models. In the inverse analysis of surface EMG, the active sources were estimated with image method that was more simple method than the other methods. **Results and Discussion** As the results of the simulation with FEM, the effects of the conductivity of skin layer on the surface potential were larger than those of the thickness of skin layer in the three-layer model. In the four-layer model, the effects of the thickness and the conductivity of epidermis layer on the surface potential were small. And then, the error of peak value of surface potential between both layer models was about 20% in the case of 0.5 mm in thickness of epidermis, and about 11% in the case of 0.25 mm in thickness of epidermis. The differences of these results influenced into the estimation through the inverse analysis about anatomy and physiology of active motor units. **References** Stegeman DF, Blok JH, Hermens HJ and Roeleveld K: Surface EMG models: properties and applications, J. Electromyogr. Kinesiol., 10, 313-326 (2000) Lowery MM, Stoykov NS, Taflove A and Kuiken TA: A multiple-layer finite-element model of the surface EMG signal, IEEE Trans. Biomed. Eng., 49(5), 446-454 (2002)

### ACUTE NEUROMUSCULAR RESPONSE TO SQUAT AND DEADLIFT MAXIMUM STRENGTH TYPE RESISTANCE EXERCISE

Brandon, R.1, Howatson, G.2, Hunter, A.3

1. English Institute of Sport, 2. Northumbria University, 3. University of Stirling

**Introduction** Barbell resistance exercises are used to develop maximum strength levels. Recruitment of a high proportion of motor units is important for adaptation to strength training (Behm, 1995). For example, greater recruitment has been associated with enhanced cross sectional area and force adaptations (Takarada et al., 2000). No studies have directly compared neuromuscular (NM) responses between commonly used barbell exercises, although research shows loading task influences NM recruitment (Mottram et al., 2005). Therefore, the study aimed to assess if NM response to a maximum strength session differed when performed with either squat or deadlift. **Methods** Nine elite trained subjects performed squat or deadlift sessions consisting of five sets of five repetitions, with matched loads, on separate days. The NM response to each exercise session was assessed with continual recordings of surface electromyography and barbell displacement, from which repetition electromyographic amplitude (RMS), muscle fibre conduction velocity (MFCV) and mean

power (MP) were derived. Pre- and post- session knee extension MVC force and central activation ratio (CAR) from superimposed stimulation during MVC were also assessed. Repeated measures ANOVA was used to assess changes in repetition RMS, MFCV and MP, and changes in pre versus post session MVC and CAR assessments. Results Repetition RMS significantly increased ( $p < 0.001$ ) within sets of squat (125.3%) and deadlift (114%), relative to repetition one. A significant interaction between session and set ( $p < 0.001$ ) demonstrated RMS increased more during squat. Repetition MFCV significantly reduced to 91.7% relative to repetition one within squat sets ( $p = 0.034$ ), but not deadlift. Repetition MP was unchanged during both sessions. There were no differences in MVC and CAR pre versus post either session. Discussion The findings suggest increased motor unit activation occurred to maintain MP during sets of squat and deadlift maximum strength exercise. However, acute peripheral fatigue was more likely to have occurred during squats, indicated by reduced MFCV. Increased RMS response may result from the demands of the lifting task, with or without fatigue. However, reduced MFCV was associated with greater RMS response, possibly indicating greater stimulus for adaption. No change in MVC and CAR suggested force capacity and central drive were not reduced following five sets of barbell exercise in well-trained subjects. References Behm D. (1995). *J S&C Research*, 9(4), 264-74. Mottram C, Jakobi JM, Semmler, J & Enoka, R. (2005) *J Neurophysiol*, 93(3), 1381-92. Takarada Y, Takazawa H, Sato Y, Takebayashi S, Tanaka Y & Ishii N. (2000) *J Appl Physiol*, 88(6), 2097-2106.

### PHYSIOLOGICAL AND NEUROMUSCULAR EFFECTS OF AN ELECTRONICALLY ACCENTUATED ECCENTRIC KNEE EXTENSION TRAINING

Kasperek, P., Thilo, E.J., Babiak, S., Ferrauti, A.

*Ruhr-University Bochum*

Introduction Studies have shown, that an accentuated eccentric strength straining comes along with an increased muscle damage and consequently with stronger concentric adaptations of strength (Brandenburg et. al., 2002). The aim of the present study was to define the most effective relation between concentric and eccentric loads concerning neuromuscular activity and physiological demands during an accentuated training with an electronically controlled knee extension machine. Methods 20 athletes (n=10 males and 10 females, age  $24.3 \pm 3.1$  yrs) completed three different training protocols during three experimental days, each at least three days apart. The training was conducted on an electronically leg extension machine (Milon Industries®, Germany), with separately adjusted concentric and eccentric resistance. Protocol A was defined as a traditional strength endurance training (TST) with equal loads (20 % 1 RM) in the concentric and eccentric movements. Protocol B (ECC+) and protocol C (ECC++) consisted of reduced concentric (B 16, C 12 % 1RM) and an increased eccentric load (B 24, C 28 % 1RM). During each protocol eight sets of eight repetitions (7.5 s each and 1 min duration per set) followed by 30 s recovery were completed. Results No differences were found for the mean heart rate (A  $106 \pm 13$ , B  $107 \pm 14$ , C  $103 \pm 12$  min<sup>-1</sup>) and perceived exertion (A  $14 \pm 1$ , B  $14 \pm 2$ , C  $14 \pm 1$ ). Mean oxygen consumption was significantly lower in Protocol C (A  $8.4 \pm 2.4$ , B  $8.4 \pm 1.6$ , C  $7.5 \pm 1.8$  ml·min<sup>-1</sup>·kg<sup>-1</sup>). M. vastus medialis activity tended to be higher during concentric contraction in A (A  $0.19 \pm 0.11$ , B  $0.14 \pm 0.06$ , C  $0.13 \pm 0.04$  mV) while no differences were found for the eccentric movements (A  $0.15 \pm 0.07$ , B  $0.14 \pm 0.04$ , C  $0.14 \pm 0.04$  mV). Neuromuscular activity decreased significantly during the second half of the eccentric movements in all protocols. Discussion Results showed that an accentuated eccentric strength training comes along with an overall lower energy demand despite of a similar power output and does not increase neuromuscular activity as expected under the conditions of our study. These results may be attributed to a faster movement in case of eccentric overload. References Brandenburg, J.P. & Docherty, D. (2002). The effects of accentuated eccentric loading on strength, muscle hypertrophy, and neural adaptations in trained individuals. *J. Strength Cond. Res.* 16 (1), 25-32.

13:45 - 14:45

## Poster presentations

### PP-PM64 Training & Testing 14

#### CORRECT, FAKE AND ABSENT PRE-INFORMATION ABOUT THE THEORETICAL BASIS OF THE BILATERAL FORCE DEFICIT ACHIEVED PRIOR TO STRENGTH TESTING DOES NOT AFFECT ITS OCCURRENCE AND MAGNITUDE

Donath, L.1,3, Siebert, T.2, Faude, O.1, Puta, C.3

*University of Basel*

1 University of Basel, Institute of Exercise and Health Sciences, Basel, Switzerland 2 University of Jena, Institute of Sport Science, Motion Sciences, Jena, Germany 3 University of Jena, Institute of Sport Science, Sports Medicine and Health Promotion, Jena, Germany Introduction The Bilateral Force Deficit (BFD) is characterized by lower bilaterally (BL) generated maximal muscle strength compared to the sum of the unilaterally (ULright + ULleft) produced maximal strength. Beside spinal and supra-spinal inhibitory mechanisms during bilateral tasks, also volitional influences on these inhibitory pathways have been hypothesized (Jakobi & Chiibeck 2001, Secher et al. 1988). Thus, the present randomized cross-over study intended to differentiate whether no, fake or correct pre-information achieved prior to strength testing differently affect the occurrence and magnitude of the BFD. Methods 20 heterogeneously trained male adults (age:  $24.5 \pm 1.7$  years; weight:  $77.5 \pm 7.1$  kg; height:  $1.81 \pm 0.05$  m) were examined on three days within seven days employing a negatively inclined leg press slide with separate force plates for the left and right leg. Each participant semi-randomly completed three separated maximal isometric strength test sessions with no (first day), fake (bilateral force > sum of unilateral forces; second day) and correct (third day) pre-information during bilateral, unilateral-left and unilateral-right leg-press. The sum of left- and right-sided force values were calculated for bilateral ( $FBL = FBL_{left} + FBL_{right}$ ) and unilateral ( $FUL = FUL_{left} + FUL_{right}$ ) analyses. Results Comparative descriptive analysis for no pre-information (No) condition force (N) values revealed: Mean (SD):  $FUL_{No} = 3023$  N (435) vs.  $FBL_{No} = 2812$  (453), fake pre-information (Fa) showed  $FUL_{Fa} = 3013$  N (459) vs.  $FBL_{Fa} = 2843$  (446) and the correct (Co) pre-information revealed  $FUL_{Co} = 3035$  (425) vs.  $FBL_{Co} = 2844$  (385). The three (no, fake, correct) \* 2 (FUL, FBL) repeated measures analyses of variance revealed a high significant main effect of force ( $F = 61.82$ ,  $p < 0.001$ ). Neither the main effect for information ( $F = 0.11$ ,  $p = 0.90$ ) nor the interaction for information\*force ( $F = 1.07$ ,  $p = 0.35$ ) was significant. Discussion The occurrence and magnitude of the BFD both seem not affected by pre-information conditions. Our results indicate that volitional influences on the BFD on supra-spinal level might not be likely. However, bilateral maximal strength exercises in alternating multi-joint movements in closed chains, such as e.g. cycling, running and jumping should be supplemented by a proper



amount of alternating-unilateral strength exercises. References Jakobi JM & Chilibeck PD. (2001). *Can J Appl Physiol* 26, 12-33. Secher NH, Rube N & Elers J (1988). *Acta Physiol Scand.* 134, 333-339

### MAXIMUM NUMBER OF REPETITIONS AND LOSS OF VELOCITY WITH CLUSTER SET CONFIGURATION

Carballeira, E.1, Iglesias-Soler, E.1, Sánchez-Otero, T.1, Castro-Gacio, X.1, Mayo, X.1

1. UDC (A Coruña, Spain)

**Introduction** The purposes of this study were: monitoring the maximum number of repetitions (MNR) achieved before failure through a cluster set configuration (insertion of pause between every repetition), and studying the loss of velocity, of a high intensity parallel squat exercise (Sq). **Methods** Nine male subjects (body mass=84.1±17.2 kg; height=175.6±8.41 cm; age=23.8±4.09 years) volunteered for participation in this study. All of them had at least 18 months of experience in weight training, with a minimum frequency of two training sessions per week. In a first session four repetition maximum load (4RM) for Sq was obtained. During a second session, called failure session (FS), subjects were instructed to perform MNR within each of the 3 sets of Sq with 4RM load. Three minutes rest were fixed between sets. Finally in a third session, called cluster session (CS), MNR was obtained with the same load than in FS, but individual resting time between each repetition was set as the ratio between the total pause in FS (360 seconds) and the sum of the total number of completed repetitions in FS minus 1. **Results** The number of repetitions completed during FS was of 9.7±2.1. The obtained MNR in CS was of 45.3±32.2. The ratio MNR in CS respect the total number of completed repetitions in FS was 4.9±3.5. In addition, mean velocity of propulsive phase (Sanchez-Medina et al., 2010) resulted higher in CS than in FS (p=0.054, T-test for paired samples). Furthermore, repeated measures ANOVA showed that the loss of velocity in CS (% of first repetition velocity) was significant from 60 % of MNR. No significant correlation was found between MNR in CS and the total number of completed repetitions in FS. **Discussion** The use of pauses between every repetition allows to improve mechanical performance of a training session (Haff et al., 2003; Iglesias-Soler et al., 2012). Since the development of sets to failure entails reduction in intensity of training (de Salles et al., 2009), the results of the present study suggest that CS is an interesting approach to improve mechanical stimuli of high intensity and high volume lower body workouts. These results are coincident with others obtained previously for upper-body exercises (Iglesias et al., 2010). **References** de Salles BF, Simao R, Miranda F, Novaes JS, Lemos A, Willardson JM. (2009). *Sports Med*, 39(9), 765-77. Haff GG, Whitley A, McCoy LB, O'Bryant HS, Kilgore JL, Haff EE, Pierce K, Stone MH. (2003). *J Strength Cond Res*, 17(1), 95-103. Iglesias E, Boulosa DA, Dopico X, Carballeira E. (2010). *J Strength Cond Res*, 24, 1566-1572. Iglesias-Soler E, Carballeira E, Sanchez-Otero T, Mayo X, Jimenez A, Chapman ML. (2012). *Int J Sports Med*. DOI: 10.1055/s-0031-1299699. Sanchez-Medina L, Perez CE, Gonzalez-Badillo JJ. (2010). *Int J Sports Med*, 31(2), 123-9.

### PERFORMING EACH REPETITION AT MAXIMUM VELOCITY PRODUCES GREATER GAIN IN STRENGTH COMPARED TO PERFORMING EACH REPETITION AT 50% OF THE MAXIMUM VOLUNTARY VELOCITY

Pareja-Blanco, F.1, Rodríguez-Rosell, D.1, Otero-Esquina, C.1, Mora-Custodio, R.1, González-Badillo, J.J.1

University Pablo de Olavide

**Introduction** When designing resistance programs to optimize athletic performance a key variable used is training velocity. To be specific, the intention to move a load explosively has been regarded as well suited for developing strength at high contraction velocities (1). This study compares the effects of performing each repetition at maximum voluntary velocity, by measuring the exact velocity of each repetition. **Methods** Twenty-one young and healthy men to take part in this study (mean (SD): age 22.3(3.2) yr, body weight 72.6(9.2) kg, height 1.77(0.07) m), were randomly assigned to one of two groups: maximum voluntary velocity (V100; n=10) or 50% of maximum velocity (V50; n=11) with each load. Subjects trained during 6 wk for a total of 18 sessions following a periodized resistance training program using the full squat. The two groups trained at the same relative intensity in each session (increasing from 60% to 80%RM) but differed in the velocity reached in each repetition (100% vs. 50% of maximum possible velocity). Velocity was monitored in each session (T-Force System, Ergotech, Spain). A covariance test was used to compare the changes between the groups. A t-test for paired samples was used to compare pre-test and post-test measurements in each group. **Results** Both groups obtained significant increases in 1RM strength (18.6% vs. 10.3%), mean velocity with absolute loads common to both test (MV) (15.9% vs. 7.5%) and CMJ (8.7% vs. 2.5%) in V100 (p<0.01) and V50 (p<0.05), respectively. Furthermore, on comparison, V100 had significantly higher gains (p<0.01) for CMJ than V50. **Discussion** These results indicate that short-term velocity-based resistance training produces greater neuromuscular performance improvement when performing each repetition at maximum velocity. Several studies show that training to maximal voluntary velocity produces greater improvements in rate of force development and power, and similar gains in strength (2-3). In addition, the present study shows greater improvements in physical performance measured by CMJ. **References** Behm, DG, and Sale, DG. Intended rather than actual movement velocity determines velocity-specific training response. *J Appl Physiol* 74: 359-368, 1993. Fielding, RA, LeBrasseur, NK, Cuoco, A, Bean, J, Mizer, K, and Fiatarone Singh, MA. High-velocity resistance training increases skeletal muscle peak power in older women. *J Am Geriatr Soc* 50: 655-662, 2002. Young, W, and Bilby, G. The effect of voluntary effort to influence speed of contraction on strength, muscular power, and hypertrophy development. *Journal of Strength and Cond. Research* 7: 172-178, 1993.

### A COMPARISON BETWEEN A VERSA-PULLEY™ FLYWHEEL AND THE FREE WEIGHT RESISTANCE DURING A 6X6 REPEATED POWER ABILITY TEST.

Nunez, F.1,2, Suárez-Arrones, L.1,2, Cater, P.3

(1) Universidad Pablo de Olavide (Seville, Spain). (2) VF Sport (Seville, Spain) (3) www.Athlete-International.com (EE.UU).

**Introduction** The majority of research concerning flywheel resistance has been performed with Tesch's Yo-Yo technology. To date, there are few known peer reviewed journal articles investigating the VersaPulley device. The current research comparing Versapulley high-pull (VPHP) and Olympic barbell high-pull (OBHP) with standard velocity and relative load between both forms. The investigation hypothesizes that eccentric loading characteristic of the VersaPulley will increase metabolic demand and therefore be a more efficient and safer method of power endurance training. **Methods** 15 sub-élite rugby players performed totally 6x6 maximal sets, with 20 seg. of rest, on the Versapulley and in Olympic barbell high-pull. Peak force, mean force, time force, were measured in concentric and eccentric phase. Mean propulsive velocity, peak propulsive velocity, peak acceleration, mean propulsive acceleration and propulsive phase (%), was measured or calculated in concentric phase. Heart rate between sets and accumulated blood lactate immediately following the series of 6 sets, 3 and 5 minutes post-test, were measured **Results** The maximal concentric force was significant higher in the 6th set with barbell. The VP average eccentrics were significant higher in all sets. During the first 3 sets, versapulley force time is higher in concentric phase, and lower in eccentric phase, than with barbell. Peak velocity and mean propulsive acceleration were significant higher with versapulley

than with barbell. The heart rate were significant higher with versapulley in all sets. The lactate concentration was higher in all measures too. Discussion The results of the study show that using versapulley we can produce the same concentric power and force than using free weight exercise, but higher values for the eccentric phase. VersaPulley will have greater accumulated blood lactate, heart rate and total work in the same magnitude of exercise when compared to free weights. Concentric displacement and eccentric loading characteristic of the VersaPulley will increase metabolic demand and therefore be a more efficient and safer method of power endurance training. References Berg HE, TESCH PA A gravity-independent ergometer to be used for resistance training in space. *Aviat Space Environ Med* 65:752-756; 1994. Caruso JF, Coday MA, Monda JK, Ramey ES, Hastings LP, Vingren JL, Potter WT, Kraemer WJ, Wickel EE. Blood lactate and hormonal responses to prototype flywheel ergometer workouts. *J Strength Cond Res*. 2010. Mar;24(3):749-56. Chiu LZ, Salem GJ. Comparison of joint kinetics during free weight and flywheel resistance exercise. *J Strength Cond Res*. 2006 Aug;20(3):555-62. Norrbrand L, Pozzo M, Tesch PA. Flywheel resistance training calls for greater eccentric muscle activation than weight training. *Eur J Appl Physiol*. 2010 Nov;110(5):997-1005.

### **LOW INTENSITY ECCENTRIC EXERCISE WITH BLOOD FLOW RESTRICTION IMPROVES ECCENTRIC STRENGTH WITHOUT MUSCLE SORENESS.**

Kubota, A.

*School of Health and Sports Science, Juntendo University*

KUBOTA, A.1, SAKURABA, K.1, 2, FUJIMINE, S.1, FUJITA, S.2, OGURA, Y.3, KOH, S.4, NAKADAKE, M.1, SHIKAKURA, J.1 1: School of Health and Sports Science, Juntendo University, Japan, 2: Graduate School of Health and Sports Science, Juntendo University, Japan, 3: St. Marianna University School of Medicine, Japan and 4: Koh Orthopaedic Clinic, Japan Introduction Strenuous eccentric exercise improves eccentric strength, while it results in muscle damage with muscle soreness. Low intensity training with blood flow restriction is known to increase muscle strength equivalent to high intensity training. The aim of this study is to clarify whether low intensity eccentric exercise with blood flow restriction improves eccentric strength without muscle soreness. Methods Twelve-college students (4 males and 8 females, Age: 20.7yr) volunteered for this study. They were divided into two groups: low intensity exercise (~30% of peak torque) without blood flow restriction (control group: CON) and that with blood flow restriction (compressive force = 120 mmHg, blood flow restriction group: BFR). The dominant arm of all subjects was assigned to eccentric exercise and the opposite arm was assigned to concentric exercise in the both groups. The exercise, consisted of 3 or 4 sets of 15 elbow flexion using the Biodex unit, performed 3 times a week for 8 wk. Before and after the experimental period, elbow flexor muscle torque was evaluated in following settings: concentric contraction at angular speeds of 60 and 120 deg•s<sup>-1</sup> (CC60 and 120), eccentric contraction at angular speeds of 60 and 120 deg•s<sup>-1</sup> (EC60 and 120), and isometric contraction. Elbow flexor muscle cross sectional area (CSA) was also analyzed with MRI before and after the experimental period. Muscle soreness of the upper arm was evaluated by a visual analog scale during the experimental period. Results In the CON, all the elbow flexor torque was not significantly increased after 8 wk. In the BFR, the concentric exercise significantly increased the torque of CC60 (pre: 28.8 ± 12.2 N•m, post: 32.6 ± 12.1 N•m), whereas the eccentric exercise significantly increased that of EC60 (pre: 54.0 ± 17.4 N•m, post: 59.6 ± 20.1 N•m) after 8 wk (p < 0.05). However, the concentric exercise did not increase eccentric strengths, and vice versa. CSAs in elbow flexor muscles significantly increased after the experimental period in the both exercises respectively (p < 0.05), the difference between both exercises in the BFR were not significant for the percent changes of CSAs. Muscle soreness was never developed in the both groups during the experimental period. Conclusion Low intensity eccentric exercise combined with blood flow restriction improves an eccentric strength without muscle soreness. Our results also indicate that the effect of low intensity training with blood flow restriction is contraction mode-specific.

### **THE EFFECT OF A RESISTANCE TRAINING PROGRAM ON DETECTING MUSCLE IMBALANCE BETWEEN HAMSTRINGS AND QUADRICEPS OF NONDOMINANT AND DOMINANT LEGS**

Elnemr, A.1, Elkhateb, N.2, Elnemr, O.3

*Faculty of physical education / Helwan University 1: HFPE (Giza, Egypt), 2: GFPE (Giza, Egypt), 3: HU (Cairo, Egypt)*

Introduction Exercises selected for soccer should maintain a balance of muscular strength across joints and between opposing muscle groups to prevent the the risk of injury due to a disparity between the strength of the agonist, (the muscle or muscle groups actively causing the movement (e.g., the quadriceps in the leg extension exercise), and the antagonist, (the muscle or muscle group located on the opposite side of the limb (e.g., the hamstrings in the leg extension exercise). Methods 12 soccer players ages 17-18 years participated in the study. Tests for determination right and left hamstrings and quadriceps 10 RM strength were undertaken before and after 10 weeks of training. The pretest results showed that the right and left hamstrings were extremely weak compared with the right and left quadriceps and the hamstrings and quadriceps of the non dominant leg (the lift leg) were extremely weak compared with the dominant leg (the right leg). The researchers designed a training program to restore strength balance to achieve a ratio not less than 90:100 between the left and right hamstrings to the left and right quadriceps, the left hamstrings to the right hamstrings and the left quadriceps to the right quadriceps. The training program of the right quadriceps, left quadriceps, right hamstrings and left hamstrings started with (one 10 RM set, 3d / wk), (two 10 RM sets, 3d / wk), (three 10 RM sets, 3d / wk) and (four 10 RM sets, 3d / wk) respectively. Results Strength variables increased according to the training program. The ratio between the left and right hamstrings to the left and right quadriceps was improved, the ratio between the left hamstrings to the right hamstrings was improved and the ratio between the left quadriceps to the right quadriceps was improved. Discussion The results of the present study seem to correspond to the fact that if certain patterns or muscular actions are performed repeatedly, muscles develop more in either the front of the body or the back of the body. Players in soccer benefit from a well- rounded muscular training program focusing on the hamstrings and quadriceps, dominant and nondominant to prevent injuries and enhance performance.(Foran, 2001, Baechle & Earle, 2000, and Spring et al., 1991) References Baechle, T., ed.(2000). *Essentials of Strength Training and Conditioning* (2nd ed). Champaign,IL:Human Kinetics.112-115. Forman, B., ed. (2001). *High-performance sports conditioning*. Champaign, IL: Human Kinetics. 119-120. Spring H, Illi U, Kuny H, Rothlin k, schneider W, Tritschler T.(1991) *Stretching and Strengthening Exercises*. Thieme Medical Publishers, Inc.,New Yourk.400-401.

## POWERLIFTERS IMPROVED STRENGTH AND MUSCULAR ADAPTATIONS TO A GREATER EXTENT WHEN EQUAL TOTAL TRAINING VOLUME WAS DIVIDED INTO 6 COMPARED TO 3 TRAINING SESSIONS PER WEEK

Raastad, T., Kirketeig, A., Wolf, D., Paulsen, G.

*Norwegian School of Sport Sciences*

**Introduction** Traditionally, powerlifters have divided total training volume into 3-4 weekly training sessions, where each of the three competition lifts (squat, deadlift and bench-press) typically is trained twice a week in addition to other exercises. Interestingly, in weightlifters and female athletes favourable training adaptations have been indicated when training volume was divided into more frequent and smaller training sessions (1, 2). Therefore, the aim of this study was to compare the effect performing three large vs. six small training sessions per week in a group of competitive powerlifters. **Methods** A total of 16 powerlifters with the mean age of  $21.1 \pm 3.6$  years volunteered for the study (13 men, and 3 women). All subjects had competed in national powerlifting competitions within the last 6 months, and all had trained continuously for competitive powerlifting for at least 1 year before entering the study. Effect of training was assessed as changes in 1 RM in squat, bench-press and deadlift (all tests were performed without powerlifting suits), and as changes in cross sectional area (CSA) of m. quadriceps. Testing was conducted before and after a 15 week intervention period, in which the weekly training volume was distributed as either 3 or 6 weekly training sessions. Total training, volume, training intensity and exercises was identical in the two training groups, and briefly the lifters in the 3/week group performed twice as many sets as the 6/week group in each session. **Results** At the start of the study performance without suits in squat, bench press and deadlift were similar in the two groups ( $167 \pm 45$ ,  $123 \pm 40$  and  $201 \pm 46$  kg respectively). After the 15 week intervention period 1 RM in squat and bench-press increased more in the 6/week than in 3/week group ( $11 \pm 6$  vs.  $5 \pm 3\%$  and  $11 \pm 4$  vs.  $6 \pm 3\%$ , respectively,  $p < 0.05$ ), whereas no significant difference between groups was observed for the deadlift ( $9 \pm 6$  v.  $4 \pm 6\%$ ). CSA of m. quadriceps increased more in the 6/week group than in the 3/week group ( $4.2 \pm 4.3$  vs.  $-0.6 \pm 1.6\%$ , respectively). **Discussion** Dividing total training volume into 6 smaller sessions was more effective than the traditional 3 sessions per week regime both for the increase in 1 RM in squat and bench-press, as well as for the increase in thigh muscle CSA. The mechanisms behind the superior effects of more frequent and smaller sessions cannot be directly addressed in this study, but more frequent stimuli for hypertrophy and less fatiguing sessions might be possible explanations. 1 Häkkinen & Kallinen (1994) *Electromyogr. Clin. Neurophysiol.* 2 Hartman et al. (2007) *Int. J. Sports Physiol. Perform.*

## SESSION-RPE AT DIFFERENT TIME POINTS AFTER A CIRCUIT WEIGHT TRAINING WORKOUT

Silva, L.H.1, Fontes, E.B.2, Drigo, A.J.3, Ribeiro, L.F.P.1,3

*1: UESC (Ilhéus, Brasil), 2: UNICAMP (Campinas, Brasil), 3: UNESP (Rio Claro, Brasil).*

**Introduction** Session RPE (SRPE) taken after the exercise bout is considered to provide a quantitative evaluation of the entire exercise session (Foster et al., 2001). Yet, controversial results exist regarding its correspondence to averaged acute RPE in resistance exercise (Egan et al., 2006; Singh et al., 2007). In addition, the influence of the interval length between exercise cessation and rating moment on SRPE (Singh et al., 2007) and the usefulness of differentiating it in central and peripheral components are underexplored. Thus, we investigated the effects of time lag between exercise termination and rating moment on overall and differentiated SRPE and their usefulness against RPE in a circuit weight training (CWT) workout. **Methods** Ten healthy volunteers ( $22.3 \pm 2.8$  yrs) completed a CWT workout involving 3 circuits of single sets in 5 exercises (lying row, squat, shoulder press, dead lift and bench press). 20 repetitions at 30% 1RM were performed in each exercise, with 3 min and 30 sec rests between exercises and circuits. HR was continuously monitored during the workout and blood lactate ( $[\text{La}]_{\text{cb}}$ ) was determined after each circuit. Overall, chest and active muscle RPE were assessed at the end of each circuit by means of the Borg's 6-20 scale. Using the modified CR-10 scale by Foster et al. (2001), overall, chest, and active muscle SRPE were taken at minutes 10, 20 and 30 after CWT cessation. Averaged RPE values were transformed for comparisons to SRPE. **Results** Mean HR and  $[\text{La}]_{\text{cb}}$  during the session were  $66.8 \pm 4.4\%$  HRmax and  $6.4 \pm 1.0$  mM. Overall, chest and active muscle RPE increased significantly ( $P < 0.05$ ) throughout the workout. Stable values were observed for overall ( $3.7 \pm 0.6$ ,  $3.8 \pm 0.7$  and  $3.7 \pm 0.6$ ), chest ( $3.7 \pm 0.6$ ,  $3.8 \pm 0.8$  and  $3.8 \pm 0.8$ ) and active muscle ( $3.9 \pm 0.8$ ,  $3.6 \pm 0.7$  and  $3.7 \pm 0.7$ ) SRPE assessed 10, 20 and 30 min after the CWT, with no significant main effects or time x SRPE type interaction ( $P > 0.05$ ). No significant differences ( $P > 0.05$ ) were observed between averaged SRPE and RPE (overall:  $3.7 \pm 0.6$  vs  $3.5 \pm 0.9$ ; chest:  $3.8 \pm 0.7$  vs  $3.6 \pm 0.8$ ; active muscle:  $3.7 \pm 0.7$  vs  $3.5 \pm 0.7$ ). **Discussion** Stability of SRPE at different time points after exercise argues against the statement that it should be taken 30 min after the bout in order to avoid the influence of particular easy or hard effort towards the end of the session (Foster et al., 2001). In line with Egan et al. (2006) but in contrast to Singh et al. (2007), averaged RPE and SRPE provide similar ratings for overall and differentiated perceptions. These results suggest that SRPE, irrespective of the moment at which it is taken, is an useful tool for assessing whole session strain in a CWT workout in healthy men. **References** Foster C, Florhaug JA, Franklin J, Gottschall L, Hrovatin LA, Parker S, Doleshal P, Dodge C. (2001). *J Strength Cond Res* 15 (1): 109-115. Egan AD, Winchester JB, Foster C, McGuigan, MR. (2006). *J Sports Sci Med* 5: 289-295. Singh F, Foster C, Tod D, McGuigan MR (2007). *Int J Sports Physiol Perform* 2: 34-45.

## PREDICTING THE 1RM FROM THE LOAD-VELOCITY RELATIONSHIP

Jidovtseff, B.1, Harris, N.2, Cronin, J.2, Crielaard, J.M.1

*University of Liege*

**PREDICTING THE 1RM FROM THE LOAD-VELOCITY RELATIONSHIP** Jidovtseff B1, Harris N2, Cronin J2, Crielaard JM1 1:ULG (Liege, Belgium), 2:AUT (Auckland, NewZealand) **Introduction** Determination of the 1RM is often considered to be problematic for populations such as the young as well as aged. As a result different methods have been developed to allow the estimation of 1RM from performing sub-maximal repetitions to failure (1). The accuracy of this method depends on several parameters such as the number of repetitions, type of exercise, training background and the population used (1). Very recently, authors have suggested to use the load-velocity relationship in order to determine the 1RM (2,3). The aim of the present study was to investigate the ability of such method to predict the 1RM in different strength exercises and with different technological devices. **Methods** Data from five studies including in their protocol the 1RM determination and the load-velocity relationship profiling were gathered for the present analysis. Bench press, half-squat, horizontal press, leg curl and lat pulldown exercises were selected. A laboratory very accurate inertial dynamometer (4) was used for half-squat and bench press exercise. The Myotest (Myotest, Switzerland) accelerometer was used for bench press, leg curl, horizontal press and lat pulldown exercises. Each study contain two sessions. The first was used for position standardisation, exercise familiarisation and 1RM determination. In the second session, velocity was measured at three or four increasing loads ranging from 30 to 95% of the 1RM. For each subject and each exercise, the best fit load velocity relationship and equation was determined. Associated parameters such as slope and intercept point

on the Y axis were calculated and used for 1RM estimations. Results Our study demonstrated contrasted results for the 1RM prediction using load-velocity relationship. Average velocity appears to be more relevant than peak velocity to estimate 1RM. The Myotest, that only allow peak velocity measurement, showed slightly lower prediction ability. With laboratory device, bench press 1RM prediction was practically perfect ( $r=0.98$ ) providing evidence that the load-velocity relationship may be used to estimate 1RM with a standard error of estimate (SEE) of 7%. Acceptable correlations were observed with half-squat ( $r=0.76$ ,  $SEE=11\%$ ), horizontal press ( $r=0.75$ ,  $SEE=10\%$ ) and lat pulldown ( $r=0.62$ ,  $SEE=8\%$ ) exercises. For equipment reason it was impossible to estimate the 1RM for the leg curl exercise. Discussion Bench press results confirm the use of the load-velocity relationship in the 1RM prediction. Unfortunately, prediction appears to be dependant from selected parameter, device, exercise and equipment. References : 1. Horvat, et al. J Strength Cond Res 17: 324–328, 2003. 2. Jidovtseff et al. J Strength Cond Res 25 : 267–270, 2011 3. Bosquet et al. J Sport Sc Med 9, 459-463, 2010. 4. Jidovtseff et al. Isokinetics Exerc Sci 14: 53–62, 2006.

**13:45 - 14:45**

## Poster presentations

### PP-PM65 Physiology 16

#### VARIABILITY OF HEART RHYTHM OF ELITE ATHLETES AT ACTIVE ORTHOSTATIC TEST

Sukhov, S.

*National Research and Practical Centre of Physical Culture*

**Introduction** Vegetative nervous system (VNS) plays important role in regulation of adaptation to intensive physical load. One of the most informative methods of study of VNS is spectral analysis of variability of heart rhythm at active orthostatic test (VHR at AOT). Goal of the study was to compare VHR at AOT of elite athletes and young male non-athletes. **Methods** Twenty-five elite judoists (experimental group) and fifteen healthy young male non-athletes (control group) have been examined. VHR at AOT according to the International Standard (1996) was conducted with use of hard- and software complex VNS-Spectrum. Study protocol included a 350-second registration of ECG in supine position and after standing up with determination of spectral power in each frequency range (High Frequency – HF, Low Frequency – LF and Very Low Frequency – VLF) and total power (TP) of the range, recording of systolic pressure in the supine position and 3 minutes after standing up. K30:15 coefficient (ratio of R-R30 to R-R15) was registered. **Results** In the experimental group the heart rate at AOT was  $78.2 \pm 2.5$  bpm, and in the control group –  $98.1 \pm 3.3$  bpm ( $p < 0.05$ ). Athletes showed growth of TP at AOT as compared with  $5189 \pm 806$  ms<sup>2</sup>/Hz at rest to  $9682 \pm 903$  ms<sup>2</sup>/Hz, relative input of LF-component in the structure of spectral power practically was the same (28.2 % at rest and 29.7% after standing), HF-component declined from  $43.5 \pm 2.9\%$  to  $35.8 \pm 4.0\%$ , growth of the ratio of LF/HF was less as compared with the control group (from  $0.65 \pm 0.10$  at rest up to  $0.83 \pm 0.29$  at standing up), share of VLF-component has increased from  $28.3 \pm 3.6\%$  to  $34.5 \pm 4.2\%$ . The ratio of LF/HF in the athletes group evidences to parasympathotonia. At conducting AOT in the control group, the TP also grew in comparison with the resting position, from  $2450 \pm 643$  ms<sup>2</sup>/Hz to  $5512 \pm 1640$  ms<sup>2</sup>/Hz, the absolute capacity of LF-component increased and the relative input of the LF-component in the structure of spectral power has grown (from 28,7% at rest to 42,1% at standing up), HF-component did not change, and the ratio of LF/HF increased from  $0.78 \pm 0.16$  to  $1.18 \pm 0.41$ , while the share of VLF-component dropped from  $34.7 \pm 6.4$  to  $22.2 \pm 4.9\%$ . K30:15 in experimental group was  $1.50 \pm 0.06$ , while in the control group –  $1.27 \pm 0.04$  ( $p < 0.05$ ), with the normal values above 1.35 and borderline values of 1.35–1.2. Drop of systolic pressure after standing up in AOT was less than 10 mmHg in both groups, which was in normal ranges. **Conclusion** Indicators of VHR at AOT in athletes and non-athletes differ substantially. This test allows collecting objective information on the state of VNS, and has diagnostic and prognostic value.

#### CHARACTERISTICS OF HEART RATE VARIABILITY DURING NIGHT SLEEP IN ELDERLY LONG-DISTANCE MALE RUNNERS

SHIMAMOTO, H.1, TANIDA, K.2, SHIBATA, M.2

*1: Osaka University (Osaka, Japan), 2: University of Hyogo (Akashi, Japan)*

**Introduction** Light-to-moderate exercise habituation induces a shift to a predominance of parasympathetic nervous system (PNS) activities and/or the extension of slow-wave sleep (SWS) time during night sleep. However, the influence of exercise itself on heart rate variability (HRV) during the night is not known in the case of elderly men habituated to high-intensity and highly frequent exercise. Therefore, to evaluate the influence of exercise habituation on HRV during the night, we compared the HRV on the exercise (E) day and rest (R) day in elderly men habituated to long-distance running. **Methods** This study involved 6 elderly male long-distance runners (mean  $\pm$  SD: age,  $67.8 \pm 9.1$  years) who were habituated to high-intensity and highly frequent exercise for over 20 years or more. On the R day and E day, a Holter electrocardiography monitor (FUKUDA FM-160, Japan) was used for recording R-R Interval (RRI) data, with 1 kHz sampling frequency. The RRI data were analyzed for each 10-min segment by using a time series-power spectral analysis software, MemCalc/Win ver.2 (GMS, Japan). The frequency band power was divided into 2 parts: low-frequency (LF, 0.04-0.15 Hz) and high-frequency (HF, 0.15-0.4 Hz) components. The relative PNS and sympathetic nervous system (SNS) activities were evaluated using the HF/(LF+HF) and LF/HF values. These HRV indices were compared for the first 1 h, first 3 h, and throughout the sleep period during the night on the E and R days. Repeated one-way ANOVA was used to evaluate the significance of the difference between the 2 settings. **Results** During the first 1 hour of sleep, PNS was higher on E day ( $p < 0.05$ ) and SNS was higher on R day ( $p < 0.05$ ). However, these differences were not seen during the first 3 h of sleep and for the entire nighttime sleep period. **Discussion** Previous studies reported that SNS activities were lower during slow-wave sleep than other sleep stages during non-rapid eye movement (N-REM). PNS activities were higher during rapid eye movement (REM) than N-REM sleep (Busek et al., 2005). Overnight PNS activity is reported to be positively correlated with SWS duration (Brandenberger et al., 2003). The results of our study were in accordance with those of these previous studies in that the quality of sleep was higher on the E day than on the R day during the first 1 h of sleep. In conclusion, elderly people who have long-term habituation to high-intensity and high-frequency running exercise have higher quality night sleep during the first 1 h on days when they exercise than when they rest. References Busek P, Vanková J, Opavský J, Salinger J, Nevsímalová S (2005) *Physiol Res*, 54, 369-376 Brandenberger G, Viola AU, Ehrhart J, Charloux A, Geny B, Piquard F, Simon C (2003) *J Sleep Res*, 12, 173-180

## IMPACT OF BODY SCALES AND THE TYPE OF SPORTS ON THE LEFT VENTRICULAR DIMENSIONS IN JUNIOR COMPETITIVE ATHLETES

Kinoshita, N.1, Ishida, H.2, Katsukawa, F.2

1. Hosei University, 2. Keio University

**Introduction** Left ventricular (LV) dilatation/hypertrophy is commonly observed in competitive athletes (athlete's heart). Both body scales (body surface area [BSA] or fat free mass [FFM], etc.) and types of physical training were predictors for LV geometry of athlete's heart (1). However, the most evidences for the impact of those determinants were of adult athletic population. The aim of the study was to compare LV geometry of junior athletes with 2 extreme types of body scales; male professional sumo wrestlers (SUMO) and female long distance runners (LDR) and to evaluate the role of body scales in LV dimensions in junior athletes. **Methods** The subjects were Japanese 26 female LDR (160.5 cm, 46.5 kg) in a highly competitive team with the national level of achievements and 24 male SUMO (179.3 cm, 111.9 kg). All were 17-18 y/o and had had 2-3 years of competitive training career for each discipline. Echocardiography and underwater weighing (LDR) or air plethysmography (SUMO) were performed. LV mass (LVM) was calculated according to Devereux RB, et al (2) and LVM and LV end diastolic dimension (LVDd) were indexed to  $\text{height}^{2.7}$ , BSA, and FFM. The differences in variables were tested by unpaired t-test ( $p < 0.05$  was considered significant) and all values were expressed by the mean. Results LVDd and LVM of SUMO were significantly larger than those of LDR (58.0 vs 49.8 mm and 179.3 vs 160.5 g, respectively). LVDd of almost all LDR did not exceed the normal limits ( $< 54$ mm). After adjusted to body scales, however, LDR had significantly larger LV dimensions than SUMO: LVDd/BSA; 33.7 vs 25.4  $\text{mm}/\text{m}^2$ , LVDd/FFM; 1.24 vs 0.73  $\text{mm}/\text{kg}$ , LVDd/ $\text{height}^{2.7}$ ; 13.9 vs 12.0  $\text{mm}/\text{m}^{2.7}$ , LVM/FFM; 3.69 vs 2.93  $\text{g}/\text{kg}$ , respectively). LVM/BSA was not different from each other (101.3 vs 100.6  $\text{g}/\text{m}^2$ ) and SUMO had larger LVM/ $\text{height}^{2.7}$  than LDR (47.8 vs 41.3  $\text{g}/\text{m}^{2.7}$ , respectively). **Discussion** Female junior LDR had large adjusted LVDd corresponding to the level of elite male adult endurance athletes (3). Although LVDd of SUMO exceeded the normal limits, adjusted LVDd were smaller than those of LDR. The same was the case as for LVM except for LVM/BSA. These indicated that as in adult athletes, endurance training had powerful impact on the development of LV dilatation and adjustment to body scales was necessary when LVDd was evaluated in junior athletes. Adjustment by BSA or  $\text{height}^{2.7}$  might be appropriate to compare LVM in junior athletes with extremely different body scales. **References** 1. Pelliccia A, et al. *Ann Intern Med* 1999;130:23. 2. Devereux RB, et al. *Am J Cardiol*. 1986;57:450. 3. Abergel E, et al. *J Am Coll Cardiol* 2004;44:144.

## AUTONOMIC CONTROL OF HEART RATE IN CHILDREN. EFFECT OF BODY POSITION ON HEART RATE VARIABILITY

Gobbo, M., Capogrosso, M., Gheza, A., Perini, R.

University of Brescia

**Introduction** Cardiac autonomic activity has been evaluated extensively by analysis of Heart Rate Variability (HRV) in physiological and pathological conditions in subjects of different ages. HRV data are less consistent in very young individuals than in adults. Modifications in HRV autonomic indices, especially of vagal activity, have been observed during childhood and adolescence, likely as the result of the maturation of HR nervous control mechanisms. The influence of this process on the cardiac response to perturbations, such as orthostatic load, has not been clearly defined. We therefore evaluated the sympatho-vagal interaction in a group of pre-pubertal children by analyzing differences in HRV in different body positions. **Methods** 30 children (9 females) aged 9-10 years (gr A) and 24 children (9 females) aged 11-12 (gr B) participated in the study. All of them were healthy, pre-pubertal, normally active. In each subject R-R intervals were continuously recorded (Polar S810) in resting condition for 10 min in supine (Sup) and for additional 10 min in sitting (Sit) position. By time and frequency domain (AR method) analysis of HRV, the following parameters were calculated: standard deviation of the R-R intervals (SDNN); root mean square of successive differences of R-R intervals (rMSSD); power of the low frequency (LF, 0.04-0.15 Hz) and high frequency (HF, 0.15-0.4 Hz) bands in normalized units (nu), i.e. as percent of total power; the ratio between LF and HF. **Results** HR was similar in group A and B in Sup ( $79 \pm 2$  b/min) and significantly increased by about 8 b/min in Sit in both groups. Both SDNN and rMSSD were significantly higher in gr A (respectively  $90 \pm 32$  ms and  $100 \pm 50$  ms) than in gr B ( $62 \pm 25$  ms and  $62 \pm 30$  ms) and decreased by about 20-25 % in Sit ( $p < 0.05$ ). LF and HF powers were similar in the two groups, respectively  $45 \pm 18$  nu and  $53 \pm 22$  nu in Sup and  $63 \pm 18$  nu and  $31 \pm 16$  nu in Sit ( $p < 0.05$  between positions). LF/HF was  $1.3 \pm 0.9$  in Sup, independently of the group, and significantly higher in Sit ( $3.1 \pm 1.1$ ). **Discussion** The higher HR in Sit than in Sup was coupled with the reduction of all vagal markers, namely SDNN, rMSSD and HF, and with the increase of LF/HF, as expression of sympatho-vagal interaction. Thus, the modifications in HRV autonomic indices induced by the change in body position are comparable to those described for adults. The lack of differences between the two groups suggests no main effect of age on this autonomic functional response, at least in the range here evaluated. Nonetheless, the markedly different values of time domain parameters, i.e. SDNN and rMSSD, found in the two groups, could be the expression of the reducing vagal prevalence in autonomic interaction, possibly occurring with growth.

## PROLONGED STRENUOUS EXERCISE - IMPACT OF EXERCISE MODE UPON MYOCARDIAL TISSUE VELOCITIES

Williams, K., Whyte, G., George, K.

University of Surrey

**Introduction** A dose dependent relationship has been suggested previously whereby increasing aspects of exercise volume such as intensity, frequency and duration has a positive impact upon cardiovascular function up to an individually defined maximum. Exercise beyond this limit has been associated with a decline in myocardial tissue velocities and a subsequent decrease in cardiac function. Exercise induced cardiac fatigue has been reported in a number of sports, predominantly running and cycling however few studies have assessed whether mode has an impact upon the level decline in cardiac function. **Methods** Seven trained athletes completed a two hour bout of running and cycling exercise at 90% of their calculated anaerobic threshold on two separate occasions. Echocardiographic scans to measure myocardial tissue velocities at the septal wall, the left ventricular wall and right ventricular wall were performed pre, post, two hours post and 24 hours post each exercise bout. **Results** Changes in ventricular wall tissue velocities were minor and not cumulative across both cycling and running modes. Peak atrial diastolic tissue velocity in the left ventricular free wall increased ( $P < 0.05$ ) from 11 to 18  $\text{cm} \cdot \text{s}^{-1}$  during the running bout but this did not significantly impact the ratio of early to late diastolic wall motion. In the cycling group there were no pre-post exercise bout changes in cardiac function ( $P < 0.05$ ). **Discussion** The lack of apparent change in cardiac function during each exercise bout and the dislocation of the kinetics of septal, left and right ventricular wall velocities between modes of exercise suggest that cardiac dysfunction is not impacted by the mode of exercise. In summary, changes in cardiac function during a separate cycling and running exercise bout displayed limited evidence of accumulation between bouts which suggests that athletes coped well with the extreme cardiac work demanded by the different exercise protocol and no mode of exercise resulted in a greater decline.

**RELIABILITY OF A NEW PROTOCOL TO ASSESS HR RECOVERY AFTER SUBMAXIMAL EXERCISE.**

Romagnoli, M.1, Alis, R.1, Basterra, J.1, Villar, J.1, Perez, P.2, Arduini, A.3

*Catholic University of Valencia*

Reliability of a new protocol to assess HR recovery after submaximal exercise. Romagnoli M.1, Alis, R.1; Basterra, J.1, Villar, J.1, Perez P.2, Arduini, A.3 1 Catholic University Valencia (Valencia, Spain). 2 University of Valencia (Valencia, Spain) 3 Harvard University (Boston, MA, USA) Introduction: HR recovery after exercise is a measure used to assess adaptation to training and it has been proposed as independent predictor of all-cause mortality. The reliability of models for HR recovery assessment at submaximal intensities is poor and there a lack of standardization of the duration of recovery. It has been established that submaximal exercise is more reproducible than maximal and allows a better standardization of the test [1]. Our purpose is to determine the reliability of the indexes of HR recovery after a test on cycle ergometer at two submaximal exercise intensities (65% and 80% HRmax). Methods: HR recovery was assessed by 8 models, based on monoexponential kinetics or absolute recovery (recovered HR at fix time points) on 21 healthy subjects. Intraclass correlation coefficient (ICC) and standard error of measurement (SEM, %SEM) were used to address reliability of measurements. Results: Our results point to: assessment of HR recovery after 80% HRmax exercise is more reliable than after 65% HRmax (mean ICC: 0.827 vs. 0.747); at longer recovery time we found better absolute consistency of the measurement (%SEM: 26.7 at 60 s, 19.5 at 120 s and 16.3 at 180 s, irrespective of model or exercise intensity); to assess the fast component of HR recovery (HR kinetics calculated over  $\leq 60$  s) after exercise T30min is more reliable than T30 (ICC: 0.691 vs. 0.528; %SEM: 28.5 vs. 70.8). Discussion The protocol exhibits a good sensitivity of measurement - large ICC and small SEM - for analysis of HR recovery after submaximal exercise on cycle ergometer. Internal workloads of 80% HRmax has better reliability and the consistency of the results at this intensity increases with the duration of recovery. References 1. Cole, C.R., et al., Heart Rate Recovery after Submaximal Exercise Testing as a Predictor of Mortality in a Cardiovascularly Healthy Cohort. *Annals of Internal Medicine*, 2000. 132(7): p. 552-555.

**EFFECT OF AGING AND AEROBIC PHYSICAL TRAINING ON THE RAT ISOLATED HEART CONTRACTILITY.**

Souza, H., Tezini, G., Becari, C., Salgado, M.

*University of Sao Paulo*

EFFECT OF AGING AND AEROBIC PHYSICAL TRAINING ON THE RAT ISOLATED HEART CONTRACTILITY. Souza HC, Tezini GCSV, Becari C, Salgado MCO. School of Medicine of Ribeirão Preto, University of São Paulo, Brazil. Introduction Clinical and epidemiological studies show a low incidence of cardiovascular diseases (CVDs) in pre-menopause women compared to men at the same age group (Reckelhoff et al, 2001). On the other hand, such a difference decreases with age, especially after menopause when cardiovascular diseases become an important cause of death (Colditz et al, 1987). However, the mechanisms involved in the cardioprotective action of ovarian hormones have not yet been established. Therefore, we investigate in female rats the effects of aging on blood pressure, heart rate and heart contractility. Additionally, we investigated the effects of physical training on all parameters evaluated. Methods Female Wistar rats (10 and 70 weeks old, n=11) were divided into four groups: sedentary young rats, trained young rats, sedentary aged rats, and trained aged rats. Animals from the trained groups were submitted to a physical training protocol (swimming) for 10 weeks. After blood pressure and heart rate measurements, the rat heart was isolated and perfused by a Langendorf apparatus to measure the inotropic responses to the agonists dobutamine (0.5, 1, 10, 50 nmoles,  $\beta_1$ -adrenergic receptors) and salbutamol (0.5, 1, 10, 50, 100 nmoles,  $\beta_2$ -adrenergic receptors). Results Aging rats showed higher mean blood pressure and heart rate compared to young rats (109 $\pm$ 2 vs. 93 $\pm$ 2 mmHg, p<0.0001, and 403 $\pm$ 10 vs. 359 $\pm$ 6 bpm, p<0.001). Physical training did not change blood pressure (94 $\pm$ 2 mmHg,) but decreased heart rate (324 $\pm$ 5bpm, p<0.0001) of young rats. In the aged rats, physical training decreased both blood pressure (97 $\pm$ 2 mmHg, p<0.0001) and heart rate (339 $\pm$ 8 bpm, p<0.0001). The isolated heart contractility of sedentary aging rats in response to dobutamine was significantly depressed compared to the young group (Emax: 3.4 $\pm$ 0.2 vs. 6.2 $\pm$ 0.6 g, p<0.001). Physical training increased the responses to dobutamine in both young (9 $\pm$ 0.7 g, p<0.01) and aged rats (5.6 $\pm$ 0.9 g, p<0.05). In contrast, contractile effects induced by salbutamol were not affected either by aging or by physical training. Discussion Aging in female rats is associated with augmented blood pressure and heart rate and diminished inotropic response to  $\beta_1$ -adrenergic receptors activation. Additionally, physical training improves the hemodynamic parameters and cardiac contractility in aged rats. References Reckelhoff JF, Fortepiani LA. (2004). Hypertension. 2004; 43:918-923. Colditz GA, Willett WC, Stampfer MJ, Rosner B, Speizer FE, Hennekens CH. N. Engl. J. Med. 1987; 316:1105-1110.

**HEART RATE VARIABILITY IN ATHLETES AND SEDENTARY CONTROLS DURING ACTIVE ORTHOSTATIC TEST**

Somlev, P.

*National Sports Academy "Vassil Levski", Sofia*

Introduction Studies comparing heart rate variability (HRV) at rest between athletes and non-athletes suggest that endurance training is related to changes in cardiac autonomic regulation (Aubert et al., 2003). The active orthostatic task has been used to evaluate HRV in trained and untrained subjects, but the results are scarce and contradictory. Aim of this investigation was to assess the differences in HRV between endurance trained athletes and sedentary controls at rest and during active orthostatic test (AOT). Methods Sixteen endurance trained athletes (age=22.0 $\pm$ 2.42 years) and sixteen (age=21.5 $\pm$ 1.03 years) untrained controls participated in the study. In the supine position after 20 min of rest RR intervals of each subject were recorded for 5 min with Polar S810i heart rate monitor. After that subjects actively stood up (AOT) and data were collected for 5 min from 3th to 8th minutes in upright position. HRV parameters were obtained with Kubios HRV 2.0 software and included Mean RR, SDNN, RMSSD, pNN50%, LF power and HF power, (both in absolute and normalized units - ms<sup>2</sup> and nu), and LF/HF ratio. Aerobic fitness (VO<sub>2</sub>max) was determined indirectly with Astrand cycle ergometer test. Results VO<sub>2</sub>max in athletes was higher (p<0.05) than in sedentary subjects. During AOT in both groups there were significant increase (p<0.05) in Mean HR, LF nu and HF/LF ratio and significant decrease (p<0.05) in SDNN, RMSSD, pNN50%, HF ms<sup>2</sup> and HF nu. During supine rest Mean RR, RMSSD, pNN50%, HF ms<sup>2</sup> and HF nu were significantly greater (p<0.05) in athletes than in untrained subjects and LF nu and HF/LF ratio were significantly lower (p<0.05) in athletes than in untrained. Athletes also demonstrated lower heart rate at rest. During AOT there were no differences in all HRV indices between athletes and untrained controls. Discussion These results indicate that athletes have an increased vagal influence on heart rate and an attenuated sympathetic tone in supine position in comparison with sedentary controls. In both groups AOT induces identical changes in HRV indices, showing decrease of vagal activity and increase of sympathetic activity. Active standing eliminates the differences in HRV between athletes and untrained subjects. This effect requires further study. References Aubert AE, Seps B, Beckers F. (2003). *Sports Med* 33, 889-919

**ASSESSMENT OF SYMPATHOVAGAL BALANCE IN SOCCER PLAYERS**

Somlev, P., Uzunova, G., Pavlova, E.

*National Sports Academy "Vassil Levski", Sofia*

Introduction Heart rate variability (HRV) has been used as a method to assess the influence of training on sympathovagal balance mostly in endurance athletes. Studies with HRV, evaluating athletes from sports with aerobic and anaerobic training, are scarce. Soccer is a sport in which both endurance and anaerobic capabilities are important (Helgerud et al., 2001, Bangsbo et al., 2006). Aim of this investigation was to assess the sympathovagal balance in soccer players with HRV. Methods In the study participated 11 elite soccer players (age=21.5±3.8 years), 14 non-elite soccer players (age=21.6±1.4 years) and 14 soccer players, who have stopped their training (age=21.8±2.5 years). The elite players were studied during transition period. Non-elite players were studied during competitive season. RR intervals of each subject were recorded for 5 min with Polar S810i heart rate monitor in supine rest. HRV indices included SDNN, RMSSD, pNN50%, LF ms2, LF nu, HF ms2, HF nu. Sympathovagal balance was assessed with LF/HF ratio and newly proposed SD/RMSSD ratio (Balocchi et al., 2006). Cardiorespiratory fitness was determined indirectly with PWC170 cycle ergometer test. Results Physical working capacity was greatest in elite players. Heart rate was lower ( $p<0.05$ ) in elite and non-elite group than in the group of former players. SDNN in elite and non-elite players was higher ( $p<0.05$ ) than in former players. RMSSD and pNN50% were higher ( $p<0.05$ ) in the elite and non-elite players than in former players. LF ms2 was higher ( $p<0.05$ ) in the non-elite players than in former players. HF ms2 was higher ( $p<0.05$ ) in elite and non-elite players than in former players. LF nu was lower ( $p<0.05$ ) in elite players than in former players. HF nu was higher ( $p<0.05$ ) in elite players than in former players. LF/HF ratio was lower ( $p<0.05$ ) in elite players than in former players. There is no difference in SD/RMSSD ratio between the three groups. Discussion Bradycardia and vagal related HRV indices show a shifting in autonomic balance toward parasympathetic predominance in elite and non-elite soccer players in comparison with former soccer players. HRV of non-elite players may reflect the known sympathetic activation related to intensive training or competitive constraint (Bricout et al., 2010). The use of SD/RMSSD ratio as an alternative of LF/HF ratio for assessment of sympathovagal balance in athletes needs further study. References Balocchi R, Cantini F, Varanini M, Raimondi G, Legramante JM, Macerata A. (2006). *Biomed Tech (Berl)* 51, 190-193. Bangsbo J, Mohr M, Krstrup P. (2006). *J Sports Sci* 24, 665-674. Bricout VA, Dechenaud S, Favre-Juvin A. (2010). *Auton Neurosci* 154, 112-116 Helgerud J, Engen LC, Wisloff U, Hoff J. (2001). *Med Sci Sports Exerc* 33,1925-1931

**PHYSICAL TRAINING HAS FEW EFFECT ON THE AUTONOMIC CARDIOVASCULAR CONTROL IN OLD RATS SUBJECTED TO EARLY OVARIAN FAILURE.**

Souza, H., Tezini, G.

*University of Sao Paulo*

PHYSICAL TRAINING HAS FEW EFFECT ON THE AUTONOMIC CARDIOVASCULAR CONTROL IN OLD RATS SUBJECTED TO EARLY OVARIAN FAILURE. Souza HC and Tezini GCSV. School of Medicine of Ribeirão Preto, University of São Paulo, Brazil. Introduction Women with loss of ovarian function before 40 years old, a condition defined as premature menopause or early ovarian failure, are more susceptible to cardiovascular diseases (Coulam et al., 1986). Some authors showed that this condition, compared to physiological menopause or physiological ovarian failure, is associated with even more severe heart dysfunctions (Atsma et al., 2006). These dysfunctions are usually associated with impairment in the cardiac autonomic control. Therefore, we have investigated and compared the effects of physiological ovarian failure (POF) and early ovarian failure (EOF), including the effect of physical training on the cardiovascular autonomic control of elderly female rats by using different approaches. Methods Seventy-two female rats were assigned to 3 groups: control (22 weeks old), POF (82 weeks old) and EOF (82 weeks old). Half of the animals of each group underwent physical training. All groups were submitted to double autonomic blockade (DAB) with methylatropine and propranolol; baroreflex sensibility (BRS) and spectral analysis of heart rate variability (HRV). Results The sedentary groups (POF and EOF) had hypertension, tachycardia, and reduced intrinsic heart rate (HR). After physical training, only POF group had a reduction in the mean arterial pressure. In turn, all trained groups had a decrease in the basal HR despite the fact that only control and POF groups showed a reduction in intrinsic HR. The evaluation of cardiac autonomic tone showed that the vagal autonomic component was predominant in the control group, whereas the other groups had a sympathetic predominance. Analysis of the heart rate variability (HRV) showed no difference between the sedentary groups in normalized units. On the other hand, control and POF groups had a decrease in the low-frequency oscillations (LF, 0.25-0.75 Hz) and an increase in the high-frequency oscillations (HF, 0.75-2.5 Hz) following physical training. With regard to the systolic arterial pressure variability, our results showed that POF and EOF groups had increased LF oscillations, whereas only POF group had a reduction after physical training. Finally, analysis of the baroreflex sensitivity showed that POF and EOF groups had a reduced gain (ms2/mmHg), which was attenuated by the physical training. Discussion The ovarian failure, either physiological or premature, promotes negative effects on arterial pressure, HR, and cardiac autonomic control. On the other hand, physical training promoted few positive effects on animals undergoing EOF compared to those undergoing POF. References Coulam CB, Adamson SC, Annegers JF. (1986). *Obstet Gynecol.*67(4):604-6. Atsma F, Bartelink ML, Grobbee DE, van der Schouw YT. (2006). *Menopause*, 13(2):265-79.

**13:45 - 14:45****Poster presentations****PP-PM66 Physiology 17****CARDIAC RESPONSE TO ACUTE HIGH-INTENSITY INTERVAL AND MODERATE-INTENSITY CONTINUOUS EXERCISE IN UNTRAINED FEMALES**

Lancaster, R.E.1, Castle, P.1, George, K.2, Oxborough, D.3, Sculthorpe, N.1

*University of Bedfordshire*

Cardiac response to acute high-intensity interval and moderate-intensity continuous exercise in untrained females Lancaster, RE.1, Castle, P.1, George, K.2, Oxborough, D.3, Sculthorpe, N.1 1: Institute of Sport and Physical Activity Research, University of Bedfordshire 2: Research

Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool 3: School of Healthcare, University of Leeds, Leeds

Introduction Research on cardiac responses to acute exercise has focused on prolonged exercise and athletic populations. Untrained individuals and shorter bouts of exercise (<60 minutes) have received less attention. This study aimed to evaluate the acute response in untrained females to isocaloric high-intensity interval exercise (HIIE) and moderate-intensity continuous exercise (MICE). Methods 15 female participants ( $20.9 \pm 4.8$  yr) undertook assessments of body composition, blood pressure, echocardiography and  $\text{VO}_2\text{MAX}$ . Participants completed both a HIIE and a MICE session in a counterbalanced design with >7 days between tests. HIIE consisted of  $6 \times 3$  min high intensity efforts interspersed with  $6 \times 3$  min recovery. MICE consisted of 50 min steady state exercise. Protocols were matched for average intensity, distance, duration and calories expended (Bartlett et al. 2011). Echocardiography was performed pre, and 0.5 hr, 4 hr, and 24 hr post exercise. Measurements included; left ventricular (LV) dimensions and volumes using Simpsons biplane, left atrial diameters, peak early ( $E_m$ ) and peak atrial ( $A_m$ ) transmitral flow, tissue Doppler imaging (TDI) longitudinal peak systolic ( $S'$ ), early diastolic ( $E'$ ), and late diastolic velocities ( $A'$ ) and isovolumic relaxation time, as well as  $E_m/E'$ . Bioelectrical impedance and metabolic rate were measured at rest and 24 hours post exercise. Results LV end-diastolic volume was increased ( $p < .05$ ) 4 hours following HIIE from pre-exercise, however no differences were observed following MICE. No other trial or time effects were observed in any cardiac or non cardiac indices. Discussion There is little difference in the acute (< 24 hr) cardiac response to HIIE and MICE in untrained females. This suggests that the stimulus for the differing cardiac responses in high and moderate intensity training programmes (Wisloff et al., 2006) is related to the exercise stress and not any persistent alterations in cardiac function. References Bartlett JD., Close GL., MacLaren DP., Gregson W., Drust B., and Morton JP (2011). High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: Implication for exercise adherence. *Journal of Sport Sciences*. 29 (6): 547 – 553. Wisloff U., Nilsen TIL., Drøyvold WB., Mørkved S., Slørdahl SA., and Vatten LJ. (2006). A single weekly bout of exercise may reduce cardiovascular mortality: how little pain for cardiac gain? 'The HUNT study, Norway'. *European Journal of Cardiovascular Prevention and Rehabilitation*. 13: 798 – 804.

### PHYSIOLOGICAL RESPONSES IN SUPRAMAXIMAL HIGH-INTENSITY INTERMITTENT TRAINING IN YOUNG COMPETITIVE CYCLISTS

Nicolò, A., Bazzucchi, I., Lenti, M., Haxhi, J., Scotto di Palumbo, A., Conti, A., Sacchetti, M.  
*University of Rome "Foro Italico"*

Introduction High intensity intermittent training (HIT) is recognized to be the preferential type of exercise to elicit further adaptations in already highly-trained endurance athletes (Laursen and Jenkins, 2002). However, the acute physiological responses of HIT protocols remain to be fully explored. We investigated two types of supramaximal HIT protocols used by some cycling coaches to notably stress both the aerobic and anaerobic metabolism. Methods Thirteen competitive cyclists ( $19 \pm 2$  yr,  $\text{VO}_2\text{max}$  of  $63.1 \pm 4.2$   $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ) performed a maximal incremental test and two randomized HIT protocols to exhaustion during the competitive season. HIT protocols differed in work and rest duration (40 s:20 s and 30 s:30 s) but had the same work (135% of peak power output) and rest (0 W) intensity. Gas exchange and ventilatory parameters, heart rate (HR), blood lactate [ $\text{La}^-$ ] and surface electromyographical (sEMG) parameters (root mean square and muscle fibre conduction velocity) from the vastus lateralis (VL) muscle were collected. Results Time to exhaustion was  $10 \pm 3$  min and  $38 \pm 13$  min, and average  $\text{VO}_2$  was  $89 \pm 4\%$  and  $75 \pm 4\%$  of  $\text{VO}_2\text{max}$  for 40 s:20 s and 30 s:30 s, respectively. Maximum values of  $\text{VO}_2$  and ventilation ( $V_e$ ) for 40 s:20 s were significantly higher ( $p < 0.01$ ) than those of the other two trials. Peak [ $\text{La}^-$ ] value was significantly higher ( $p < 0.01$ ) for 40 s:20 s than for 30 s:30 s ( $13 \pm 1.5$ ,  $10 \pm 2.9$ ) while mean values of [ $\text{La}^-$ ] for 30 s:30 s were at or above the 8 mmol/l value for about 20 min. The kinetics of  $V_e$  as a function of time was incremental while that of  $\text{VO}_2$  was quite stable throughout the test, except for a slight but significant ( $p < 0.05$ ) decrease in the last part of the trial. The HR kinetics showed a cardiac drift. All the kinetics described were similar between the two HIT tests. The EMG analysis indicated a substantial neuromuscular involvement of the VL but did not detect significant changes in the sEMG parameters kinetics during the two trials. Discussion In the two HIT tests, the metabolic and ventilatory parameters seemed to better explain athlete exhaustion than the neuromuscular ones. The aerobic and anaerobic metabolism appeared highly stimulated, although in different ways, due to the different mean total exercise duration. The 40-s:20-s test enabled physiological parameters to reach maximum values, while the 30-s:30-s one stimulated the lactate tolerance, allowing to maintain quite high [ $\text{La}^-$ ] levels for a long period of time. Moreover, both the HIT tests provide an important tool to reach high levels of  $V_e$ . These results can help coaches and exercise scientists choose and prescribe supramaximal HIT protocols. References Laursen PB, Jenkins DG. (2002). *Sports Med*, 32(1), 53-73.

### NOCTURNAL CARDIAC AUTONOMIC RECOVERY AFTER HIGH-INTENSITY INTERVAL AND LONG-SLOW DURATION TREADMILL RUNNING IN YOUNG MALE, ELITE ENDURANCE ATHLETES

Mikkilä, S., Welde, B.

*North Troenderlag University College*

NOCTURNAL CARDIAC AUTONOMIC RECOVERY AFTER HIGH-INTENSITY INTERVAL AND LONG-SLOW DURATION TREADMILL RUNNING IN YOUNG MALE, ELITE ENDURANCE ATHLETES Mikkilä, S. Welde, B. North-Troenderlag University College (Levanger, Norway) Introduction Extensive training in elite athletes requires adequate recovery in order to increase performance or performance potential, and to avoid overtraining or other health problems. Heart rate variability (HRV) has been said to reflect the state in the autonomic nervous system and to provide essential information of the parasympathetic regulation, which is significant for post-exercise recovery. HRV has been widely investigated during and after exercise in daytime and after exercise at night, with conflicting results. Therefore, the aim of this study was to investigate the nocturnal cardiac autonomic recovery after one high-intensity interval training session (HIIT) and one long-slow duration training session (LSD), with approximately equivalent training impulse (TRIMP). We hypothesized a greater impact on HRV after the HIIT session and more rapid recovery after the LSD session. Methods 4 well-trained endurance athletes' nocturnal HRV was monitored during a 7-day protocol: after two non-training days, and for two nights after HIIT and LSD training sessions. Recommendations of Brandenberger et al. (2005) were followed in order to isolate a 5-minute sequence during the first slow wave sleep for further HRV analysis. HRV data for frequency analyzes were processed by Kubios HRV software. TRIMP was calculated prior to exercise according to Foster et al. (2001). Also, TRIMP was calculated after the sessions according to the actual %HRmax during both training sessions. Athletes' life satisfaction was investigated using the Quality of Life Index questionnaire in order to consider the non-training stressors influencing the HRV. Results No significant effect in the nocturnal cardiac autonomic recovery was found between rest and training, or between the training sessions. Also, no significant change in the non-training stressors was found. Discussion HIIT or LSD sessions did not introduce significant effects on cardiac autonomic recovery when the non-training stressors remain unchanged. Therefore, the results do not support the hypothesis that a HIIT session would cause greater changes in HRV compared to a LSD session. Also, the hypothesis regarding



more rapid recovery after LSD session is not supported. These results are in partial conflict with previous studies, although these did not investigate a single session of exercise. References Brandenberger, G.; Buchheit, M.; Ehrhart, J.; Simon, C.; & Piquard, F. Is slow wave sleep an appropriate recording condition for heart rate variability analysis? *Autonomic Neuroscience: Basic and Clinical* (2005);121:81-86. Foster, C.; Florhaug, J.; Franklin, J.; Gottschall, L.; Hrovatin, L.; Parker, S.; Doleshal, P.; Dodge, C. A. New Approach to Monitoring Exercise Training. *J. Strength Cond. Res.* (2001);15:109-115.

### **EFFECT OF HIGH-INTENSITY INTERVAL TRAINING ON CARDIO-METABOLIC RISK MARKERS IN ADOLESCENTS: 3-MONTH FOLLOW-UP OF PROJECT FFAB**

Taylor, K., Azevedo, L., Bock, S., Batterham, A.M.

*Teesside University*

Effect of high-intensity interval training on cardio-metabolic risk markers in adolescents: 3-month follow-up of Project FFAB (Fun Fast Activity Blasts) Taylor, K.1, Azevedo, L.1, Bock, S. 2, Batterham, A. M. 1. 1Teesside University (Middlesbrough, UK). 2Durham University, UK. Introduction Project FFAB is an exploratory controlled before and after study of the effects of a practical and engaging low-volume high-intensity training (HIT) intervention on cardio-metabolic risk markers. The extent to which adaptations to HIT can be maintained is unknown (Gibala & McGee, 2008). We aimed to evaluate the maintenance of any beneficial intervention effects at 3 months follow-up. Methods Participants were 102 adolescents (64 male; 14.3 ± 0.3 years; mean ± SD) from four schools; two schools were assigned to the Intervention (n = 41) and two to the Control, matching for socioeconomic status. The intervention comprised four sets of 45 s maximal effort exercise (at least 90% of maximum heart rate) involving boxing, dance, soccer and basketball drills, with 90 s rest between sets, up to three times weekly for 10 weeks. The number of sets was increased by one every two weeks. Outcomes were blood lipids and glucose, waist circumference, C-reactive protein, blood pressure, physical activity levels (7-day accelerometry), aerobic fitness (multistage fitness test), and carotid artery intima-media thickness. The difference in the change from baseline (intervention minus control) was estimated for each outcome, with sex, the baseline value, and maturity offset as covariates. Using magnitude-based inferences (MBI) with qualitative probabilistic descriptors (Hopkins et al., 2009), we calculated the probability (P, MBI) that the true population effect was greater than the minimum important difference (MID; 0.2 standard deviations). Results Compliance was indicated by 75% of the intervention group completing at least 70% of the sessions. At the post-intervention time point, we had previously observed clinically relevant improvements vs. control ('likely' or 'very likely' to be greater than the MID) in triglycerides (-24%), waist circumference (-2.7 cm), and mean daily moderate to vigorous physical activity (MVPA) (14.3 min). At 3-months follow-up the mean triglyceride level was 6% lower in Intervention vs. Control (90% confidence interval, -22 to 14%; P, MBI = 0.38), waist circumference was 2.2 cm smaller (-3.4 to -1.1 cm; P, MBI = 0.43), and mean daily MVPA was 12.8 minutes greater (-12.0 to 37.7 minutes; P, MBI = 0.69). All three effects were 'possibly' important. There was no substantial effect on any other outcome. Discussion Clinically relevant post-intervention effects were attenuated at 3-months follow up. There is some evidence of a possible residual benefit, but exercise interventions must be regular to maintain beneficial adaptations. References Gibala MJ, & McGee SL (2008). *Exerc Sport Sci Rev*, 36:58-63. Hopkins, WG, et al. (2009). *Med Sci Sports Exerc*. 41:3-13.

### **SHORT TERM INTERVAL TRAINING IMPROVES MITOCHONDRIAL RESPIRATION AND EXERCISE CAPACITY**

Gant, N., Vincent, G.E., Edge, J.A., Vincent, P.J., MacDonald, J., Hickley, A.J.R.

*The University of Auckland*

Purpose Low volume high-intensity interval training (HIT) is a potent exercise strategy that stimulates metabolic adaptation in humans. However, current training protocols consisting of repetitive 'all out' maximal sprinting efforts of ~30 s require a high level of participant motivation and specialized laboratory equipment. Recently, a more practical HIT model has been introduced involving tolerable intensity and extended duration bouts, which are interspersed with appropriate recovery periods. The influence of HIT on mitochondrial respiration has yet to be studied. Method Here we use groups of matched males and females to show the effects of HIT over a short period (2 weeks) on whole body and mitochondrial respirometry, skeletal muscle performance, and cellular adaptation. Eight men and eight women (age 22 ± 2 y, body mass 75 ± 14 kg) performed one-legged VO<sub>2</sub> peak tests with bilateral muscle biopsies (vastus lateralis) taken before and after two weeks of HIT. Training involved single-leg cycling using the non-exercising leg as the control. Exercise bouts were performed 4 days/week and comprised 12 x 1 min intervals at 120% of peak power output performed during VO<sub>2</sub> peak tests, separated by 90 s of rest. Mitochondrial respiration and the activity of enzymes citrate synthase and lactate dehydrogenase were quantified. Results Training increased peak power in the trained limbs of both males (22.9%) and females (45.9%) (P < 0.05). Maximal oxidative phosphorylation capacities improved in male participants (20.7%), as did cytochrome c-oxidase respiration (12.9%) and citrate synthase activity (79.6%) (P < 0.05 for all). Apparent enhancements in mitochondrial and enzymatic function failed to reach statistical significance in females. Baseline training status, antioxidant capacities and stress-induced responses may explain the gender differences. Conclusion HIT is a time-efficient training method that can improve exercise capacity and mitochondrial function over a 2-week period.

### **PHYSIOLOGICAL AND PSYCHOLOGICAL RESPONSES TO ROYAL AUSTRALIAN AIR FORCE ENVIRONMENTAL SURVIVAL TRAINING IN THE TROPICS**

Edwards, A., Chester, A.L., Crowe, M., Quirk, F.

*James Cook University*

Title: Physiological and Psychological Responses to Royal Australian Air Force Environmental Survival Training in the Tropics. Authors: Edwards AM1, Chester AL1, Crowe M1, Quirk F2 1 Institute of Sport and Exercise Science, James Cook University, Australia 2 School of Medicine and Dentistry, James Cook University, Australia Introduction: Military personnel experience extreme levels of physiological and psychological stress during sustained operations [1]. Stressful, realistic training is recognised as a key element of physical and psychological preparation for military operations, yet the extent to which existing training practices prepare military for combat and/or survival situations are rarely reported [2]. The aim of this study was to quantify the physiological and psychological responses to a 15 day programme of RAAF Environmental Survival Training (EST) in the tropical conditions of Far North Queensland. Methods: Fourteen RAAF volunteers were assigned to an experimental group (9 males, 5 females), while a further 10 matched for age and fitness (7 males, 3 females) were recruited to a control group. The experimental group completed a series of physical challenges throughout EST in different environmental conditions while the control group maintained typical day-to-day activities. The physiological and psychological impact of EST was measured through: 1) biochemical markers (IL-6 and creatine kinase), 2) physiological and anthropometric variables (vertical jump, body mass, flexibility and hydration) and 3) psychological questionnaires. Results: Creatine kinase concentration significantly increased (p<0.01)

in experimental at day 5 ( $p<0.05$ ) and remained elevated over the survival course ( $p<0.01$ ). Vertical jump height (-8.8%), peak power output (-6.2%), average power output (-15.5%) and body mass (7.0%) all declined in experimental ( $p<0.01$ ). Perception of pain increased ( $p<0.01$ ) over EST while no significant changes were found in IL-6, flexibility, blood lactate or hydration. The EST produced negative psychological responses such as mood ( $p<0.01$ ), depression ( $p<0.05$ ), anxiety ( $p<0.01$ ) and stress ( $p<0.01$ ). No significant changes were observed in the control condition. Conclusion: The RAAF EST imposed significant physiological and psychological stress evident from markers of muscle damage, deterioration in physical performance, substantial weight loss, negative mood and psychological distress. However, as IL-6 concentrations did not change in response to EST, this suggests the imposed training load was challenging, yet probably not so substantial as to compromise the immune system. References: 1. Mudambo K, et al. Dehydration in soldiers during walking/running exercise in the heat and the effects of fluid ingestion during and after exercise *Eur J Appl Physiol* 1997;76: 517-524. 2. Carins J, Booth C. Salivary immunoglobulin-A as a marker of stress during strenuous physical training. *Aviat Space Environ Med* 2002; 73: 1203-7.

### TESTOSTERONE, CORTISOL, T:C RATIO AND EXERCISE RESPONSES DURING 135 MILES MOUNTAIN FOOT RACE

Belli, T.1,2, Araújo, G.G.2, dos Reis, I.G.M.2, Scariot, P.P.M.2, Ackermann, M.A.2, Gobatto, C.A.2

1: Sao Paulo State University (UNESP), Rio Claro/SP, BRAZIL. 2: State University of Campinas (UNICAMP), Limeira/SP, BRAZIL.

Introduction: It is widely documented that exercise produces an imbalance between anabolic and catabolic hormones, however, the relationship of these hormones with exercise performance during ultramarathon races has not been studied. Thus, the aim of this study was assess the relationship between testosterone, cortisol and T:C ratio responses and exercise performance during 135 miles race. Methods: It was studied 10 male athletes (43±3 years; 171.4±1.9 cm height; 72.0±3.1 kg body weight; 15±3 years of race training; 118±20km/week of training volume) that participated of the 'BAD 135 World Cup' mountain race called "Brazil 135 Ultramarathon". Race and pause time were obtained by official race reports. Blood samples were obtained at baseline, 52, 110 and 135 miles to testosterone (T) and cortisol (C) determinations (Siemens Coat-A-Count kits®). All data were expressed by mean ± SEM, repeated measures ANOVA was used to comparisons, Scheffé post hoc test was performed when appropriate and Pearson's correlation coefficient was used for analyzing relationships (statistical significance  $P<0.05$ ). Results: The subjects completed the race in 46.8±3.4h, speed average of 3.1±0.2 mph and total pause time of 3.9±0.9 h. C levels increases whereas T:C ratios decreases significantly ( $P<0.05$ ) from baseline to 52, 110 and 135 miles (195±40, 252±42, 176±45% and -64±11, -69±11, -59±21%, respectively). Furthermore, C levels at 135 miles were positively correlated ( $P<0.05$ ) with running velocity ( $r=0.82$ ) as well as inversely correlated ( $P<0.05$ ) with race time ( $r=-0.83$ ) and pause time ( $r=-0.78$ ) while T levels and T:C ratio at 135 miles were positively correlated ( $P<0.05$ ) with pause time ( $r=0.65$ ;  $0.77$ , respectively). Discussion: Present investigation showed increases in C concentrations, corroborating previous studies (Nieman et al. 2006, Nieman et al. 2007), and decreases in T:C ratios denoting a catabolic profile during the race. In addition, we observed that higher running intensity and lower race and pause time may be related to greater C levels whereas higher pause time may be related to greater T levels and T:C ratio after 135 miles mountain foot race. References: Nieman DC, Henson DA, Dumke CL, Oley K, Mcanulty SR, Davis JM, Murphy EA, Utter AC, Lind RH, Mcanulty LS, Morrow JD (2006) *Brain Behav Immun*, 20(6),578-584. Nieman DC, Henson DA, Davis JM, Dumke CL, Gross SJ, Jenkins DP, Murphy EA, Carmichael MD, Quindry JC, Mcanulty SR, Mcanulty LS, Utter AC, Mayer EP. (2007) *J Interferon Cytokine Res*, 27,1003-1011.

### TOTAL IGF-I RESPONSES TO A 5-DAY MILITARY COURSE WITHOUT CALORIE RESTRICTION

Teo, Y., Nindl, B., Lee, J.

1: DSO National Laboratories, Republic of Singapore, 2: Yong Loo Lin School of Medicine, National University of Singapore, Republic of Singapore, 3: The U.S. Army War College, Carlisle, United States

INTRODUCTION Insulin-like growth factor I (IGF-I) is an important metabolic biomarker, influenced by energy balance, anabolic and nutritional status (Nindl & Pierce, 2010). Rarick et al (2007) reported a ~30% total IGF-I decline in the absence of body mass loss after 7 days of physical activity where energy expenditure was balanced with caloric intake (3,600-4,000 kcal/d) in a laboratory setting. This study investigated total IGF-I responses to a military operational stress scenario without calorie restriction. METHODS Thirty-three male military personnel (Mean±SD; 19.5±0.9 y; 1.75±0.06 m; 66.8±6.2 kg; 9.6±2.8 % body fat) participated in a 5-day military training course, which comprised of continuous physical activity with minimum sleep (total 1 h). Caloric intake was ~3,500 kcal/d. Measurements were taken a day prior and immediately following the course. Body composition was determined via skinfold measurement at 7 sites (chest, axilla, triceps, subscapula, abdomen, suprailiac and thigh). Body mass, serum IGF-I, tumor necrosis factor- $\alpha$ , interleukin-6 and creatine kinase were measured. Cognitive function was assessed as alertness, divided attention and decision making via the Vienna Test System. Upper body strength was determined by a JTECH force gauge. Vertical squat and countermovement jump height were assessed by a vertical jump yardstick. RESULTS There was no change in body mass (PRE: 66.8±6.2; POST: 66.8±6.0 kg;  $P=0.68$ ), fat mass (PRE: 6.5±2.5; POST: 6.3±2.5 kg;  $P=0.08$ ) and muscle mass (PRE: 33.5±2.7; POST: 33.1±2.9 kg;  $P=0.11$ ) following the course. Post course IGF-I decreased by 26% (PRE: 218±43; POST: 161±38 ng/mL;  $P<0.001$ ). There was an increase in interleukin-6 (330%;  $P<0.001$ ) and creatine kinase concentrations (1906%;  $P<0.01$ ) post course. Tumor necrosis factor- $\alpha$  levels remain unchanged ( $P=0.09$ ). Number of correct reactions decreased ( $P<0.001$ ) for alertness (14%), divided attention (26%) and decision making (18%) at the end of the course. Mean reaction time for correct reactions increased for alertness (38%;  $P<0.001$ ) but remained unchanged for divided attention ( $P=0.50$ ) and decision making ( $P=0.91$ ) at the end of the course. Average upper body strength and vertical squat jump height degraded by 22 and 35% ( $P<0.001$ ) respectively post course. No associations were found between IGF-I and the performance tests. CONCLUSION The decrease in IGF-I coincides with degradation of cognitive and physical performance and therefore established the intense physiological strain of the 5-day military course. Our findings further reinforced that decrease in IGF-I can occur in the absence of calorie deficit in actual military field settings. REFERENCES Nindl BC, Pierce JR (2010). Insulin-like growth factor I as a biomarker of health, fitness, and training status. *Med Sci Sports Exerc*, 42(1):39-49 Rarick KR et al (2007). Energy flux, more so than energy balance, protein intake, or fitness level, influences insulin-like growth factor-I system responses during 7 days of increased physical activity. *J Appl Physiol*, 103(5): 1613-21

### LEPTIN AND OVERLOADING

Uusitalo, A.

Helsinki University Hospital

LEPTIN AND OVERLOADING Uusitalo, A.1,2, Tanskanen, M.3, Atalay, M.4, Häkkinen, K.3, Kyröläinen, H.3. 1: Helsinki University Hospital (Finland), 2: University of Helsinki (Finland), 3: University of Jyväskylä (Finland), 4: University of Eastern Finland (Kuopio, Finland) Introduction Leptin is a protein secreted by white adipose tissue. Its secretion decrease with energy deficit and increase with energy overloading and

obesity. It is unclear if physical overloading could influence leptin metabolism independently from energy homeostasis, and what is a role of leptin and energy deficit in the development of overtraining state (1). Leptin influences the stress response at every main level of HPA-axis, and it is suggested to reduce adrenal cortisol synthesis (2). Our aim was to study whether leptin level differed between overreached (OR) and no-OR conscripts during the first 9 weeks of military service. Correlation between leptin and cortisol levels were also analysed. Methods Fifty seven male conscripts (19.7  $\pm$  0.3 yrs) took part into the study. The blood samples were taken after one, 4 and 7 week's of service and after one week of recovery (9 wk) before and immediately after the 45-minute submaximal marching test. OR subjects had to fulfill three of five criteria; decreased VO<sub>2</sub>max, increased RPE in 45-min submaximal test or absence due to sickness from these tests, increased somatic or emotional symptoms of OR and high incidence of absence due to sickness from daily training (3). Results Out of 33 conscripts who were healthy on the test days and were able to perform the test scheme, 9 were classified as OR and 24 as no-OR subjects. Both OR and no-OR lost their weight and fat mass about 2 kg ( $p < 0.001$ ) during the service. Also their resting ( $p < 0.01$ ) and submaximal exercise related ( $p < 0.05$ ) leptin concentration decreased. There seemed to be significant leptin x fat mass interaction but overreaching had no significant effect on leptin behavior. Cortisol at rest was higher in OR than no-OR ( $p < 0.05$ ) especially at 9 wk time point, and it decreased during the service in the both groups. However, we did not find correlation with change in cortisol and leptin concentrations. Discussion Changes in leptin levels were related to change in fat mass but we did not find signs of independent effect of overreaching on leptin behavior. This, however, does not rule out it's possible role in pathophysiology of overtraining. Both leptin and cortisol decreased during the service, but we could not find linear relationship between cortisol and leptin changes, which, however, does not rule out the possible central interaction between leptin and HPA-axis. However, the effect may not be linear and strong and there are other even much stronger influencing factors. 1. Jürimäe J et al. (2011). *Metabolism Clinical and Experimental*, 60, 335-60. 2. Roubos EW et al. (2012). *Gen Comp Endocrinol*. In press. 3. Tanskanen MM. (2011). *J Strength Cond Res* 25, 787-97.

## 13:45 - 14:45

### Poster presentations

#### PP-PM67 Physiology 18

##### WEIGHT REDUCTION BY DIETARY INTERVENTION FOR THREE MONTHS DECREASED MEDICAL RISK IN HEAVY-WEIGHT FEMALE JUDO ATHLETES

Murata, H.1, Takata-Ishikawa, K.2, Higuchi, M.3, Taguchi, M.3

1: Japan women's College of physical education(Tokyo, Japan), 2: National Institute of Health and Nutrition(Tokyo, Japan), 3: Faculty of Sports Science, Waseda University(Saitama, Japan)

**Introduction** It is known that obese individuals have higher medical risk such as insulin resistance, hypertension and dyslipidemia. Previous studies reported that male athletes who possess heavier body weight such as American football players and Judo athletes have higher medical risk induced by excessive weight gain associated with excessive body fat accumulation. However, no information is available to evaluate medical risk concerned with excessive body fat accumulation for female Judo athletes categorized in heavy weight class. The purpose of the present study was to examine the effect of weight reduction by dietary intervention to aim the decrease in higher medical risk for female Judo athletes with heavier body weight. **Methods** Ten Japanese female Judo athletes categorized 78kg and over 78kg classes (age 20.3  $\pm$  1.9 years, height 166.4  $\pm$  4.1 cm, body weight (BW) 92.1  $\pm$  16.7 kg, % body fat 30.3  $\pm$  6.2% (%BF), fat-free mass (FFM) 63.4  $\pm$  7.2kg and body fat mass 28.7  $\pm$  10.3kg) completed a 12-week weight-loss intervention. Sports dietitian instructed to reduce their caloric intake through lipids intake control or sugar restriction. Before and after intervention, body composition was measured by dual energy X-ray absorptiometry (DXA). Physical fitness tests were performed before and after the intervention. Blood samples were taken after 12-hour over-night fasting. Aspartate aminotransferase (AST), alanine aminotransferase (ALT), lipids, insulin, and glucose levels in blood were analyzed in all subjects before and after the intervention. Insulin resistance was assessed in terms of HOMA-IR. **Results** After the dietary intervention for 12-week, total body weight and fat content significantly reduced by 4.5kg (5.4%), and 2.5kg (10%), respectively, whereas no significant decrease was observed in FFM. Muscular and cardiorespiratory physical fitness was not changed in response to the intervention. Values of AST (26  $\pm$  11 vs. 18  $\pm$  5 U/L), ALT (29  $\pm$  17 vs. 17  $\pm$  5 U/L), total cholesterol (194  $\pm$  29 vs. 176  $\pm$  21 mg/dL) and glucose (92  $\pm$  10 vs. 87  $\pm$  9 mg/dL) in blood significantly decreased, respectively. HOMA-IR decreased significantly (3.3  $\pm$  2.0 vs. 2.6  $\pm$  2.1), but the three subjects still had abnormal insulin resistance. **Conclusion** This study suggested that long-term mild weight reduction by dietary intervention can reduce any medical risks without decreases of FFM and physical fitness for female Judo athletes categorized heavy weight class.

##### EXERCISE INTENSITIES AND DETERMINANTS IN BASIC AQUATIC MOVEMENTS

Kawano, H.

Waseda University

**BACKGROUND:** Aquatic (aqua aerobics) exercise is characterized in that exercise intensity can be easily adjusted with viscosity of water and reduction in load on knee joints is induced with buoyant force, in contrast to exercising on land. Although aquatic exercise program is mainly composed of basic aquatic movements such as Rocking, Jumping, Kicking, or Scissors, it remains unclear the exercise intensities of these aquatic movements. Moreover, because it is thought that, in the case of a body movement under the water environment, greater body surface area contacted on water may be associated with higher water resistance, aquatic exercise intensity may be accounted for by body size such as body surface area as well as physical fitness such as cardiorespiratory fitness. Therefore, the aims of this study were to determine the exercise intensity of basic aquatic exercises and to examine the determinants of the exercise intensities from physical characteristics such as body size or physical fitness. **METHODS:** A total of 38 healthy young men (11 sedentary, 15 endurance-trained, and 12 resistance-trained men) were participated in the study. Averages of age, height, body weight, percentage of body fat, body surface area, cross-sectional area in calf, and maximal oxygen consumption (VO<sub>2</sub>max) were 21.2  $\pm$  1.7 (19-27) yrs, 172.3  $\pm$  6.0 (158.6-183.5) cm, 68.2  $\pm$  12.7 (52.5-108.0) kg, 15.7  $\pm$  6.8 (5.0-33.7)%  $\pm$  1.80  $\pm$  0.15 (1.54-2.20) m<sup>2</sup>, 100.7  $\pm$  15.0 (80.5-151.1) cm<sup>2</sup>, and 50.0  $\pm$  11.2 (29.1-69.5) ml/kg/min, respectively. They randomly performed 4 basic aquatic exercises in a swimming pool for 5 min each, which the water depth was at the level of xiphoid process, and oxygen uptake was measured by a Douglas bag during final a minute of the

each exercise session. RESULTS and DISCUSSION: The highest intensity of aquatic exercises was in Kicking ( $61.7 \pm 15.0\% \text{VO}_{2\text{max}}$ ), followed by Scissors ( $49.4 \pm 13.7\% \text{VO}_{2\text{max}}$ ), Jumping ( $32.4 \pm 8.4\% \text{VO}_{2\text{max}}$ ), and Rocking ( $30.9 \pm 9.8\% \text{VO}_{2\text{max}}$ ). Multiple regression analysis revealed that body surface area was independently related with exercise intensity of Rocking ( $\beta=42.3$ ), and  $\text{VO}_{2\text{max}}$  was independently related with them of Scissors ( $\beta=-0.68$ ) and Kicking ( $\beta=-0.75$ ). In addition,  $\text{VO}_{2\text{max}}$  and cross-sectional area in calf were independently related with exercise intensity of Jumping ( $\beta=-0.38$  and  $-0.30$ , respectively). These results suggest that body size as well as cardiorespiratory fitness should be considered to determine the aquatic exercise intensity for constructing exercise program in water.

### PREDICTIONS DEVELOPMENTS OF MAXIMAL AEROBIC POWER BY GENERAL VARIABLES AND METABOLICAL RESPONSES IN SUBMAXIMAL EXERCISE FOR SOUTH KOREAN ADULT FEMALE

Lee, B.K.1, Kim, K.H.1, Shin, J.M.1, Im, J.H.2, Jeon, Y.J.2, Chang, H.K.3, Kim, H.J.4, Choi, D.H.5

1: SangMyung U(Cheonan, S Korea), 2: KAIST(Daejeon, S Korea) 3: Seoul Women's U(Seoul, S Korea), 4: ChoSun U(Gwangju, S Korea) 5: SeoGang U(Seoul, S Korea)

**Introduction** The purpose of this study was to develop the prediction model of maximal aerobic power by general variables and submaximal metabolic responses from the Bruce protocol for S Korean adult female, and to compare and analyse the validity of these prediction models. **Methods** The subjects were consisted of 198 South Korean adult female. They were participated maximal exercise testing with Bruce treadmill protocol(Bruce et al., 1973), and the general physical variables and the metabolic responses were measured in the end of the first(3 minute) and second stage(6 minute). Measurement items were Age, WT, HT, BMI, and  $\text{VO}_2$ ,  $\text{VCO}_2$ , VE, HR of 3 and 6 minute, time to HR 150 bpm. To determine the predicted model of  $\text{VO}_{2\text{max}}$ , multiple and simple regression analysis with stepwise methods analysis were applied. Results Analyzing with all variables using stepwise method, the multiple R of total variable model was 0.73( $p<.01$ ), SEE was 3.4 ml/kg/min, CV was 10.3%. The multiple R of 3 minutes model was 0.68, SEE was 3.6ml/kg/min, CV was 11.0%. The multiple R of 6 minutes model was 0.69, SEE was 3.6ml/kg/min, CV was 10.8%. The multiple R of general variables model was 0.59, SEE was 4.0ml/kg/min, CV was 12.2%. The R of HR 150 model were 0.16, SEE was 4.0ml/kg/min, CV was 14.8%. **Discussion & Conclusion** Cao, et al.(2009) reported the prediction of  $\text{VO}_{2\text{max}}$  model with daily step counts, BMI, Age for Japanese adult women, and R of this prediction was 0.81( $p<.001$ ). In conclusion, with considering usefulness and convenience through the validity of these prediction models, the prediction model of Maximal Aerobic Power recommended total model, general variables model, 6 and 3 minute model, and HR 150 model by tunes. **References** Bruce, R. A., Kusimi, F., & Hosmer, D. (1973). Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. *American Heart Journal*, 85(5): 546-562. Cao, J. B., Miyatake, N., Higuchi, M., Ishikawa-Takata, K., Miyachi, M., & Tabata, I. (2009). Prediction of  $\text{VO}_{2\text{max}}$  with daily step counts for Japanese adult women. *European Journal of Applied Physiology*, 105(2): 289-296.

### RESTING ENERGY EXPENDITURE DOES NO CHANGE WITH OPTIMAL WEIGHT REDUCTION IN JAPANESE FEMALE HEAVY-WEIGHT CLASS JUDO ATHLETES

Taguchi, M.1, Murata, H.2, Ishikawa Takata, K.3, Higuchi, M.1

1) Faculty of Sports Sciences, Waseda University (Saitama, Japan), 2) Japan Women's College of Physical Education, 3) National Institute of Health and Nutrition (Tokyo, Japan)

**Introduction** Previous studies reported that treatment of body weight reduction in obese women with caloric restriction consistently induced lower resting energy expenditure (REE). It is not clear if REE is reduced caused by weight loss intervention in female heavy weight athletes. The aim of the present study was to examine whether body weight loss reduces REE of Japanese female Judo athletes who were categorized in heavy weight class. **Methods** Ten heavy-weight Judo athletes including Japanese elite class athletes (age 20.3 +/- 1.9 years, height 166.4 +/- 4.1 cm, body weight 92.1 +/- 16.7 kg, percentage of body fat 30.3 +/- 6.2 % and fat-free mass (FFM) 63.4 +/- 7.2 kg) completed a 12-week weight-loss intervention by the direction of the sports dietitian. REE was measured by indirect calorimetry, and body composition was estimated by dual energy X-ray absorptiometry (DXA) at pre- and post- intervention. Results The total weight loss was obtained by 4.5 +/- 2.1 kg (5.0 +/- 2.4 %) after the intervention. Only the weight of adipose tissue was decreased significantly by 10% ( $p<.01$ ), and FFM components (weight of skeletal muscle, bone mass, and residual mass) were maintained. Measured REE decreased significantly after the intervention, however, REE did not change after adjusting for FFM (pre;  $1767 \pm 46$  kcal/d, post;  $1702 \pm 46$  kcal/d,  $p=0.340$ ). **Discussion** REE reflects underlying tissue composition, mass, and metabolic rate, and FFM alone account for 45-50% of inter-individual variability of REE in Japanese female athletes. In the present study, athletes were required mild caloric restriction without reduction of protein and micro-nutrients intakes. Consequently, total body weight and fat mass were significantly decreased while FFM remained after the intervention. FFM including different resting metabolic rate such as muscles (13 kcal / kg /day) and organs (200 - 440 kcal / kg /day) maintenance was considered as the key factor of unchanging REE. **Conclusion** Optimal weight loss by reducing fat mass may conserve REE, and maintaining REE will be helpful for body weight management in heavy weight female athletes. **References** Taguchi M, Ishikawa-Takata K, Higuchi M et al. 2011 Resting energy expenditure can be assessed by fat-free mass in female athletes regardless of body size. *J Nutr Sci Vitaminol*, 57(1): 22-29.

### ESTIMATION OF $\text{VO}_2$ KINETICS FROM GRADED EXERCISE TESTS IN ENDURANCE RUNNERS

Sentija, D., Vucetic, V.

Faculty of Kinesiology, University of Zagreb

**Introduction** The kinetics of oxygen uptake are determined by computation of the time constant, or 'tau' ('tau'), from breath-by-breath  $\text{VO}_2$  data during square-wave work. In an incremental (ramp) test, presuming a linear increase of  $\text{VO}_2$  with increasing intensity (for the intensity range below the anaerobic threshold), tau can be estimated from the time delay ( $\tau=\Delta t$ ) needed to reach the  $\text{VO}_2$  that corresponds to the steady-state  $\text{VO}_2$  ( $\text{VO}_{2\text{ss}}$ ) at the same intensity (Whipp et al., 1981). We hypothesized that in treadmill tests with graded increases of intensity (step tests, no steady-state stages with short duration) the same estimation of tau can be performed from: 1) a single step test, if  $\text{VO}_{2\text{ss}}$  is known, or 2) two step tests with different speed increments. **Methods** 23 endurance runners completed 3 incremental treadmill tests to exhaustion with increase in running speed of: 1 km/h each min (T1), 1 km/h each 1/2 min (T05), and 2 km/h each 4 min (SS). Breath-by-breath  $\text{VO}_2$  data were averaged to 30 s, and centered to the corresponding running speeds for T1 and T05. The  $\text{VO}_{2\text{ss}}$  values at 8, 10 and 12 km/h were defined as the average  $\text{VO}_2$  values in the 4th minute of respective stages in the SS test, and were corrected to account for the  $\text{VO}_2$  difference between ramp and step protocols. The time constants ( $\Delta t$ ) were determined from linear regression parameters derived from the  $\text{VO}_2$ /running speed relationship in SS, T1 and T05. The analysis was performed within the aerobic speed range (8-12

km/h). The significance of differences between  $\Delta t$  were determined from 1) SS-T1, 2) SS-T05, and 3) T1-T05 test data ( $p < 0.05$ ). Results and discussion Similar  $\text{VO}_2$  kinetics were found for  $\Delta t$  determined from SS-T1, SS-T05 and T1-T05 data ( $32.5 \pm 26.6$  s,  $34.0 \pm 45.4$  s, and  $31.1 \pm 18.8$  s, respectively;  $p > 0.05$ ), and were consistent within the analyzed speed range. The increase of intensity in T05 (1 km/h/30s) is exactly twice the increase in T1 (1 km/h/60s). Therefore, for a certain  $\text{VO}_2$ , the  $\Delta t$  between T1 and T05 tests should be equal to  $\Delta t$  between T1 and SS, enabling estimation of  $\tau$  and  $\text{VO}_{2ss}$ . Indeed, the average error of  $\text{VO}_{2ss}$  and  $\Delta t$  estimated from the time delay between T1 and T05 was practically irrelevant (0.1-0.15 ml/min/kg, or 2-3 s). The  $\Delta t$  values of endurance runners in this study proved to be very variable (many of them outside of the physiological range for  $\tau$ ), reflecting accumulated effects of high biological variability and technical errors for repeated measurements. Also,  $\Delta t$  values were significantly higher compared to tau values measured directly from square-wave tests in previous studies. This difference may be explained by the delay time needed for transportation of blood from working muscles to the lungs (~ 10-20 s). An alternative explanation is that incremental exercise, unlike constant (square-wave) exercise, has more complex and slower  $\text{VO}_2$  kinetics. References Whipp BJ et al (1981). *J Appl Physiol* 50(1):217-21

## AN ANALYSIS OF THE TYPICAL DAILY PHYSICAL ACTIVITY PATTERNS OF JOCKEYS

Cullen, S.1, Mc Goldrick, A.2, O'Loughlin, G.1, May, G.1, Warrington, G.1

1: *Dublin City University (Dublin, Ireland)*, 2: *The Turf Club (The Curragh, Ireland)*

**Introduction** The specific physiological demands of horse racing remain largely unknown. Research suggests jockeys must perform close to their physiological limit in a race to be successful (Trowbridge et al., 1995), whilst maintaining the stipulated competition riding weight. This study aimed to characterise daily physical activity patterns of jockeys. **Methods** Apprentice jockeys ( $n=30$ ) completed a daily physical activity questionnaire. Trainee jockeys ( $n=11$ ; age  $16 \pm 1$  yr; height  $1.67 \pm 0.1$ m; body mass  $55.2 \pm 6.1$ kg; BMI  $19.7 \pm 1.8$ kg.m<sup>-2</sup>; % body fat  $7.62 \pm 0.09$ %) performed a maximal incremental cycle ergometer test starting at 60W, with 25W increments to volitional exhaustion to determine maximal aerobic capacity ( $\text{VO}_{2\max}$ ) and maximum heart rate ( $\text{HR}_{\max}$ ). Subjects subsequently completed a riding trial at a self-selected pace for different equine gaits: walk, trot and canter (3 minutes per gait). Each gait was performed in succession and the mean  $\text{VO}_2$  and HR were recorded for each gait. **Results** Questionnaire results revealed jockeys typically 'ride work'  $3.4 \pm 1.7$  days a week. The majority of riding time each day is spent at a walk, trot and canter with an average of  $6 \pm 3$  horses ridden each day for a period of  $36 \pm 15$  minutes per horse. Seventy three percent of jockeys ( $n=22$ ) reported undertaking additional exercise to riding when weight loss is necessary, with 40% ( $n=12$ ) reporting regular exercise. Mean  $\text{VO}_{2\max}$  for trainee jockeys was  $57.8 \pm 5.3$  ml.kg.min<sup>-1</sup> and  $\text{HR}_{\max}$  was  $191 \pm 11$  beats.min<sup>-1</sup>. During riding at a walk, trot and canter, mean  $\text{VO}_2$  corresponded to  $15 \pm 4\%$ ,  $38 \pm 6\%$  and  $47 \pm 9\%$  of  $\text{VO}_{2\max}$  and mean HR corresponded to  $48 \pm 6\%$ ,  $60 \pm 6\%$  and  $71 \pm 7\%$  of  $\text{HR}_{\max}$  respectively. **Discussion** The majority of an apprentice jockey's day is spent riding at a walk, trot and canter. These riding activities are associated with a relatively low physiological demand when compared to peak physiological data obtained from trainee jockeys. Limited training effects may occur at these intensities. To regulate weight for competition and maximise performance, riders must physically train for several hours per week in addition to typical daily riding. Questionnaire results reveal a small percentage of apprentice jockeys ( $n=12$ ) regularly undertake additional exercise. Further research is required to determine the specific physiological demands of horse racing during competition. This will provide a better understanding of the specific exercise training required to meet the stipulated competition riding weight and optimise performance. **References** Trowbridge E, Cotterill J, Crofts C. (1995). *Eur J Appl Physiol*. 70: 66-69.

## EFFECTS OF UPPER LIMB SWING ON THE LOWER LIMB MULTI-JOINT MOVEMENT

Yamauchi, J.1,2, Kobayashi, M.1

1: *Tokyo Metropolitan University*, 2: *Future Institute for Sport Sciences*

**[Introduction]** Many activities are performed using both upper and lower limbs in multi-dimensional movements. The integration of muscle activities in the extremities with those in trunk muscles is often required for activities of everyday life and better performance in sports. However, despite requiring the integrity of extremities in daily activity, there are only few researches on the study of the integration of extremities on the muscle force generating capacity in the dynamic movement. The present study investigated the effects of upper limb swing on the dynamic lower limb multi-joint movement. **[Method]** Twenty-one healthy young subjects (men=10, women=11; age,  $21.5 \pm 2.4$  year; height,  $165.5 \pm 8.1$ cm; body weight,  $58.6 \pm 10.7$ kg; mean $\pm$ SD) performed the knee-hip extension movement of one leg at their maximal effort on ergometer with an electromagnetic load control. Measurements were repeated three times with at least one-minute rest period between bouts, and the highest value among the measurements was used. Then, subjects performed the dynamic knee-hip extension movements with or without upper limb swing on the ergometer. During the dynamic movements, knee-hip extension movement velocity and foot pressure were measured with speedometer and pressure sensor mat, respectively. Subjects first performed a few submaximum efforts to familiarize themselves with the measurements, and then measurements were repeated five times with at least one-minute rest period between bouts and the highest value among the measurements was used. **[Result and Discussion]** The foot pressure during the dynamic knee-hip extension movements with and without upper limb swing was both average 80% of MVC and was not significantly different between two conditions. The movement velocity during the dynamic knee-hip extension movements tended to be faster in the leg movement with upper limb swing as compared to the movement without upper limb swing, but was not significantly different between two conditions. When men and women were separately analyzed, the movement velocity in men was significantly ( $p < 0.05$ ) faster in the leg movement with upper limb swing as compared to the movement without upper limb swing. The results indicate that because the knee-hip extension movements with upper limb swing changes leg movement velocity, the upper limb swing during the dynamic lower limb multi-joint movement interacts with force generating mechanism of lower limb.

## MUSCLE STRENGTH AND FUNCTIONAL CAPACITY IN PATIENTS WITH PARKINSON'S DISEASE

Paulista, H., Santos, T., Fonseca, R., Homem, R., Cruz, L., Santos, P., Moraes Filho, A., Silva, M., Oliveira, R.

*University of Brasilia*

**Introduction** Parkinson Disease (PD) is a progressive neurodegenerative condition related to decrease in muscular strength. The aim of this study was to correlate leg muscular strength with functional performance tests in patient with PD. **Methods** The sample was composed by 14 patients with PD from outpatient Parkinson's Hospital de Base and the Parkinson's Association members at Brasilia, Brazil, predominantly classified in stage 2.0 of Hohen & Yahr scale (mean and SD:  $63.5$  SD  $1.8$  years;  $1.69$  SD  $0.06$  m;  $74.7$  SD  $13$  kg;  $26.6$  SD  $4$  kg/m<sup>2</sup>). Muscle strength was measured by isokinetic knee extension (Biodex System 3) at  $90^\circ$  per second speed. Functional capacity was assessed by the Timed Up and Go Test (TUG). Statistical analysis was performed by Spearman correlation through BioEstat 5.0. **Results**

The Peak Torque (PT) was 143.25 SD 42.77 N/min., resulting in a relative torque (RT) of 196.12 SD 44.32% of body weight. The time needed for the TUG was 7:00 SD 1:54 seconds. PT was not correlated with TUG ( $p = 0.3137$ ), but it was possible to observe the correlation between RT and TUG ( $p = 0.0128$ ). Discussion The relative muscular strength of lower limbs was correlated with functional capacity, confirming the findings of Schilling et al. (2009). This result suggests that functional performance gains may depend on relative muscular strength increase as what was previously described by Sousa and Sampaio (2005). References Sousa N, Sampaio J. (2005). *Am J Hum Biol*, 17, 746–751. Schilling B, Karlage R, LeDoux M, Pfeiffer R, Weiss L, Falvo M. (2009). *Park Rel Dis*, 15, 776–780.

### FIVE DAYS SLEEP SHORTAGE ALTERED PHYSICAL FUNCTIONS

Kubota, C.1, Shioda, K.1, Morita, Y.1, Kojima, T.1, Sumitomo, J.1, Ganeko, M.1, Uchida, S.2

*Waseda University*

Introduction: Sleep loss has become an increasingly important issue in health science. Similarly in competitive sports, athletes sometimes cannot ensure enough sleep when they participate in a competition. A cause of sleep loss in athletes varies, from early morning workouts to jet-lag syndrome in international athletes. Sports-related activities need both physical and cognitive abilities. It has been studied that sleep shortage deteriorates cognitive performances. For sleep shortage situations, it is a concern that whether sleep shortage results in poor physical and cognitive performances. This study focuses on physical and vigilance performance to investigate how sleep shortage (SS) affects physical functions. Methods: Subjects were six healthy young students. They underwent two conditions (regular sleep condition: RSC, sleep deprivation condition: SDC). In order to measure regular sleep length, subjects wore wrist actigraphy for 14 days. After a regular sleep night, subjects slept five sleep shortage nights. In the SDC, sleep was shortened to 50% of regular sleep length for each subject. Exercise performances (EX) (aerobic capacity: VO<sub>2</sub>, VCO<sub>2</sub>, RER, VE, RPE during 5min pedaling exercise of a moderate intensity, anaerobic capacity: peak power during 7s maximum pedaling) and Psychomotor Vigilance Test (PVT) were examined on two conditions. EX was examined at 18:00 of the 1st, 3rd, 5th day, and PVT was examined at 9:00 and 17:00 every day. Standard PSG was performed on the regular sleep night and 1st, 3rd, 5th shortened sleep nights. Result: There were no significant differences in exercise performances. While PVT was impaired after three SS nights. Frequency analysis revealed that total delta density increased on the 3rd and 5th night ( $p < 0.05$ ). High frequency (25–40Hz) total power increased on 1st SS night. Moreover, rapid eye movement (REM) density increased on 1st SS night ( $p < 0.05$ ) and total number of REM tended to increase on 1st SS night ( $p = 0.057$ ). Conclusion: The present results suggested that five days of shortened sleep did not affect exercise performances. This may be because these experimentally measured physical performances are not much affected by sleep shortage. While PVT was impaired after three days of SS. Thus, increased delta recovery did not compensate after three nights. Increased high frequency (25–40Hz) total power could be related to increased REM, since high frequency (25–40Hz) total power and REM density and/or total number of REM increased on 1st SS night.

**13:45 - 14:45**

## Poster presentations

### PP-BN12 Sport Biomechanics 7 : Gait & Balance

#### MOTOR VARIABILITY AND ABILITY TO ADAPT IN BALANCE TASKS

Caballero, C.

*Miguel Hernández University*

Introduction Several works suggest that the complexity shown in the biological signal may be related to the system's ability to adapt to perturbation (Manor et al., 2010) but there is controversy about complexity results, performance and learning. The aim of our study is to analyze the relationship between movement complexity, performance and ability to adapt in a standing balance task. Methods Twenty-one volunteers took part in this study (Age  $27.82 \pm 7.03$  years; Height  $1.74 \pm 0.09$  m; Mass  $67.53 \pm 10.33$  Kg). Participants were asked to stand still (30s) both on a stable surface and on an unstable surface over a force platform. Eleven participants performed 10 trials on the unstable surface. Ten participants served as control group. Both groups performed a posttest. Dynamics of the center of pressure (COP) were measured through Sample Entropy (SampEn) and Detrended Fluctuation Analysis (DFA). Ability to adapt was measured as the change in performance (inverse of the standard deviation of COP) from stable to unstable condition and from pretest to posttest. Results In the stable condition, the correlation between performance and SampEn is positive ( $r = .709$ ;  $p < .01$ ). However, under the unstable condition, this relationship is negative ( $r = -.555$ ;  $p < .01$ ). In the stable condition, better ability to adapt is associated with greater SampEn ( $r = .708$ ;  $p < .05$ ). Ability to adapt is related to lower SampEn ( $r = -.844$ ;  $p < .01$ ), in the unstable condition. The DFA auto-correlation values are associated with the performance ( $r = .654$ ;  $p < .01$ ) and ability to adapt ( $r = .844$ ;  $p < .01$ ), as these are more persistent, which comes close to  $\alpha = 1$ . Discussion In the stable condition, a greater complexity in COP fluctuation is associated with a better performance and ability to adapt (Manor et al. 2010). In the unstable situation we have found an inverse correlation. These differences in the complexity of a behavioral system are found dependent on the nature of both the intrinsic dynamics of the system and the task demands (Vaillancourt & Newell, 2002). On the other hand, better performance and the ability to adapt are associated with DFA values close to 1. Goldberger et al. (2002) suggest that increased irregularity (SampEn) does not imply increased physiologic complexity. References Goldberger, AL, Peng, CK & Lipsitz, LA (2002) What is physiologic complexity and how does it change with aging and disease? *Neurobiology of Aging*, 23, 23–26. Manor, B, Costa, MD, Hu, K, Newton, Starobinets, E, Kang, HG, Peng, CK, Novak, V & Lipsitz, LA (2010). Physiological complexity and system adaptability: evidence from postural control dynamics of older adults. *J Appl Physiol*, 109, 1786–1791. Vaillancourt, DE & Newell, KM (2002) Changing complexity in human behavior and physiology through aging and disease. *Neurobiology of Aging*, 23, 1–11.

## THE EFFECTS OF THE FELDENKRAIS METHOD ON MUSICIAN POSTURE

Forte, C.

*Forte Feldenkrais Training*

**Introduction** The Feldenkrais Method® is an activity based on the awareness through movement and recently has become very popular in the world. It is known that 15% of orchestral musicians frequently suffer of back and joint pain because of many hours engaged to study and play their instruments (Knishkowsky, 1986; Fishbein et al., 1988). The aim of our study was to examine whether the Feldenkrais Method can be used for treating the back pain in orchestral musicians and improving their performance and life quality. Methods Seventeen musicians were divided into two groups. One group, called Control, was composed by 8 participants (5 men and 3 women with  $34.63 \pm 4.81$  years,  $71.56 \pm 13.3$  kg weight and  $169.93 \pm 10.51$  cm height; BMI:  $24.78 \pm 3.2$ ) and did not participate to the treatment. The other group, called Feldenkrais, was composed by 9 participants (5 men and 3 women with  $34.78 \pm 8.50$  years,  $69.56 \pm 12.45$  kg weight and  $168.92 \pm 9.72$  cm height; BMI:  $24.38 \pm 2.4$ ) and were recruited to participate in a 4 sessions of Awareness Through Movement (CAM®) for 2 hours per week under the guide of the same teacher for all length of treatment period. This protocol consisted of movements of the pelvis, head, shoulders and eyes in sitting and in supine position coordinated to their breath. Before and after 4 weeks, Control and Feldenkrais groups were evaluated with sit and reach test, trunk lift and eye convergence test. In addition, we measured height in upright and sit position, shoulder symmetry in both groups. We used the visual rating scale (VRS) to select participants with a frequency of back pain ranging from 'occasionally' to 'always'. Significant differences ( $p < 0.05$ ) within group were analyzed with Wilcoxon Test, whereas differences between the two groups with Mann-Whitney Test. Results After 4 weeks of treatment, we found a significant increase in the upright position height and a significant decrease in eye convergence in the Feldenkrais group. Moreover, Feldenkrais group showed an increase in range of motion of spine compared with Control group. We did not observe any improvement in the Control group. These changes were associated with a bigger number of participants who showed a significant reduction of back pain frequency ( $p < 0.05$ ). Discussion The Feldenkrais Method® has positive effects in the treatment of the back pain in the orchestral musicians through an improvement of spine flexibility and the eye movement during and after the artistic performance. References Fishbein M, Middlestadt SE, Ottati V, Straus S, Ellis A (1988). *Med Probl Perform*, 3, 1-8. Knishkowsky B, Lederman RJ (1986) *Med Probl Perform*, 1, 85-89.

## CHANGES IN POSTURAL MOVEMENTS AND MUSCLE ACTIVITY FOLLOWING THE LONG-TERM USE OF UNSTABLE SHOES

Uchida, Y.1, Ohbu, T.1,2, Iwata, H.1, Hazama, Y.2, Kanosue, K.1

*1: Waseda university (Saitama, Japan), 2: EVERNEW Inc. (Tokyo, Japan)*

**[Introduction]** It is important to maintain an appropriate upright standing posture in order to perform diverse movements. The stability of a natural standing has generally been considered as an index of ability in postural control. Masai Barefoot Technology Shoes (MBT®) have been developed to promote muscle activity by creating an unstable foot condition with the aims of training static and dynamic posture and postural control. This study examined changes in postural movements and lower-limb muscle activity following the long-term use of MBT. **[Methods]** Fourteen non-MBT users participated in this study. They wore MBT for three months. Experiments were done 4 times, just before the start of wearing MBT and 1, 2, and 3 months after the start. In total 27 markers were attached to the body surface for 3 dimensional analysis of body movements. Electromyograms (EMGs) were recorded with surface electrodes from 8 muscles (RF, VM, BF, TA, PL, GM, GL, and SOL). Subjects were instructed to maintain a natural standing position for 60 seconds per measurement under 2 different foot conditions: 1) barefoot and 2) wearing MBT. Head movement was analyzed based on the position of a marker attached to the parietal in both vertical and horizontal directions using EVaRT 5.0. Center of pressure excursion was also recorded using a force plate. EMG values were normalized with those of the MVC after full-rectification. **[Results]** The data obtained under the two conditions were compared, focusing on time-dependent changes in postural movements in the period of MBT usage. While no changes were observed in the head movements in both vertical or horizontal directions through the 3 month period under the barefoot condition, a significant increase in head movements was observed in both directions after 3 months under the MBT condition ( $p < 0.05$ ). A significant difference was observed in head movement in both directions after 0, 1, and 2 months ( $p < 0.05$ ). The EMG activities of the RF and BF significantly increased at 3 months under the MBT condition ( $p < 0.05$ ). In contrast, under the barefoot condition, no time-dependent changes in EMGs of any muscles were observed. Such a barefoot-MBT difference in EMG activities increased with the time-dependent changes in postural movements. **[Discussion]** An important role of MBT is promoting muscle activities even at standing position through inevitable or voluntary sway that would activate postural maintenance mechanism. The time-dependent increase in postural movements may indicate that the subjects adapted to the structure of MBT and developed the MBT-specific postural maintenance movements. The consequent increase in muscle activity suggests that the postural maintenance function is improved through the long-term use of MBT.

## BALANCE REACTIONS OF FEMALE BASKETBALL PLAYERS AFTER PERTURBATION IN THE SAGITAL PLANE

Ramazanoglu, N., Tatar, Y., Sayli, O., Uzun, S., Camliguney, F., Cotuk, B.

*Marmara University*

The female basketball players studied were reported to suffer a significantly greater number of knee and ankle injuries than male basketball players. During team sport activities, planned change of movement direction allow the athlete to anticipate, which allow these postural adjustments to be made much more easily. However, in the case of unpredictable postural perturbations or cutting movements, postural adjustments are harder to make, which affects loading of the lower limb joints and muscles, and causes balance loss. Objective: To investigate displacement of center of foot pressure (COF), recovery time and leg muscle activity pattern after perturbation in the knee joint and to compare female basketball players with sedentary subjects. Method: Twenty six young female students: 11 elite basketball players (age=  $17.55 \pm 0.52$  years, height= $178.36 \pm 5.90$  cm, weight= $67.14 \pm 5.86$  kg) with at least 3 training years and 15 sedentary subjects (age= $17.47 \pm 0.64$ , height= $159.53 \pm 5.68$  cm, weight= $61.93 \pm 12.04$  kg) were included in the study. Vertical jump was used to measure leg muscle strength. Assessment of balance was measured with Matscan (Tekscan, Boston, MA). The following balance tests were utilized: two feet eyes opened (EO), eyes closed (EC), right foot EO, and left foot EO both unperturbed and perturbed conditions. 13 N force was applied in the sagittal plane (anterior- posterior (A/P) direction) to the knee joint in order to produce balance loss during perturbation. Surface EMG (DELYSIS) measurements were taken from the quadriceps femoris, biceps femoris and tibialis anterior and gastrocnemius muscle to examine the order of muscle activation during unanticipated perturbation. Results: Female basketball players legs were stronger than sedentary students ( $p < 0.01$ ). No differences were found for COF in both perturbed and unperturbed condition for two feet eyes opened (EO), eyes closed (EC), right foot EO, and left foot EO between female athletes and sedentary subjects. However, there

were significant differences in terms of recovery time after perturbation (A/P direction) for two feet eyes opened (EO), eyes closed (EC), right foot EO, and left foot EO between the groups. Although female basketball players had longer height, athlete's recovery time was shorter than their sedentary peers ( $p < 0.05$ ). There was no difference in EMG muscle activation pattern for leg muscles between two groups during two feet OE. Discussion: Short recovery time may be important in providing early defense against loss of balance during unanticipated perturbation in the game. Unexpected perturbation training facilities should be addressed as part of the player's individualized program to improve postural balance.

### COORDINATION OF UPPER AND LOWER EXTREMITIES MOVEMENTS DURING THE GAIT OF WOMEN

Kalichova, M., Novotny, M., Korvas, P., Lukásek, M.

*Faculty of Sports Studies, Masaryk University, Brno*

**Introduction** Human gait is one of the basic human movement used to change place in the space. The aim of this study is to analyze the most important temporal and velocity parameters determining the movement of lower and upper limbs. Our purpose is to compare interindividually the coordination of these movements by evaluating these observed parameters of each proband. This research was implemented within the framework of the project 'Creating a research team for the purpose of determining the level of physical activity (inactivity) in selected age groups of the population of men and women in the Czech Republic' (CZ.1.07/2.3.00/20.0044). The project is financed by the European Social Fund and the state budget of the Czech Republic. **Methods** We did a 3D kinematical analysis of gait. For scanning the picture we used two high-frequency synchronized digital cameras SIMI MOTION Version 7. The gait cycle was performed by 16 women at the age of 20 – 45. On the basis of 3D kinematical analysis the characteristics of key phases of the gait cycle were evaluated. Results Walking speed was 1.2 m·s<sup>-1</sup> on average and the step duration 0.574 s on average. Swinging movement of arm took less, 0.508 s on average. We were mainly interested in speed parameters of ankles and wrists. The ankle speed oscillated between 0 m·s<sup>-1</sup> and 4.355 m·s<sup>-1</sup>, the average value of ankle speed of all probands was 1.805 m·s<sup>-1</sup>. The wrist speed ranged from 0.061 m·s<sup>-1</sup> to 3.790 m·s<sup>-1</sup>. **Discussion** The motion of the upper limbs is considered as a facultative component of human gait to reduce the energy cost of walking (Umberger, 2008). During human walking, arms normally swing in opposition to legs, which helps balance angular momentum generated in the lower body (Park, 2008). We observed temporal coordination of swinging phase of upper and lower limbs. The arm swing back ended a little bit earlier than the ipsilateral heel contacted the floor while the contralateral arm stopped its swing forward at the time of the initial contact of the heel with the floor. The chronology of moments at which the ankles and the wrists reached their maximum speed was the next observed parameter of limbs movement coordination. Every attempt showed that the minimum speed of the standing ankle and the contralateral wrist is reached approximately at the same moment. This temporal coordination wasn't proved in reaching the maximum speed of the lower and upper limb. The maximum speed of the swinging ankle is reached later than the maximum speed of the contralateral wrist swinging forward. **References** Park J (2008) Synthesis of natural arm swing motion in human bipedal walking. *J Biomech* 41:1417–1426 Umberger BR (2008) Effects of suppressing arm swing on kinematics, kinetics, and energetics of human walking. *J Biomech* 41:2575– 2580

### KINEMATICAL ANALYSIS OF GAIT

Lukásek, M., Kalichová, M., Novotný, M.

*Faculty of Sport studies, Masaryk University*

**Introduction** In nature is human walking unique and we can not find it in the same form in any other animal. Human gait and its details are individual. Minor differences in gait pattern may vary not only between different individuals, but may vary for a given individual in time. These facts complicate the definition of a standard 'normal' gait pattern. Nevertheless, based on the principle of cyclic walking its pattern is described, which deals with the description of one cycle (Ellis, 2005). Knowledge of the physiological characteristics of walking is necessary for a confrontation with pathological gait. Creating a population gait model is important for to assess the possibility of pathological gait and also can help to determine the causes of injury or wear skeletal muscle system. Results of work can help to prevent injury and also can be used in rehabilitation or orthopedics. **Methods** We used a 3D kinematical analysis of basic human walk. The research group consisted of 16 woman (age 20 – 45 years). For scanning the picture we used two high-frequency synchronized digital cameras SIMI MOTION Version 7. We evaluated kinematical characteristics of 13 body points that were in the performance marked with retro reflexive balls. Center of gravity was made by model of Gubitz. Most authors agree on the basic allocation step cycle into two phases. Stance phase is described as part of the step cycle when the foot is in contact with the ground. Swing phase is part of the step cycle when the foot is in the air (Rose and Gamble, 1994). On this basis, we follow the kinematic characteristics of body segments in each phase and at the moment of take-off and impact of the foot: center of gravity movement (horizontal, vertical), step length in relation to height, angle in the knee, ankle and elbow, comparison between left and right part of body, extremes and averages of flexion and extension, synchronization – the correlation between the angles dissenting limbs. Results We selected just one of the monitored parameters. The mean flexion in the joint of knee during impact – 161,5° on the right foot (min. 153,2°; max. 164,3°) and 157,6° (min. 148,9°; max. 163,1°) on the left foot. **Discussion** It is assumed that the whole movement is the reset of pre-prepared lunch of central motor program that is encoded in memory neural network. (Králíček, 1995). Our research has primarily descriptive character and serves as a pilot project of more comprehensive study of komplex gait analysis. On a small sample of respondents verify, if our procedure is correct. The aim of this work was based on a kinematic parameters and describe the gait pattern in a selected group of people without difficulty of neuro muscular and skeletal system. **References** Ellis, W. (2004). Gait analysis after amputation. Retrieved 12. 2. 2006 from the World Wide Web: <http://www.emedicine.com/orthoped/topic633.htm>. Králíček, P. (1995). Úvod do speciální neurofyziologie. Praha: Karolinum, ISBN 8024603500. Rose, J. & Gamble, J. G. (1994). Human Walking. Baltimore: Williams & Wilkins, ISBN 068304605.

### CHANGES IN COUPLING ON REAR FOOT, SHANK AND THIGH IN THE DIFFERENT SPEEDS DURING HUMAN WALKING

Lee, B.K., Shin, J.M.

*SangMyung UI Cheonan, S Korea*

**Introduction** Rear foot is contacted on the ground directly due to position the last lower extremities. Rear foot transfers the force which produced by contacting on ground to shank and thigh. In the processing transfer to force to upper segments, rear foot, shank and thigh are generated coupling. Therefore, the aim of this study was to analyse the changes of coupling on rear foot, shank, and thigh using vector coding technique. **Method** Subjects were selected 10 healthy college male students and 6 infra cameras were used for cinematograph. The walking speeds were determined fast (3.2 km/h), normal (4.0 km/h) and slow (4.8 km/h) speed. Coupling angles were by vector



coding technique (Chang, Van Emmerik & Hamill, 2008) of pronation/supination of rear foot and in/external rotation of shank and thigh. Changes of coupling were analyzed the amount of portion of in-phase and out-phase in the phase angle created by vector coding. Result There was no significance in the in-phase of pronation/supination of rear foot and in/external rotation of shank and hip each. There is significance in the out-phase of pronation/supination of rear foot and in/external rotation of hip. The out-phase portion in the fast walking was greater than normal and slow walking's in the rear foot ab/adduction and hip in/external rotation. The out-phase portion of rear foot ab/adduction and hip in/external rotation was greater than rear foot in/eversion and dorsi/plantar flexion's in the fast walking ( $p < .05$ ). Discussion Rear foot coupling appeared in the out-phase during support phase between ab/adduction of rear foot and in/external rotation of hip in the fast walking. Coupling of ab/adduction of rear foot and in/external rotation was more out-phased as walking speed was increased. This out-phase showed at the first half of support phase while in-phase appeared at the last half of it. Therefore hip extension and rear foot abduction were important feature producing out-phase during the first half of support phase between two segments. Reference Barton, C. J., Levinger, P., Menz, H.B., Webster, K.E., 2009. Kinematic gait characteristics associated with patellofemoral pain syndrome: a systematic review. *Gait Posture* 30, 405–416. Chang, R., Van Emmerik, R., Hamill, J., 2008. Quantifying rearfoot-forefoot coordination in human walking. *Journal of Biomechanics* 41, 3101–3105. Souza, T. R., Pinto, R. Z., Trede, R. G., Kirkwood, R. N., Fonseca, S. T., 2010. Temporal couplings between rearfoot-shank complex and hip joint during walking. *Clinical Biomechanics* 25, 745–748.

## **INFLUENCE OF A FOUR WEEK TREADMILL TRAINING TO IMPROVE POSTURAL CONTROL IN LOW BACK PAIN: A PILOT STUDY**

Schellendorfer, S., Stegen, C., Bauer, C., Kool, J.

*Zurich University of Applied Sciences*

Introduction Patients with lower back pain (LBP) are known to have reduced postural control (Dankaerts et al., 2009; Ruhe et al., 2011; Van Daele et al., 2009). Exercise and activity are an effective means of improving postural control (Henchoz and Kai-Lik 2008). The purpose of this study was to evaluate the influence of a treadmill-training on postural control and concurrent muscle activation. Methods 10 patients suffering from LBP were recruited. They received eight supervised treadmill training sessions (two times a week for four weeks) The following tasks were performed to measure balance and postural control before and after the training intervention: 1) narrow stance 2) tandem stance 3) one-leg stance 4) narrow stance on block of 9cm width 5) a dynamic balance test on the MFT® S3-check balance board The tests lasted 50 seconds and were performed barefoot and with eyes open and closed. 3D kinematics of the whole body, the centre of pressure (COP) and muscle activation of back muscles were recorded and analysed. Results Training resulted in no significant changes in the range of the COP excursion and in the angular range of motion, mean velocity and peak velocity in the pelvis-, hip-, thorax- and ankle-segments. Changes in kinematic variables and muscular activity were very heterogeneous. Variable movement strategies with different combinations of movement and muscular activity were observed. Challenging postural control tests such as standing on a block with eyes closed, one leg stance on a flat surface with eyes open and the MFT® S3-check balance board were useful assessment tests because they provoked some postural control movement and/or activation of the back muscles. The other tests were either too easy, with no movement provocation, or too challenging, so that they couldn't be performed by all the patients. Discussion The large variability in movement strategies and responses to the training-intervention observed in this study is considered to be the main cause for the non-significant results. Dynamic and challenging balance tests seem to be more meaningful than static tests. Focussing on pre-defined subgroups may be a more promising approach. Future research should identify subgroups of patients with LBP with different postural control strategies. These results support the statement of Dankaerts et al. (2009) who underline the importance of the need to identify and use subgroups in clinical research. References Dankaerts W., O'Sullivan P., Burnett A., Straker L., Davey P., Gupta R. (2009). *Spine* 34(15): 1610-1618 Henchoz Y. and Kai-Lik So A. (2008). *Joint Bone Spine* 75(5): 533-539. Ruhe A., Fejer R., Walker B. (2011). *Eur Spine J* 20(3): 358-368. Van Daele U., Hagman F., Truijen S., Vorlat P., Van Gheluwe B., Vaes P. (2009). *Spine* 34(11): 1233-1238.

## **SIMPLIFIED PLANAR KINEMATIC CHAIN MODEL OF INITIAL START PHASES IN LUGING**

Fedotova, V.1, Pilipiv, V.2

*1: Riga Technical University (Riga, Latvia), 2: Latvian Olympic Team (Riga, Latvia)*

Introduction In the sport of luge the start plays an important role for an overall performance (Bruggemann et al., 1997). During the initial phases of the start, when an athlete is holding to the start handles, athlete's body and the sled are forming a closed kinematic chain. The aim of the present study was to develop and evaluate limitations of a planar kinematic chain model for two initial start phases in lugging. Methods The closed kinematic chain was modelled using SimMechanics(TM) computer modelling environment. Kinematic drivers for the model were obtained from motion capture data (Yeadon and King, 2008); motion capture performed with 3 high-speed cameras at 100 fps using Simi Motion software. Segment inertia parameters estimated as in (de Leva, 1996; Zatsiorsky et al., 1990). Results 4-, 5-, 6- (without leg segments) and 7-segment (with leg segments) models were developed. Testing of the models had shown that modelling the torso with one segment (4-segments model) is inappropriate for the selected movements. A model with two-segment torso gave a more realistic representation of the athlete's performance. It was possible to simulate the movement adequately without hand and foot segments (5- and 7-segment models), however, adding the hand segment (6-segment model) improved the simulation. Discussion During the initial start phases in the sport of luge movement of legs and arms is essentially three-dimensional; therefore modelling in-plane is an expected simplification. Nevertheless, the developed models can simulate the movement realistically in one plane. From the practical application perspective the planar models can be used as a first step in more sophisticated 3D modelling of the start phase in lugging. As standalone models they can be used as a visualization tool in movement optimization procedure. The developed models are purely kinematically driven, as no force data was available to use as drivers. Deriving kinetic data from movement simulation is theoretically possible, but validation of the results is challenging as long as no reference measurements are available. References Bruggemann GP, Morlock M, Zatsiorsky VM. (1997). *J Appl Biomech*, 13, 98-108. de Leva. (1996). *J Biomech*, 29(9), 1223-1230. Yeadon MR, King MA. (2008). Biomechanical evaluation of movement in sport and exercise, 176-205. Routledge, Abingdon. Zatsiorsky V, Seluyanov V, Chugunova L. (1990). *Biomechanics of Human Movement: Applications in Rehabilitation, Sports and Ergonomics*, 186-202. Bertec, Ohio.

13:45 - 14:45

## Poster presentations

## PP-BN13 Motor Learning 2

**KINEMATICS AND MOVEMENT VARIABILITY RELATED TO SERVICE PERFORMANCE IN YOUNG TENNIS PLAYERS**

Urbán, T., Hernández-Davó, H., Moreno, F.J.

*Universidad Miguel Hernández*

**Introduction** Recent studies have focused on analyzing kinematics related to performance in precision skills and in tennis service in particular (Reid, Whiteside & Elliott, 2011). Regarding kinematics variability, some studies have analyzed this topic in sport skills (Wagner, et al. 2011). Nevertheless, few researches have addressed this problem in tennis shots. The aim of this study is to analyze the relationship between kinematic variables, movement variability and performance of the tennis service in young players. **Methods** Twenty-nine young intermediate level tennis players (20 male, 9 female) (age  $12.9 \pm 1.64$ ) took part in the study. All participants carried out twenty services towards a target located on the service box. Kinematic variables from the dominant hand, arm, hip and the non-dominant hand were collected (Polhemus Liberty 240Hz update rate). Ball speed (RS3600 radar) and radial error of ball bounces (video digitized) were recorded to assess service performance. Correlation analysis was carried out to analyze the relationship between kinematics, variability and performance. **Results** Range of motion in the three axis correlated with higher velocity of the ball ( $r = .491$ ;  $p=0.007$ ; X axis, ( $r = .484$ ;  $p=0.008$ ; Y axis), ( $r = .608$ ;  $p<0.001$ ; Z axis). Right arm, hip and left hand position in Y axis also correlated with higher velocity values ( $r = .635$ ;  $p<0.001$ ;  $r = .517$ ;  $p=0.004$ ;  $r = .420$ ;  $p=0.023$ , respectively). Ball velocity correlated negatively with variability of the hand in the X and Z axis at the beginning of the movement ( $r = -.417$ ;  $p=0.024$ ;  $r = -.529$ ;  $p=0.003$  respectively). Radial error correlated with standard deviation of movement velocity of the hand during middle of the movement in the Y axis ( $r = .432$ ;  $p=0.019$ ) and the Z axis ( $r = .466$ ;  $p=0.011$ ). **Discussion** Higher range of motion and forward displacement of the dominant arm, hip and non-dominant hand has proved effective to increase the velocity of services. The variability of the movement affects the velocity of services only when this variability is observed at the beginning of the movement. Regarding service accuracy, the variability of the movement in the Y and Z axis reduces performance only if this variability is showed at the beginning or in the middle of the service movement. **References** Reid, M., Whiteside, D., & Elliott, B. (2011): Serving to different locations: set-up, toss, and racket kinematics of the professional tennis serve. *Sports Biomechanics*, 10:4, 407-414. Wagner, H., Pfusterschmied, J., Klous, M., von Duvillard, S., & Müller, E. (2011). Movement variability and skill level of various throwing techniques. *Human Movement Science*, 10, 31(1):78-90.

**EFFECTS OF INCREASED VARIABILITY ON MOTOR LEARNING OF THE SHORT SERVE IN RECREATIONAL AND COMPETITIVE BADMINTON PLAYERS**

Jaitner, T., Schinz, F.

*TU Dortmund University, University of Kaiserslautern*

**Introduction** In recent years, a growing focus of motor learning research has been put on variability of practise. Based on the coordination dynamics theory variations are no more restricted on movement parameters as proposed by the Schema theory (Schmidt, 1975), but also extended to movement structures. As example, the differential learning approach tries to utilize the fluctuations and voluntarily variations in human motor behavior to induce a self-organising process to the athlete which takes advantage of individual movement and learning characteristics. Especially for goal directed movement, increasing the amount of variation to such an extent that no exercise is repeated during the learning process results in superior performance than repeating the same movement many times during acquisition (Frank et al, 2008). The purpose of this study was to investigate effects of differential learning on the short Badminton serve. **Methods** 51 Badminton players of two different levels of expertise (recreational vs. competitive players on regional/national level) participated in a learning experiment with 8 practice sessions. Subjects were divided into a differential (DT) and a traditional (TT) training group. The TT group started with basic exercises and increased complexity systematically during the experiment. Each exercise was repeated extensively, and feedback was given by demand. For the DT group variations with increasing complexity were implemented in a way that neither exercise was repeated, and no feedback on performance was given. In pretest, posttest and retention test two weeks after the posttest each participant performed 40 serves from two positions on a regular badminton court. All serves must be placed in the service area as closed as possible to the front and centre line. Net clearance and landing position of the shuttle were filmed and then rated on a ten point scale. A performance index was calculated as mean of both scores. Mann-Whitney-U-test was applied to analyze the performance of the subjects that completed all tests. **Results and discussion** The recreational as well as the competitive DT group improved performance from pretest to posttest significant, whereas as both TT groups showed no effect. From posttest and retention test the recreational players of the DT as well as of the DT decreased their performance significant. No effect was found for the competitive players. Therefore, a positive learning effect can only be stated for variable practise following the differential learning approach. Contrary to Frank et al. (2008) a further increase after the acquisition phase can not be observed in this study. Moreover, it can be assumed that only Badminton players on a higher level of expertise are able to maintain their level of performance during the retention phase. **References** Frank, T.D., Michelbrink, M., Beckmann, H. & Schöllhorn, W. I. (2008). *Biological Cybernetics*, 98, (1), 19-31. Schmidt, R.A., (1975) *Psychological Review* 82, 225-260.

**HANDEDNESS, FOOTEDNESS AND SKI-SIDE DOMINANCE IN ELITE CROSS-COUNTRY SKIERS**

Hébert-Losier, K.I, Holmberg, H.C.I, Stöggl, T.I,2

*Mid Sweden University, University of Salzburg*

**Introduction** Laterality in sports is researched in motor learning, injury prevention, and biomechanics. Handedness and footedness in sports is commonly addressed in isolation, and investigates tasks that are predominantly upper (baseball) or lower (soccer) body dependent. In contrast, cross-country skiing (XCS) is a whole-body exercise that relies on arms and legs. Although asymmetric techniques are used in XCS, and side preferences are observed; little research has explored lateralization in skiers. Thus, the aim was to investigate if handedness and footedness correlated with ski-side preference. **Methods** Eleven male elite XC skiers ( $28 \pm 5$  yrs) completed a standard

handedness (n=12 items), footedness (n=10 items), and ski-side dominance (n=11 items) questionnaire. Each item could be answered right, left, or either based on the side that was habitually used to perform a given task (i.e. write, kick a ball, preferred ski-curve). Each response was entered into a contingency table and measures of associations were expressed using correlation coefficients. Significance level was  $P < .05$ . Results Six of the 11 items on ski-side dominance were correlated to handedness or footedness items (all  $P < .05$ ), but no ski-side item correlated with hand/foot items simultaneously. The dominant side in steep uphill skating (V1) was associated with 3 handedness items ( $r = .63$ ). Using V1 at 15k race velocity, the dominant side was correlated to 9 of the 12 handedness items ( $r = .65$ ). At peak velocity, the dominant V1 side correlated with the leg used to balance on one foot ( $r = .82$ ). The leg used to accept weight when standing, stand on one foot, and step onto a chair or push a shovel into the group correlated with the dominant kick leg in kick double poling, preferred curve direction at a high velocity, and leg pushed forward at the end of a sprint race ( $r = .69$  to  $.91$ ), respectively. Discussion XCS is biomechanically complex, and relies on upper and lower body. Certain ski techniques favor one side of the body, and some were correlated with the sides used in daily tasks. Certain associations between ski-side and hand/foot dominance were more intuitive than others. For instance, several hand items were correlated with the dominant side in V1. Foot items were correlated with the preferred kick leg in kick double poling, which presumably reflects the need for the skis to grip to the snow. Correlations changed with skiing velocities, suggesting that velocity is an important factor in lateralization. This was a first attempt to address laterality in skiers using validated handedness and footedness questions, in addition to a ski-specific questionnaire. Standard, valid, and reliable ski-side questions should be used in future research to increase the understanding of lateralization in humans.

### DYNAMICAL SYSTEMS THEORY IN THE GOLF PUTTING PERFORMANCE

Mendes, R.1, Dias, G.2, Couceiro, M.3, Figueiredo, C.3, Luz, M.3, Clemente, F.2, Martins, F.4, Mendes, P.2

1: ESEC (Coimbra-Portugal), CIPER (Lisboa – Portugal), 2: FCDEF (Coimbra – Portugal), 3: ROBOCORP (Coimbra – Portugal), 4: IT (Covilhã – Portugal)

**ABSTRACT** Introduction Embodied within Dynamical Systems Theory, this study aimed to determine if the manipulation of constraints on the performance of golf putting, in different conditions of practice variability (distance, slope and angle), resulted in intra and inter-individual significant differences in amplitude, velocity, acceleration and duration of this movement (i.e., process variables), confirming a dynamic interaction between the practitioner, the environment and the task. Methods The sample consisted of 10 male golfers, adults ( $33.8 \pm 11.89$  years), volunteers, righties and experts ( $10.82 \pm 5.4$  handicap). On the first study, 30 practice trials were performed at 1, 2, 3 and 4 meters away from the hole without any constraints. On the second study, 30 trials were performed at 2, 3 and 4 meters away from the hole with a constraint imposed by a ramp. On the third and last study, 30 trials were performed at 2 meters away from the hole with a constraint imposed by a ramp and an angle of 25 degrees to the left and right of it. Results The ANOVA one-way test was used to accomplish a statistical analysis of the data. Moreover, a nonlinear analysis of the data was carried out, which included the Fourier series to determine players' behaviors (trends) at the level of product measures (i.e., radial error), as well as the approximate entropy and Lyapunov exponent to verify the periodicity and regularity of players in the performance of the putting. Discussion Given the constraints imposed in the task, the results demonstrate that the contextual information perceived by players was essential in accomplishing this movement. The intra and inter-individual variability resulting from a motor performance shows a 'signature putting' that is unique to each performer. The existence of significant differences in the process and product measures is confirmed.

### THE PRACTICE OF FOOTBALL 7 SOCIETY IMPROVES FINE MOTOR SKILLS OF LOWER EXTREMITIES IN CHILDREN BETWEEN 10 AND 11 YEARS OF AGE

Stecklow, M.V.1,2, Souza, A.C.B.1, Oliveira, J.C.F.1, Silva, T.A.1

1: UNIAEBU (Belford Roxo, Brazil), 2: PEB-UFRJ (Rio de Janeiro, Brazil)

**Introduction** The fine motor skills can be defined as the ability to produce and control small gestures. Football 7 society (F7S) is a variation of football very practiced in large cities, and their training methods include physical, technique and tactics training. It has been shown that motor tasks, as football training, increase the activity in cortical neurons and improve motor performance of lower extremities (Perez et al., 2004), but there are no studies on the effects of football training in fine motor skills of lower extremities. Therefore, this work aims at statistically assessing changes in fine motor skills of feet from children that play F7S. **Methods** The casuistry was composed of 60 health children between 10 and 11 years old, being 30 systematic practicing F7S twice a week during 60 min, and 30 children who did physical nonspecific activities to compose a control group (CON). The subjects seated on a chair, knees flexed at 90°, with the sole of the feet at 10 cm from the ground and a marker pen fixed in first digital fovea of left and right feet. The task was to follow as precisely as possible the shape of a 100 mm<sup>2</sup> square sketched in a millimeter paper after F7S training session, without time limit and the drawing error in mm<sup>2</sup> was calculated. The Kolmogorov-Smirnov test ( $\alpha = 5\%$ ) did not indicate data normality. The Wilcoxon simple and paired tests were respectively applied at significance level of 5% to assess error differences between groups or lower extremity sides. Results The median of error were 276 mm<sup>2</sup> to left and 249 mm<sup>2</sup> to right extremity in F7S, and 807 mm<sup>2</sup> and 776 mm<sup>2</sup> to left and right of CON respectively. Although the errors were higher in left than right extremity, the paired Wilcoxon intragroup tests indicated no statistical differences between lower extremities, both to F7S ( $P$  value = 0.508) or CON ( $P$  value = 0.684). The simple Wilcoxon intergroup tests indicated less error of F7S than CON in left ( $P$  value = 0.003) and right ( $P$  value = 0.006). Discussion The results pointed out that subjects of F7S presented a shape reproduction error smaller than CON subjects. Although there are no similar studies to be compared with, such findings may indicate the benefits observed in lower limbs undergoing training as reports of Perez et al. (2004). Since the ability to accurately control the ball is an important characteristic of good football players, perhaps this ability evaluation can help in the selection of future sports talents. According to our findings, we conclude that the F7S training promotes improvement in fine motor skills of children between 10 and 11 years of age. References Perez MA, Lunngholt BKS, Nyborg K, Nielsen JB. (2004). Exp Brain Res, 159, 197-205.

### THE EFFECT OF CAFFEINE CONSUMPTION ON AROUSAL, ACTIVATION AND DART-THROWING PERFORMANCE AT DIFFERENT TIMES OF DAY

Ahmadi, P., Bhari, S.M., Azizi, M.

Share-Ray Branch, Islamic Azad University, Tehran, Iran

The Effect of Caffeine Consumption on Arousal, Activation and Dart-Throwing Performance at Different Times of Day 1Pezhman Ahmadi, 2Sydd Mohialdin Bhari, 3Mitra Azizi 1Department of Physical Education, Share-Ray Branch, Islamic Azad University, Tehran, Iran 2Department of Physical Education, Karaj Branch, Islamic Azad University, Karaj, Iran 3Department of Physical Education, Karaj Branch,

Islamic Azad University, Karaj, Iran Introduction It appears that many factors such as personal characteristics, time of day and medicines such as central nervous system stimulants may change the level of arousal and activation. The purpose of the present research was to study the effect of caffeine consumption on arousal, activation and dart-throwing performance at different times of day. Methods 24 volunteer participated in a randomized double-blind placebo-controlled repeated-measures crossover study and were studied for 6 weeks and 1 session per week in order to measuring arousal, activation and dart-throwing performance in the morning and evening. Results The results of repeated measures analysis of variance indicated that caffeine and placebo ingestion lead to increased arousal and activation but it does not affect dart-throwing performance. Further, time of day did not affect the results. Discussion The lack of a significant difference between caffeine and placebo conditions may be due to caffeine withdrawal effects. It can also be related to the psychological effects of placebo and caffeine (Schneider, 2006). Finally, the time limit can be pointed to placebo, because this effect tends to disappear in 20-30 minutes after taking a placebo (Adan, 2008). The results revealed that in comparison with control conditions, caffeine leads to increased SCL in the morning and evening. Fredholm showed that 250mg caffeine works by blocking adenosine receptors in the brain and other organs (Barry et al., 2008). It is natural that increased arousal due to caffeine leads to an increase in activation. However, greater increase in activation in comparison with arousal can be due to negative baseline SCL of some participants. Further, time of day did not affect the results. The reason could be related to the different effects of circadian rhythm on various components of performance. References Adan A, Prat G, Fabbri M, Sánchez-Turet M. (2008). Early effects of caffeinated and decaffeinated coffee on subjective state and gender differences. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 32, 1698–1703. Barry RJ, Clarke AR, Johnstone SJ. (2008). Timing of caffeine's impact on autonomic and central nervous system measures: Clarification of arousal effects. *Biological Psychology*, 77, 304–316. Fredholm BB. (1999). Actions of caffeine in the brain with special reference to factors that contribute to its widespread use. *Pharmacol Rev*, 51, 83- 133. Schneider R, Grüner M, Heiland A, Keller M, Kujanová Z, Peper M, Riegl M, Schmidt S, Volz P, Walach H. (2006). Effects of Expectation and Caffeine on Arousal, Well-Being, and Reaction Time.

### EFFECT OF DIFFERENCE IN SHOT ANGLE ON SET SHOT BEHAVIOR IN BASKETBALL

Nagata, N., Inomata, K.

*Chukyo University*

Introduction Movement patterns in a motor task become more consistent with the skill development. However, it is assumed that the difference of task condition affect the variable of movement patterns while skill is same. Especially, motor programming may not consistent in the conditions for the relatively less experiences; therefore the variable of the movement patterns could be increased. The main purpose of this study was to examine the effect of difference in shot angle on set shot behavior in the basketball at semi-expert level. Method Participants of this study were two male Japanese college basketball players (Participant A: 170cm, 22 years age, 12 years experiment of basketball, Left hand shooter, Guard position. Participant B: 172cm, 20 years age, 10 years experiment of basketball, Right hand shooter, Guard position). In this study, Shot made percentage was measured and shot hand movement was recorded by 2 digital cameras. Shot movement was analyzed by three dimensions motion analysis system. Participants were took 10 shots from two locations, which were arranged at Free throw distances (4m from the free throw line to basketball ring) at two angles (Front, Side). Between each trial, we set 1 minute as the rest interval. Results In the front angle, Shot made percentage was Participant A = 60% and Participant B = 70%. In the side angle, Shot made percentage was Participant A = 60% and Participant B = 60%. In addition, the standard deviation of shot movement on the side angle was increased rather than the front angle. Discussion These results suggested that the whole movement pattern has been adjusted while variability of each joint increased, therefore participants was able to shoot successfully. Preference Button, C., MacLeod, M., Sanders, R., and Coleman S. (2003) Examining movement variability in the basketball free-throw action at different skill levels. *Research Quarterly for Exercise and Sport*, 74, 257-269. Kudo, K., Tsutsui, S, Ishikura, T., Ito, T., & Yamamoto, Y. (2000) Compensatory coordination of release parameters in a throwing task. *Journal of Motor Behavior*, 32, 337-345.

### TENNIS SERVE TOSS VARIABILITY UNDER THE CONSTRAINT OF ARTIFICIAL CROSS WIND

Mendes, R.1, Mendes, P.C.2, Fuentes, J.P.2, Martins, F.4, Clemente, F.5, Figueiredo, C.6, Couceiro, M.S.6, Dias, G.5

1: ESEC (Coimbra - Portugal), CIPER (Lisboa - Portugal), 2: CIDAF (Coimbra - Portugal), 3: FCD - UEX (Cáceres - Spain), 4: IT (Covilhã - Portugal), 5: FCDEF (Coimbra -

Introduction This study proposed to analyze the variability and stability of the toss in the tennis serve, on the x (side-to-side), y (back-to-front) and z (vertical), with 12 experienced players under the influence of lateral wind (induced aerodynamic flow), produced by a removable industrial ventilator. Methods The sample comprised 12 tennis players who were asked to perform 100 serves at the maximum speed and accuracy towards an intersection point between the central and the service lines ("T" point). In the practical procedure, an electronic variator of 11 positions, SEW Eurodrive, and a telescopic elevator, GUIL ELC - 506, were coupled to the industrial ventilator, METEC - HCT - 45 - 4T. Five practical conditions were previewed: without ISF; ISF1 (2,4m/s); ISF2 (4,3m/s); ISF3 (5,8m/s) and; Random ISF (random series of the 3 speed values used in this study). The players were analyzed individually after serving the maximum speed and accuracy to the intersection point of the center line and service line (point 'T'). The three positions of the tennis toss; Initial, Peak and impact, were recorded using two digital cameras to allow a 3D analysis. Results The results allow to conclude that the experienced players tend to stabilize the vertical dimension of the serve (z axis). Additionally, this study confirms the invariance of the player height ratio: height of impact (1:1.5) in experienced players even when constrained by the 'artificial crosswind'. Discussion Given the above, the vertical dimension of the tennis serve is assumed as an invariant feature, which is guaranteed in the remaining varying spatial and temporal dimensions (y and x axes) of the launch serve (compensatory variability). Thus, the variability should be seen as part of the solution and not as something to be avoided by players and coaches.

### INDIVIDUAL AND ENVIRONMENTAL FACTORS IN CHILDHOOD MOTOR PERFORMANCE: THE NEWELL'S' MODEL APPROACH

Mourao-Carvalho, M., Silva, E., Ramalho, H., Pinto, G., Coelho, E.

*Universidade Trás-os-Montes e Alto Douro*

Introduction: Newell's model (1986) is an excellent approach to study motor behavior across the life span. According to this model, motor behavior emerges from an interaction of individual constraints (structural and functional), the environment (physical and sociocultural) and the task (goals, rules and instruments). Therefore the main aim of this study was to verify the interaction of biological and sociocultural variables in motor performance. Methods: A cross sectional survey was conducted with a 142 Brazilian children, from 6 -10 years old

(8.03±1.05). TGMD-2 was used to evaluate the gross motor skill development. BMI was calculated and the cutoff of Cole et al. (2000) was used to estimate obesity. Parents completed a written survey in order to get information about free time activities and socioeconomic status. T test was applied to compare motor competence between obese and non-obese children. GLM was used to verify the interaction between biological and sociocultural variables in motor performance. Results: Significant differences were found between obese and non-obese children on motor performance: locomotor ( $p=.007$ ), object control ( $p=.004$ ) and gross motor quotient ( $p=.002$ ). Age and play outside interacted with the three motor quotients, age with a negative effect and play with a positive. Sport interacted with a positive effect on locomotor ( $\beta=.222$ ;  $p=.035$ ) and gross motor quotient ( $\beta=.352$ ;  $p=.003$ ). Time watching TV and video-games interacted with a negative effect with object control ( $\beta=-.040$ ;  $p=.034$ ;  $\beta=-.089$ ;  $p=.015$ , respectively) and gross motor quotient ( $\beta=-.242$ ;  $p=.012$ ;  $\beta=-.475$ ;  $p=.010$ , respectively). Discussion: Analyzing the motor competence, according to the underlying Newell's model, the results identified an interaction between individual and environment variables in motor performance, mainly the age and time playing outside. They also highlight the role of physical activity and of inactivity rather than obesity. The results emphasize the importance of a holistic theoretical model, as well as, the use of multivariate statistical techniques to understand the dynamic and the complexity of motor behavior, which characterize the human being. References: Cole T, Bellizzi M, Flegal M, Dietz W, 2000. Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J*, 320, 1-6. Newell K. (1986). Constraints to the development of coordination. In Wade, M.G. & Whiting H.T.A. Motor development in children: Aspects of coordination and control: 341-360. Dordrecht, The Netherlands: Martinus Nijhoff. Ulrich DA. Test of gross motor development. 2<sup>nd</sup> ed. Austin: Pro-Ed; 2000.

## 13:45 - 14:45

### Poster presentations

#### PP-SH13 Psychology 4

##### **DO TEACHERS MATTER? INFLUENCE OF PERCEIVED TRANSFORMATIONAL TEACHING IN PHYSICAL EDUCATION ON STUDENTS' LEISURE TIME PHYSICAL ACTIVITY MOTIVATION AND BEHAVIOUR**

Spray, C.M., Manning, P.  
*Loughborough University*

Introduction Transformational leadership theory (Bass and Riggio, 2006) has recently been applied in the school physical education (PE) domain with the development of the Transformational Teaching Questionnaire (TTQ; Beauchamp et al., 2010). Beauchamp and colleagues provided support for the psychometric qualities of the TTQ and identified positive relationships between students' perceptions of transformational teaching and their sense of self-determination and experience of positive affect in PE classes. In line with theory and research into the potential transcontextual influence of the PE setting (Hagger and Chatzisarantis, 2007), this study examined relationships between perceived transformational teaching and adolescents' reported self-determination in leisure time physical activity (LTPA). Moreover, the utility of teaching perceptions in prospectively predicting reported physical activity behaviour was determined. Methods At time 1, students ( $N = 145$ ,  $M$  age = 13.25 years,  $SD = 1.88$ ) completed the TTQ and reported their reasons for engaging in LTPA. At time 2, students responded to two items assessing their involvement in LTPA over the previous four weeks. Results Hierarchical multiple regression analysis revealed that, at step 1, transformational teaching was a significant positive predictor of LTPA explaining 12% of variance. At step 2, a composite relative autonomy index was added to the model to represent students' (non) self-determined motivation for LTPA which explained a further 3% of variance. There was evidence of partial mediation of the relationship between perceptions of teaching and behaviour by relative autonomy. Discussion Current findings extend past work by establishing that adolescents' perceptions of transformational teaching in PE are associated with motivation and behaviour in the context of LTPA, providing support for the transcontextual model and the notion that teachers do matter. Future research should employ larger samples to tease out the effect of class average perceptions and supplement self-reports with objective measures of physical activity behaviour outside of school. References Bass, B. M., & Riggio, R. E. (2006). Transformational leadership. Mahwah, NJ: Erlbaum. Beauchamp, M. R., Barling, J., Li, Z., Morton, K. L., Keith, S. E., & Zumbo, B. D. (2010). *J of Health Psych*, 15(8), 1123-1134. Hagger, M. S., & Chatzisarantis, N. L. D. (2007). In M. S. Hagger & N. L. D. Chatzisarantis (Eds.), *Intrinsic motivation and self-determination in exercise and sport* (pp. 53-70). Champaign, IL: Human Kinetics.

##### **EXAMINING THE RELATIONSHIP OF FLOW EXPERIENCE AND ATHLETES' TRAIT CHARACTERISTICS**

Stavrou, N.A.1,2, Karakasidou, E.1, Psychountaki, M.1  
*National & Kapodistrian University of Athens*

Introduction Flow experience has been used in psychology in order to describe an intrinsically rewarding experience that athletes feel during high levels of performance. Flow is experienced by an athlete when the goals are clearly set, when he/she is completely and concentrated on the task at hand, feels a sense of control over his/her actions, perceives the task as self-rewarding, and his/her actions look effortlessly and automatically (Jackson, 1992). An important issue associated with the generation of flow is whether particular situational or personal characteristics facilitate the experience of flow (Kimiecik & Stein, 1992). Based on that, the purpose of the study is to examine whether athlete's trait general and competitive characteristics constitute significant predictors of flow experience. Methods Three hundred and fifty one (351) (mean age =  $M = 18.14$ ,  $SD = 5.37$ ) athletes participated in the study. In non-competitive situations, based on how they usually felt, the athletes completed the following instruments: (1) Dispositional Flow Scale-2, (2) Trait Anxiety Inventory, (3) Self-Esteem Scale, (4) Sport-Competition Anxiety Test, (5) Trait-Sport Confidence Inventory and (6) Competitive Worries Inventory. Results General trait anxiety indicated negative correlations with flow experience, as well as, competitive trait anxiety. On the other hand, significant positive correlations revealed between self-esteem ( $r_{mean} = .33$ ) and trait self-confidence ( $r_{mean} = .39$ ) with athletes' flow experience. Hierarchical regression analysis (1st step: general trait characteristics, 2nd step: competitive trait characteristics) indicated that general ( $R^2$  adjusted = .437,  $F = 16.110$ ,  $p < .001$ ) and competitive variables ( $R^2$  adjusted = .422,  $F = 4.554$ ,  $p < .001$ ) constitute significant predictors of flow experience. Discussion Self-esteem and self-confidence suggested a close positive relationship to flow experience compared to the negative characteristics, such as general and competitive anxiety, as well as, competitive worries. Thus, if an athlete feels confidence about his/her sport ability, this is associated with achieving high levels of flow experience. On the other hand, the lack of relationship

between the trait anxiety ratings and the flow subscales suggests that this variable may not be as relevant to flow experiences as self-esteem. In addition, based on the regression analysis results, positive emotional characteristics constitute significant predictors of flow experience, while, negative emotional characteristics did constitute significant predictors of global flow factor. References Jackson S.A. (1992). *Journal of Applied Sport Psychology*, 4, 161-180. Kimiecik J.C., Stein, G.L. (1992). *Journal of Applied Sport Psychology*, 4, 144-160.

### THE RELIABILITY AND THE CONSTRUCT VALIDITY OF THE ACHIEVEMENT GOAL QUESTIONNAIRE-REVISED IN PHYSICAL EDUCATION SETTINGS AND THE GREEK LANGUAGE

Zourbanos, N., Argyropoulou, E., Papaioannou, A.

*University of Thessaly, Trikala*

**Introduction** In the last decade Elliot's achievement goals model (e.g., Elliot & McGregor, 2001) attracted the attention of several investigators in sport and exercise psychology. The 2x2 model included mastery approach, mastery avoidance, performance approach and performance avoidance goals. Recently they presented the Achievement Goal Questionnaire-Revised (AGQ-R; Elliot & Murayama, 2008). The purpose of the study was to examine the reliability and the construct validity of the AGQ-R in physical education and in the Greek language. **Methods** Participants were 313 students (151 females and 162 males) aged 12 (SD = .48) years old. The factor structure of the achievement goals were tested through CFA using the EQS 6.1 (Bentler & Wu, 2004). Three alternative models were tested. One where the original four-factor structure was tested, with the four factors allowed to correlate, then a trichotomous model (2), in which the performance-approach and performance-avoidance items load on their respective latent factors, and the mastery-approach and mastery-avoidance items load together on a third latent factor; and a trichotomous model (3) in which the mastery approach and performance approach items load on their respective latent factors, and the mastery-avoidance and performance-avoidance items load together on a third latent factor. **Measures** Achievement goals in PE. Following the stem "In the Physical Education class..." students responded to the items of the Achievement Goal Questionnaire-Revised (AGQ-R; Elliot & Murayama, 2008). Ratings are made on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The alpha coefficients in the present study ranged from .54 to .70. **Results** Model parameters were estimated based on the covariance matrix and using the robust method, because examination of the descriptive statistics revealed moderate deviations from univariate normality for some of the items (kurtosis greater than 2.49). The results provided adequate support for the four-factor model (chi-square / df = 655.26 / 66, CFI = .97, IFI = .97, NNFI = .96, RMSEA = .04), which was superior to the trichotomous model (2) (chi-square / df = 655.26 / 66, CFI = .93, NNFI = .91, IFI = .93, RMSEA = .05) and the trichotomous model (3) (chi-square / df = 655.26 / 66, CFI = .70, NNFI = .62, IFI = .70, RMSEA = .10). Factor loadings for the four-factor model (1) ranged from .43 to .73. **Discussion** The results provided adequate support for the factor structure of the AGQ-R in the Greek language and the PE settings. **References** Bentler, P. M., & Wu, E. J. C. (2004). EQS 6 for Windows User's Guide. Multivariate Software, Inc., Encino, CA. Elliot, A. J., & McGregor, H. (2001). A 2x2 achievement goal framework. *J Pers Soc Psychol*, 80, 501-519. Elliot, A. J., & Murayama, K. (2008). On the measurement of achievement goals: Critique, illustration, and application. *J Educ Psychol*, 100(3), 613-628.

### ELECTRONIC MEDIA-FREE ZONE IN THE BEDROOM! A GLOBAL STRATEGY NEEDED FOR IMPROVING HEALTH-RELATED BEHAVIOURS

Soos, I.1, Biddle, S.J.H.2, Hamar, P.3, Karsai, I.4, Ling, J.1, Li, S.5, Sandor, I.6, Simonek, J.7

*1 University of Sunderland, UK, 2 Loughborough University, UK, 3 Semmelweis University, Budapest, Hungary, 4 University of Pecs, Hungary, 5 Harbin University of Engineering, China, 6 Babes-Bolyai Univ*

**Introduction** Recent work has shown that if children have a television in their bedroom they are at increased risk of being obese or overweight (Delmas et al., 2007). Therefore, keeping television and computers out of young people's bedroom may be an effective strategy for preventing obesity and associated co-morbidities (Dennison et al., 2002). The aim of this study was to investigate the relationship between the presence of electronic media (TV sets and computers) in the bedroom and young people's TV viewing, computer use/games and snacking behaviours. **Methods** Eight hundred and twelve (11.9-17.9 years of age) students from five countries (UK, China, Hungary, Romania and Slovakia) participated in this study. Data were collected by self-report ecological momentary assessment (EMA). **Results** and **discussion** Results showed that along with the highest rate of TVs (83%) and computers (26%) in British students' bedrooms, they spent more time with TV/video viewing and computer use/games (167 mins/day) than youths in the other countries, with the Chinese spending significantly less (58 mins/day) than others, as only 4% of students have a TV set and 19% a computer in their bedroom. Also, more British students (60%) consume snacks than peers from other countries, with the Chinese youth consuming fewest (28%). **Conclusions** In conclusion, parents should play a vital role to establish an "electronic media-free zone" in children's and adolescents' bedrooms, which would meet with the recommendations of clinicians and public health practitioners (Nelson et al., 2006). This effort could contribute to a global strategy to assist with the reduction of non-communicable diseases associated with sedentary behaviour. **References** Delmas, C., Platat, C., Schweitzer, B., Wagner, A., Oujaa, M. & Simon, C. (2007). Association Between Television in Bedroom and Adiposity Throughout Adolescence. *Obesity*, 15(10), 2495-2503. Dennison, B. A., Erb, T.A. & Jenkins, P. L. (2002). Television Viewing and Television in Bedroom Associated With Overweight Risk Among Low-Income Preschool children, *Pediatrics*, 109(6), 1028-1035. Nelson, C. M., Neumark-Sztainer, D., Hannan, P. J., Sirard, J. R. & Story, M. (2006). Longitudinal and Secular Trends in Physical Activity and Sedentary Behaviour during Adolescence, *Pediatrics*, 118(6), 1627-1634.

### THE SHARED ENVIRONMENT EXPLAINS INDIVIDUAL DIFFERENCES IN CHILDREN'S EXERCISE BEHAVIOR: A TWIN STUDY

Huppertz, C., Bartels, M., van Beijsterveldt, C.E.M., Boomsma, D.I., Hudziak, J.J., de Geus, E.J.C.

*Vrije Universiteit Amsterdam*

**AIM:** The aim of this study was to investigate causes of individual differences in children's exercise behavior. Twin studies offer the unique opportunity to disentangle the relative contribution of genes, shared environment and unique environment to a trait. This is the first twin study on participation in leisure time exercise activities looking at children who are younger than 12 years old. **METHODS:** Data were collected as part of a longitudinal survey study of the Netherlands Twin Register. The twins were 7 (N=3,966 subjects), 10 (N=3,562) and 12 years old (N=8,687), with longitudinal data for 27% of the sample. Both mothers and fathers were asked to report on the children's regular participation in leisure time exercise activities, including frequency and duration. Resemblance between monozygotic and dizygotic twins for weekly MET hours spent on exercise activities was analyzed as a function of their genetic relatedness. **RESULTS:** Average weekly MET hours increased with age for boys [age 7: 14.0 (SD=11.8); age 10: 22.6 (SD=18.7); age 12: 28.4 (SD=24.9)] and girls [age 7: 9.7 (SD=9.5); age 10: 15.3 (SD=15.1); age 12: 19.3 (SD=19.8)]. Around 13% of boys and girls across all age groups did not participate in any

regular leisure time exercise activities. Tracking of exercise behavior from age 7 to age 12 was modest ( $.168 < r < .534$ ). For boys, genetic effects accounted for 24% (CI: 18-30%) of the variance at age 7, 66% (53-81%) at age 10 and 38% (32-46%) at age 12. For girls, this was 22% (15-30%), 16% (9-24%), and 36% (30-43%), respectively. Environmental influences shared by children from the same family explained 71%, 25% and 50% of the variance in boys (aged 7, 10, 12) and 67%, 72% and 53% in girls. Partly different aspects of the shared environment affected exercise behavior in boys and girls. CONCLUSION: Our analyses confirmed the important role of shared environmental factors for children's exercise behavior that gradually give way to genetic influences when they reach adolescence. The shared environment is made up of all environmental factors that make members of a family more similar to each other. Parenting behavior may be the most likely suspect to explain the strong shared environmental impact in the present study as parents often act as gatekeepers to their children's leisure time activities.

### **"WHAT DO COACHES DO" AND "HOW DO THEY RELATE": THEIR EFFECTS ON ATHLETES' PSYCHOLOGICAL NEEDS AND FUNCTIONING**

Felton, L., Jowett, S.

*Loughborough University*

"What do coaches do" and "how do they relate": Their effects on athletes' psychological needs and functioning Felton, L., & Jowett, S.11: School of Sport, Exercise, and Health Sciences, Loughborough University (Loughborough, UK) Introduction The sport psychology literature (e.g., Amorose & Anderson-Butcher, 2007; Bartholomew et al., 2011) has expressed the importance of coach behaviours, both supportive and controlling in various degrees, on athlete need satisfaction and ultimately well-being, however the importance of coach-athlete relationship quality on need satisfaction has hardly ever been explored. Grounded in self-determination theory, this study aimed to examine the links of the social environment, as defined by coach interpersonal behaviours and coach-athlete relationships, with athletes' perceptions of basic psychological needs and indexes of well-being. Methods Athletes (N = 300) completed a multi-section questionnaire assessing the study variables. Structural equation modelling was used to produce a path model with EQS 6.1 (Bentler, 2002) in order to analyse the hypothesised associations between the study variables. In order to determine the adequacy of the model fit to the data various goodness-of-fit indexes were used including; the Satorra-Bentler scaled  $\chi^2$  ( $S-B\chi^2$ ), Robust Comparative Fit Index (CFI), Non-Normed Fit Index (NNFI), and the Root Mean Square Error of Approximation (RMSEA). Results Structural equation modelling supported a model whereby coach behaviour of autonomy support and the quality of the coach-athlete relationship positively predicted athletes' satisfaction of needs, and in turn, satisfaction of needs predicted vitality, negative affect, and physical self-concept (self-descriptions of skillfulness and competence). Discussion The findings suggest that, athletes' perceptions of supportive coaching behaviours and positive coaching relationships may serve to fulfil important psychological needs. Subsequently, these manifested connections may promote athletes' well-being while thwarting their ill-being. These findings support theoretical assumptions and highlight that athletes' perceptions of what coaches do, and how they relate, are important to their psychological needs satisfaction and optimal functioning. References Amorose, A.J., & Anderson-Butcher, D. (2007). Autonomy-supportive coaching and self-determined motivation in high school and college athletes: A test of self-determination theory. *Psychology of Sport and Exercise*, 8, 654-670. Bartholomew, K.J., Ntoumanis, N., Ryan, R.M., Bosch, J.A., & Thøgersen-Ntoumani, C. (2011b). Self-determination theory and diminished functioning: The role of interpersonal control and psychological need thwarting. *Personality and Social Psychology Bulletin*, 1-15. DOI: 10.1177/0146167211413125. Bentler, P.M., & Wu, E.J.C. (2002). EQS 6 for Windows: User's guide. Encino, CA: Multivariate Software.

### **THE PRELIMINARY DEVELOPMENT AND VALIDATION OF THE COACH DOPING CONFRONTATION SCALE**

Sullivan, P., Feltz, D., LaForge-MacKenzie, K., Hwang, S.

*Brock University*

Many of the anti-doping interventions in sport target coaching as a mechanism of change (Laure, Thouvenin, & Lecerf, 2001). Typically, these interventions focus on coaches' knowledge with respect to doping. However, research has noted that coaches do not lack knowledge in this area, but do lack in confidence for how to act when they feel it is appropriate (Rockwell et al., 2001). The focus of this study was to design and validate a measure of coaches' confidence in doping confrontation abilities (i.e., coaching confrontation efficacy). The Coach Doping Confrontation Scale (CDCS) was based in the theoretical framework of Newell and Stutman's (1988) Social Confrontation Model. This framework supported a multi-factorial conceptualization of confrontation that includes five interrelated factors - Initiation, Intimacy, Legitimacy, Potential Outcomes, and Personal Resources. A review of the literature on interventions in other contexts resulted in a sample of items that could be used to measure coaches' confidence in sport doping situations which were reviewed by a panel of experts in intervention and coaching, resulting in a five-factor, 45 item Likert-type scale. The CDCS was then administered to a sample of 645 coaches of high school aged athletes. A Confirmatory Factor Analysis supported the five-factor model with minimal alternations. The resultant model showed excellent fit of the model to the data (CFI = .944, RMSEA = 0.29). The five factors also showed acceptable internal consistency. Correlations between these five factors and the factors of the Perceived Motivational Climate in Sport Questionnaire-2 (Newton, Duda & Yin, 2000) were also examined. Results showed that high scores in confrontation efficacy were positively related to task-involving ego orientation. The results of these analysis support that the CDCS is a psychometrically sound instrument for assessing coaching confidence in abilities to confront athletes. Future research will utilize this measure in a competency-based anti-doping coaching workshop.

### **AFFECTIVE RESPONSES TO SOCIAL COMPARISON WITH A CHOSEN INDIVIDUAL IN PHYSICAL EDUCATION**

Barnes, J.S., Spray, C.M.

*Loughborough University*

Objectives: To date, few studies have researched children's affective responses to social comparisons and none so far, have investigated these relationships in physical education (PE). Drawing on previous research, this study sought to determine the relationships between children's comparative evaluations with a chosen individual, friendship importance and eight emotions. Design: Cross-sectional. Method: Five hundred and forty-five children (264= males, 276= females, 5= undisclosed; Mage = 13.89, SD = 1.57 years) from two schools in England completed measures of perceived relative standing in comparison to an individual identified by them as someone they compare with (PRSI), importance of friendship with that individual and eight emotions; frustrated; proud; ashamed; inferior; disappointed; jealous; happy; inspired. Results: Hierarchical regression analysis demonstrated that the higher the PRSI, the more frequently children reported experiencing pride. Comparing upward with a friend (low PRSI) was associated with higher occurrences of feeling jealous. Individuals

who compared with someone who was considered an important friend reported higher frequency of inspiration. Those who compared with someone who was not a friend reported more frequent experience of frustration. Those who reported high levels of PRSI and friendship importance indicated more frequent experiences of happiness. No significant associations were identified for ashamed, inferior or disappointed. Conclusion: As the first study to assess the relationship between social comparison with a chosen individual in PE and emotions, this research indicates that children are affected both positively and negatively by the comparisons that they make. Different emotions are associated with social comparison with an individual in different ways, highlighting the complexity of social comparison processes. The results suggest that this avenue of inquiry is a valid and useful one when investigating emotions that children experience in an achievement setting. Future research is therefore needed, to ensure that our understanding of the role social comparison may play in the experience of different emotions continues to grow.

## A COMPARATIVE ANALYSIS OF MENTAL TOUGHNESS OF MALE AND FEMALE SCHOOL ATHLETES

Tomar, R., Antony, V.C.

*King Fahd University of Petroleum and Minerals//PHYSICAL EDUCATION DEPARTMENT*

A COMPARATIVE ANALYSIS OF MENTAL TOUGHNESS OF MALE AND FEMALE SCHOOL ATHLETES Tomar, Rakesh.1, Antony, Varghese C.2 1: KFUPM (Dhahran, Saudi Arabia), 2: KFUPM (Dhahran, Saudi Arabia) Introduction Acknowledging the essential need of mental toughness, coaches have come to agree that mental toughness is a factor that could determine the success of an athlete (Gould, Peterson and Petlichkoff, 1987). Therefore the objectives of study were to compare the mental toughness between; male & female school athletes; successful & non successful male athletes and successful & non successful female athletes. Methods Total 70 national level school athletes with age ranging from 16-18 years were selected randomly as subjects for study and were divided into two groups namely; male (N=47) & female (N=23). Further in the male category two sub-groups were formed namely; successful male athletes (N=10) & non successful male athletes (N=37). Similarly in female category two sub-groups were formed namely; successful female athletes (N=6) & non successful female athletes (N=17). Mental toughness questionnaire of Allan Goldberg was administered. Winning a medal in National Championship was considered as successful performance for this study. T- test was applied to compare means between the groups. Statistical significance was set at 0.05. Results Analysis of results revealed significant difference on mental toughness (MT) between male & female athletes ( $p = .011 < .05$ ), female athletes scored significantly higher ( $M \pm SD = 39.08 \pm 4.06$ ) than male athletes ( $M \pm SD = 35.72 \pm 5.48$ ). Significant difference was observed on MT between successful & non successful male athletes ( $p = .001 < .05$ ), successful male athletes scored significantly higher on MT ( $M \pm SD = 42.9 \pm 2.60$ ) than non successful male athletes ( $M \pm SD = 33.78 \pm 4.30$ ). No significant difference was found on MT between successful & non successful female athletes ( $p = .395 > .05$ ). Discussion Successful male athletes were more mentally tough than non successful and scored significantly higher on all subscales of mental toughness. Significant differences were observed between two groups (successful & non-successful male athletes) in handling pressure ( $p = 0.001$ ), concentration ( $p = 0.001$ ), mental rebounding ( $p = 0.016$ ) and winning attitude ( $p = 0.001$ ), which is supported by (Kuan & Roy, 2007) who also observed significant differences between medallist and non medallist athletes. (Alderman, 1974) suggested that successful athletes are thought of as being not only physically tough but mentally tough as well. (Rana, 2009) also reported that successful wrestlers scored significantly higher on all sub scales of mental toughness than non successful wrestlers. References Alderman R B. (1974). W.B Saunders Company, Toronto. Gould D, Hodge K, Peterson K, Petlichkoff L. (1987). *Sport Psychologist*, 1, 293-308. Kaun Garry, Roy Jolly. (2007). *Journal of Sports Science and Medicine*, 6, 28-33. Rana Munish. (2009). *Journal of Physical Education and Sports Science*, 4, 60-69.

## SELF ESTEEM AND BODY IMAGE IN INDIVIDUALS PRACTICING FITNESS ACTIVITIES

Bianco, A.1, Alesi, M.1, Paoli, A.2, Raccuglia, M.1, Spina, S.1, Pepi, A.1, Palma, A.1

*1: University of Palermo. 2: University of Padua*

Introduction There is a considerable body of recent studies in the literature to focus on the reciprocal enhancement of physical activity and psychological constructs such as self-esteem and body-image. Self-esteem is a fundamental aspect of a person's experience and quality of life. A positive self-evaluation and view of oneself are crucial predictors of one's general well-being. In particular self-esteem refers to the evaluative component of the Self, emerges precociously when the individual is required right to verify his evaluation of himself by comparing it with his actual performance on a variety of tasks such as physical or school tasks. Perceptions of body image play a pivotal role in the self-esteem. On this theoretical basis, the study aims to investigate two specific research questions: 1. Do gender and age influence the self-esteem and body-image of individuals practicing fitness activities? 2. To what extent are correlated fitness parameters, self-esteem level and body-image? Methods At the beginning of the research subjects were given a Fitness Test aimed at evaluating parameters such as weight, height, sit-up test, push-up test, squat-test... Then were administered Self-Esteem and Body-Image tests. The subjects' self-esteem was measured by the Self-Esteem Scale (Rosenberg, 1965) and body-image by the Body Weight, Image and Self-Esteem Evaluation Questionnaire. Results The sample consisted of 100 participants, with an average chronological age of 28.59 years, subdivided into three groups of age. With regard to gender, there were 50 females and males. The medium socio-economic level was predominant. On the whole, the findings show significant differences between males and females both for Self-Esteem ( $F 1.99 = 6.694$ ;  $p < .05$ ) and for Body-image ( $F 1.99 = 11.708$ ;  $p < .01$ ). In particular, males demonstrate higher levels of Self-Esteem and Body-image than females. Moreover the results point out significant correlations between weight and negative self-esteem and between Self-Esteem and Body-Image. Discussion Further research should be carried out to determine the clinical implications of the relationship of Self-Esteem and Body-Image considered as crucial factors that lead to the risk for developing eating disorders and body dissatisfaction. References Awad A.G., Voruganti L.N.P. (2004). Body weight, image and self-esteem evaluation questionnaire: development and validation of a new scale. *Schizophrenia Research*, 70, 63-67. Griffin M., Kirby S. (2007). The effect of gender in improving body image and self esteem. *Athletic Insight*, 9, 83-89. Milligan B., Pritchard M. (2006). The relationship between gender, type of sport, body dissatisfaction, self-esteem and disordered eating behaviors in athletes. *Athletic Insight*, 8, 32-46.



13:45 - 14:45

## Poster presentations

### PP-SH14 Physical Education and Pedagogics 3

#### THE NARRATIVE ABOUT BECOMING A FEMALE ELITE JUDO PLAYER IN SOUTH KOREA

YEO, J.

*Yongin University*

THE NARRATIVE ABOUT BECOMING A FEMALE ELITE JUDO PLAYER IN SOUTH KOREA Yeo, J. 1, Kim, J.1, Park, I. 2 1:UYI(Yongin, South Korea), 2:UHN(Kwangju, South Korea) Introduction In South Korea, becoming a female elite Judo player is not common. Judo is not a popular sport for women in South Korea. Actually, most of female participants playing judo are not amateur players, and female Judo players open belong to a team, for instance school, university, or company. This research explored the process to be female elite Judo players. Method Qualitative research method was used for this study and four female elite judo players participated in the study as main informants. All participants of this study were judo players belonging to the different teams, respectively. During three months, three times interviews were operated each interviewees. Collected qualitative data was analyzed by three researchers through narrative inquiry. Result According to the information from four participants, playing Judo professionally was a process accepting their identity. Difference of gender was not an important problem to success as a superior judo player. Fulfillment as a Judo player was the best worth rather than beauty as a woman. Also, through the analysis of informer's transcription, it was revealed that the program for educating female judo players were not systematic and effective. The participants described that it was an accidental occasion for them becoming an elite Judo player. Discussion Denzin & Lincoln (2008) refers that narrative inquiry is one of the excellent method to study a life of woman. We tried to represent the experiences of female judo players. The analysis of this research was processed by the five steps of interpretation through analysis method suggested by Riessman(1993). The process to become a female elite judo player was rarely studied. Only one article handles with similar topic in South Korea, and it was an ethnological study about female elite player (Kim, 2006) References Denzin NK, Lincoln YS. (2008). *Collecting and Interpreting Qualitative Materials* (3rd Ed). Newbury Park, CA: Sage. Kim M. (2006). *The Korean Journal of Physical Education*. 45(4), 93-102. Riessman CK. (1993). *Narrative Analysis*. Newbury Park, CA: Sage.

#### OBESITY AND TRACKING OF PHYSICAL FITNESS IN ELEMENTARY SCHOOL CHILDREN

Watanabe, M., Kidokoro, M.

*College of Education*

Introduction Physical fitness (PF) in early teen years influences that in adulthood. Consequently, clarifying PF tracking at an early age is important. PF tracking during elementary school has shown a moderate correlation between lower and higher grades. However, although PF is related to obesity, its relation remains unclear. This study was conducted to elucidate the relation of first grade PF to sixth grade PF, and the influence of obesity. Methods We examined 501 sixth grade elementary school children (257 boys, 244 girls) using five-year longitudinal height, weight, and PF test data. PF tests consisted of scores of a 50 m run, standing jump, sit-and-reach, repeated side jump, hand grip, 20 m shuttle run, sit-up and softball throw. Obesity was assessed by the body mass index (BMI). The relation between first grade and sixth grade PF and the influence of obesity were assessed using Pearson's product-moment correlation coefficient. Results The 50 m run and softball throw showed high correlation ( $r > 0.60$ ). Standing jump, sit-up, 20 m shuttle run and hand grip showed moderate correlation ( $r = 0.40-0.50$ ). Sit-and-reach and repeated side jump showed low correlation ( $r < 0.40$ ). Relations between PF and BMI in the first grade were  $r < 0.20$ . Discussion Muscle strength and endurance ability should be intervened in the preschool period because tracking was moderately high in the first grade. Throwing skill acquisition was especially important. However, flexibility and agility can be acquired adequately during elementary school because the tracking was low. Furthermore, the influence of obesity on PF tracking is slight: the relation between obesity and PF in first grade is low. References Malina RM. (2001) *Am J Hum Biol*, 13,162-72. McMillan CS, Erdmann LD (2010) *Pediatr Exerc Sci*, 22, 231-244.

#### INTERRELATION BETWEEN THE MECHANISMS FOR THE CENTRAL REGULATION OF MOVEMENT AND THE COGNITIVE ABILITIES OF ADOLESCENT

Stankovic, V., Toskic, D.

*University of Pristina*

Introduction Determination of relations of motor abilities with other segments of anthropological status of sportsmen in particular sports nowadays, represents very current practical and theoretical issue. This issue is of a great importance firstly because of its possibility to form the most rational procedures in sport technology and sport training - sportsmen selection, training planning, programming and control as well as efficient monitoring of development of relevant anthropological characteristics (Stankovic, Malacko 2008). Methods We used a system of 9 tests of motor skills on a sample of 100 male participants, aged 17-18, along with 3 tests of cognitive abilities, with the aim of determining the statistically significant relations between the system of variables which were used to evaluate the mechanism of the central regulation of movement and cognitive abilities. The data were processed by means of the canonical correlation analysis (Popovic, 1993). Results Between the system of motor variables and the system of cognitive variables of the adolescents, a pair of significant canonical correlations ( $R_c = .52$ ) was obtained. The results of the research indicated that the adolescents showed better results for motor variables for the evaluation of the regulation of movement, if they had increased values for the cognitive variables of the effectiveness of the perceptive processor (IT-1) and the effectiveness of the parallel processor (S-1). Discussion On the basis of the results obtained in this study we can necessarily conclude that there are two-way relationships between cognitive mechanisms and motor functions. The obtained canonical factor indicates that, in the case of high school females, the results of the motor skills which were used to evaluate the mechanism of the central regulation of movement are undoubtedly dependent on the interrelations between the input processor, that is, the ability to receive and process information and solve problems whose elements are given in the field of perception, as well as on the ability which is formed during the process of acculturation (Milojevic, Stankovic 2010). Nevertheless, the relationships between motor and cognitive factors on their own do not play a decisive role in the success of a certain activity, and the overall relationship which includes the

remaining anthropological dimensions is necessary. References Milojevic, A., Stankovic, V. (2010). Development of motor abilities of younger adolescents. *Facta Universitatis. Series: Physical Education and Sport*, 8 (2), 107-113. Popovic, D. (1993). Programi i potprogrami za analizu kvantitativnih promena. [The programs and sub-programs for the analysis of quantitative changes]. Pristina: Faculty of Physical Education. Stankovic, V., Malacko, J. (2008). Relations between systems of motor, cognitive and conative variables of top-class handball players. *Kinesiologia Slovenica*, 3 (14), 33-43.

### THE EFFECTS OF CONTEXT ON DELIBERATE PRACTICE ORIENTATIONS IN YOUTH SPORT

Santos, A.1, Diogo, F.1, Goncalves, C.E.1

*University of Coimbra - NIF 501617582*

**Introduction** Different factors lead athletes to achieve high performances in sport. It's not just natural talent that affects the development of expertise in sport but also environmental influences (Lidor & Lavyan, 2002), namely the perspective of a professional sport career. The aim of the study is to analyze the effects of a sport season in three different contexts on the orientations for deliberate practice among adolescent athletes. **Methods** Forty-eight athletes under-17 years of age ( $15.7 \pm 0.99$ ), from a soccer academy (20), a volleyball club (14) and an elite volleyball centre (14) participated in the study. The adapted version of the Deliberate Practice Motivation Questionnaire/ DPMQ (De Bruin, Rikers & Schmidt, 2007) was used. The instrument has 21 items and 2 factors, Will to Compete and Will to Excel, and the athletes answered in the beginning of the season and in the end of the season. ANOVA analysis for the 2 factors was performed. Data about the training loads were collected. **Results** The training volume for soccer players was 7 hours/week, for volleyball players 6 hours/week and for elite volleyball players 19 hours/week. The scores for Will to Compete and Will to Excel of soccer players were higher than those of their volleyball peers and presented no significant effect of time for Will to Excel, but a significant increase in Will to Compete ( $p=0.03$ ). For both groups of Volleyball players a significant decrease in Will to Compete ( $p=0.01$ ) and Will to Excel ( $p=0.04$ ) was observed. **Conclusions** Despite the fact that elite Volleyball players practice and compete almost three times as much as their peers, it seems that it has a negative influence in their desire to become experts. The findings suggest that a context oriented to professionalization has the strongest influences in the level of engagement of adolescent athletes in a path to excellence. **References** De Bruin, A., Rikers, R., & Schmidt, H. (2007). The Influence of achievement motivation and chess-specific motivation on deliberate practice. *Journal of Sport & Exercise Psychology*, 29, 561- 583 Lidor, R., & Lavyan, N.-Z. (2002). A Retrospective picture of early sport experiences among elite and near-elite israeli athletes: developmental and psychological perspectives. *International Journal of Sport Psychology*, 33, pp. 269-289.

### THE SCHOOL NURSE'S TEACHING ABOUT MENSTRUATION AT ELEMENTARY AND JUNIOR HIGH SCHOOLS IN JAPAN

FUJIWARA, Y.1, MAKABE, C.2, KIMURA, K.3

*1: KAWASAKI UNIVERSITY OF MEDICAL WELFARE, 2: KUMAMOTO GAKUEN UNIV, 3: KOKUGAKUIN UNIV*

**Introduction:** The menstrual education in Japanese schools has been based on Government Course Guidelines. It includes contents about the growing body, hormonal mechanisms and the menstrual cycle. These contents are crucial for students to understand the many physiological changes in the adolescents. The school nurse is a key position to teach those contents in Japanese schools. The aim of this study was to investigate the practical guidance on menstruation of school nurses in Japan. **Methods:** We undertook the original questionnaire survey for the school nurses, and send the original questionnaire survey by post which was 1,200 each schools of elementary and junior high schools. The survey contained the following questions. Q1: Which of the following does your school include in practical guidance of menstruation? Q1-1: Coping with menstrual pain, YES or NO? Q1-2: Using tampons, YES or NO? Q1-3: Measuring basal body temperature, YES or NO? Q1-4: Teaching contents during menstruation in class of swimming and the other exercise out of water such as gymnastics, ball game and dance, YES or NO? Q2: Who is the leading teacher during guidance? Q3: How to teach the practical guidance? **Results:** The number of returned post from schools was 159 (13.3 %) elementary schools (ES) and 172 (14.3 %) junior high schools (JHS). The percentage of Q1-1 was 49.1 % (ES) and 64.0 % (JHS). The percentage of Q1-2 was 1.9 % (ES) and 1.7 % (JHS). For basal temperature, the percentage of Q1-3 was 5.7 % (ES) and 19.8 % (JHS). The percentage of Q1-4 was 37.7% (ES) and 23.3 % (JHS). For swimming in class during menstruation, the results were 50.3% (ES) and 31.3% (JHS). Q2: In most cases, leading teacher of practical guidance was the school nurse. However, menstruation guidance of physical education class of swimming and the other exercise out of water had been provided mostly by the physical education teacher in junior high schools, with result of 44.6 % for exercise out of water and 63.2 % during swimming. Q3: Firstly the situation of guidance at elementary school was in homeroom activities and secondly 'other time'. For junior high schools, the major situation was 'other time' and secondly was physical education class. The 'other time' was individual counseling when the students called at school nurse's room. **Discussion:** It was reported that measuring basal temperature is important for the self-control as a woman. Considering that, we discuss the guidance about basal temperature is more required. And it was reported that parents viewed school as a more appropriate setting than home for teaching physiological aspects of sexuality and providing accurate information. I would consider that the practical guidance agree with a stage of life and the situation of exercise.

### COMPARISON OF RESPIRATORY FUNCTIONS IN PHYSICAL EDUCATION CLASSES WITH PAST MEDICAL HISTORIES OF BRONCHIAL ASTHMA IN SUMMER AND WINTER

TAKAGI, Y.1,2, NAKASE, M.3, YOSHIZAWA, K.3, ANDO, Y.4, ONODERA, S.5

*1 RESEARCH FELLOW OF THE JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE, 2 GRADUATE SCHOOL, KUMW, 3 KAGAWA NATIONAL COLLEGE OF TECHNOLOGY, 4 INSTITUTE OF DEVELOPING ECONOMIES, 5 KUMW*

**Introduction:** The purpose of this study is to investigate changes in indexes of respiratory functions in physical education classes with past medical histories of bronchial asthma in summer and winter. **Methods:** Eleven Japanese healthy male students (age:  $18.3 \pm 0.5$  years) with a past medical history of bronchial asthma (Asthma group) and Eleven healthy control students (Non-asthma group age:  $18.6 \pm 0.5$  years) volunteered to this study in physical education classes, in A National College. **Investigation I :** They played basketball games for two times, and each game was 10 minutes in summer (July). Atmospheric temperature was  $26.5$  °C, and relative humidity was 78.1 %. **Investigation II :** Subjects participated in the soccer games after warm-up in winter (December). They played soccer games for two times, and each game was 15 minutes. Atmospheric temperature was  $6.8$  °C, and relative humidity was 38.9 %. We took breaks for approximate 10 minutes between each game. Participant's FEV1.0, PEF, SpO2 and the degree of dyspnea sensation (DDS) were measured before the first game (Rest) and at the time 5 minutes after each game (After-1 • After-2) **Results & Discussion:** No significant differences were found on FEV1.0, PEF and SpO2 changes between the Rest and at After-1 • After-2 within groups in summer. There was no significance between the two groups in summer. On the other hand, significant reductions in FEV1.0, PEF and SpO2 were observed at the After-1 in

Asthma group in winter ( $p < 0.05$ ). No significant differences were found on measurement indexes in Non-asthma group. DDS at After-1 and After-2 were significantly higher than that at the Rest in each group in both seasons ( $p < 0.01$ ). As high intensity exercise of aerobic and anaerobic, basketball and soccer game increased stress on the respiratory system with apparent increases in oxygen demand. Especially, in Asthma group, it was considered that significant decrease in FEV1.0 and PEF after games indicated enhancing airway reactivity induced by additive effects of increase of oral-breathing from high-intensity exercise and exposure to cold environment (6°C) from classroom (22°C). Though conditions in Asthma group after the games indicated mild asthma attack in clinical estimation, it was in safety range of exercise in Japan. Conclusion: These data suggest that stress on respiratory system indicated greater during playing a soccer game for 15 minutes in physical education classes under cold environment in individuals with past medical histories of bronchial asthma.

### TEKO - PROMOTING SAFETY IN SCHOOL SPORTS VIA INTERNET AND EDUCATION

Oksanen, R., Jussila, A.M., Ojala, A., Parkkari, J.

*UKK Institute for Health Promotion Research*

Introduction Sports injuries are the most common injury type in Finland, over 350 000 injuries occurred in year 2009. Sports injury numbers have increased considerably during the past decades. In Finnish basic education sport injuries happen mostly in PE classes, in recess and on the way to school or home. Football, floorball, basketball and skating are the most common activities causing injuries during PE class sports. Most injuries are mild, but the treatment can be time consuming and expensive. Especially knee, low back and head injuries may cause long-term pain and disabilities. A remarkable part of these injuries can be prevented by enhancing pupils motor skills and awareness of injury risks, by increasing quality and contents of PE and health education classes, and taking care of safety equipment and environment in sports. Methods The Sports and Exercise Safety in Finland program (LiVE 2006-) and its nationwide implementation project among teachers, Safety in School Sports (TEKO 2010-), is producing educational material to the internet to promote physical activity levels in general and to promote safety of sports and exercise in a nationwide setting. The main focus is to deliver national and international research findings to the schools by communication via website [www.tervekoululainen.fi](http://www.tervekoululainen.fi) and to support this communication with education methods. The main target group for TEKO is secondary school teachers (grades 7 to 9). Results In TEKO project the sports safety promotion is focused on ten different segments; physical activity, sports skills, maturation, nutrition, rest and sleep, environment and equipment, health care, atmosphere and rules, sports injuries and support network. These 10 different segments compose a model, "Element wall", which teachers can leverage to build up the safety in sports in school context. TEKO builds up information packages and practical toolkits e.g. diaries, videos and ppt slides for teaching. The education material has been developed precisely to adolescents by using their language, style and information channels. These materials are available free of charge for all users in the projects websites. During 2010-2011 TEKO project has completed 7 of the 10 Element wall segments. TEKO has been presented annually in about 10 different events (e.g. PE and Health Education teachers' national seminars) and organized several education sessions to improve safety in PE classes. TEKO websites (in Finnish) have attracted 3000 visitors and 80 000 hits per month. Discussion Successful development and implementation of preventive strategies against sports and exercise related injuries are likely to result in large reduction in the absolute number of health problems, a reduction in school absenteeism, decrease in long-term disabilities and medical costs. The true effects of the preventive measures through TEKO project will be seen within five to ten years. To support the common goals LiVE program is promoting sports safety also for sport clubs and coaches via Healthy Athlete project: [www.terveurheilija.fi](http://www.terveurheilija.fi).

### TRIAL AND RESULTS OF HOMEWORK IN A UNIVERSITY PE CLASS

Kita, T.1, Hattori, Y.2, Yoshihara, S.3, Yamamoto, T.1, Asai, T.4, Horie, S.5

*1: Musashino Art University (Tokyo, Japan), 2: Seisa University (Hokkaido, Japan), 3: St.Marianna Univ. (Kanagawa, Japan), 4: Nagasaki Univ. (Nagasaki, Japan), 5: Tokai Univ. (Kanagawa, Japan)*

Introduction: In recent years, the educational benefits of using video delay units in university physical education classes have been reported. However, physically attending classes to personally instruct students in real time can be rather difficult in terms of time constraints. Therefore, we tried assigning the evaluation of a sports video as homework for this research. Subject of Research were 20 students taking a "basketball" class in a physical education class in a university in Tokyo. Of those 20, 17 of the students who participated in the homework assignment were used as subjects for analysis. Methods: The students were given a DVD with videos of themselves playing sports (one hand set shot / free throws), along with notes to check. The students were instructed to evaluate and analyze the video, and to turn it in by a set date along with their notes. Also, a practical test was conducted before and after starting the homework assignment, and one hand set shot / free throws accuracy was evaluated. The students were given a DVD with videos of themselves playing sports, along with notes to check. The students were instructed to evaluate and analyze the video, and to turn it in by a set date along with their notes. Also, a practical test was conducted before and after starting the homework assignment, and one hand set shot / free throws accuracy was evaluated. Results: Most of the students noted that "it was my first time objectively watching myself play and evaluating myself, and my form was different from how I'd imagined it," and that they were able to find concrete points to fix among the various checkpoints. A one hand set shot / free throws accuracy test was also conducted before and after the homework assignment. Results of having the students basketball one hand set shot / free throws the five times each showed that more than 40% of the students improved their goal rate after the homework assignment. Discussion/Conclusion: Most of the students noted that "it was my first time objectively watching myself play and evaluating myself, and my form was different from how I'd imagined it," and that they were able to find concrete points to fix among the various checkpoints. A one hand set shot / free throws accuracy test was also conducted before and after the homework assignment. Furthermore, in regards to improvement in physical performance after the homework assignment, male and females felt that they had "improved" one hand shot abilities. [Postscript] :This research was conducted as part of the Kanagawa Society of Physical Education and Sports Science 2010 grant program to "Testing the introduction of homework to a university physical education class" (Principal researcher: T. Kita).

### 1000M. RUN TEST PERFORMANCE DURING YEARS: FOURTEEN URBAN STUDENTS RESULTS.

Fratini, G., Vago, P., Casolo, F., Bruseghin, P., Lovecchio, N., Merati, M.

*Catholic University of Milan, Italy*

Introduction During adolescence (A) individuals experiment a great number of changes in their own body. At the same time, physical activity represents an important element for health and physical efficiency. Unfortunately, PA practice often ceases at the start of high school. The purpose of this study was to investigate the performance of 14 y old students during their first week in high school. Data were

collected for 7 consecutive years (2005-2011). Material and methods Every year in September the students of an high school (Milano city) performed the 1000m run test. All students followed the same path and were assessed by the same teacher. Over than 500 students (228 M and 280 F) were tested during the first lesson of Physical Education (PE). Thus, every year 72 students (on average) were tested about physical efficacy during the transition from middle to high school. Thus a useful baseline could use to set the educational programs. All students lived in the city (I) since their birth. Results These tests show a different trend between boys and girls. In particular, boys increased the performance during years while girls are fluctuating. Boys students run the test in 293sec  $\pm$  34 (data pooled within years) while girls in 338sec  $\pm$  32. The best performances were 210 and 251 sec (M and F respectively) while the worst 416 and 445 sec. In 2005, male run the test in 318 sec while during September 2011 the 14y old students took only 285 sec. Indeed boys decrease, every years, the time spent to run the test of about 5,5 sec. Girls were not constant or regular following a decreasing or increasing trend. Their were, always, more slow than their same age mates: from 5 sec (in 2005) to 71 sec (in 2006) of difference. The best years for girls was 2005: mean speed about 3,1 m/sec. Girls shown a minor variability (each years) while boys group obtained variation close to 45 sec. Discussion The use of motor fields tests allows a valuable monitoring about physical skills. The repetition of 1000m run test during years shown a general decreasing (boys) or a fluctuating performances (girls). Other factors could influence the physical practice: i.e. world events of national team for boys and a cultural drop-out during A for girls. The PE course (2) that are compulsory throughout the country are the only common element that could improve the physical efficiency especially in an urban environment where play sport is not always easy. References 1. Chillón et al. *J Sci Med Sport*. 2011; 14(5):417. 2. Starc & Strel. *BMC Public Health*. 2012;12(1):61.

### A COMPARATIVE STUDY OF BONDING WITH PHYSICAL EDUCATION AT SCHOOL AMONG 11-18 YEAR-OLD HUNGARIAN AND TRANSYLVANIAN STUDENTS

Hamar, P.1, Versics, A.1, Adorjänné, O.A.1, Volák, A.1, Karsai, I.2, Soós, I.3

*1Semmelweis University Budapest, HU, 2University of Pécs, HU, 3University of Sunderland, UK*

Introduction Bonding with school subjects is an attribute of affectivity. Studying bondings throws light upon which subjects students prefer and to what extent in addition to showing which subjects they prefer more and which ones to a lesser degree (Báthory, 1989). A survey conducted at the end of the twentieth century in Hungary (Gombocz, 1999) shows that physical education teachers think the popularity of physical education is falling among students. This tendency is particularly true at secondary but also at primary schools. The aim of this research is to find out about the attitudes of 11-18 year-old Hungarian and Transylvanian boys and girls towards physical education and sports at school and whether the positive and negative attitudes towards physical education at school are manifest according to geographical units, sex and age. Methods The sample was made up of 3941 students, including 2840 Hungarian and 1101 Transylvanian boys and girls. The method applied with the cross-section test was a questionnaire survey. Data collection and filling in the questionnaires took place in the academic year 2006/2007. Factors were created from the questions of the questionnaire. Nine questions belonged to the factors relevant to our study. Factors were created from the items of the questionnaire. Nine items belonged to the factor relevant to our study which measured the positive attitude to the physical activity and PE classes. The values of the factor were expressed using the percentages of the positive answers in the factor. After descriptive statistics the three way 2\*2\*3 ANOVA was used (country\*gender\*age) to test the main effects and Bonferroni Post Hoc test for checking the group differences. We accepted the results as significant difference when  $p < 0.05$ . Summary The majority of the 11-18 year-old Hungarian and Transylvanian students participating in the study had a positive attitude towards physical education and sports at school. Our test results confirmed that Transylvanian boys and girls showed a more favourable attitude to physical education at any age than their Hungarian counterparts. Boys, except for the Transylvanian age group of 11-12, had a more positive attitude to physical education at any age than girls. Positive emotional attitudes towards physical education show a decreasing tendency. References Báthory, Z. (1989): *Tantárgyi kötődések vizsgálata négy tanuló korosztály körében*. *Pedagógiai Szemle*, 39: 12. 1162-1172. Gombocz, J. (1999): *Az iskolai testnevelés problémái az ezredfordulón*. *Kalokagathia*, 37: 1-2. 15-39.

**13:45 - 14:45**

## Poster presentations

### PP-SH15 Social Sciences and Humanities 2

#### AN ALTERNATIVE WAY TO DEVELOP THE TEACHING COMPETENCE IN THE PRE-SERVICE TEACHER EDUCATION FOR PHYSICAL EDUCATION

Shin, K.

*Jeonju National University of Education*

Introduction In Southern Korea, the elementary school teachers are raised mainly from the national universities of education. But there are limitations to teach them sufficiently to teach physical education. First of all, the required courses toward Pre-service Teachers (PTs) are uniformly organized. Second, PTs are obligated to cover the all of subjects. Third, there is a lack of time to learn content knowledge sufficiently. The motive of this study is that it is needed to find alternative way to overcome the limitations of Physical Education Teacher Education (PETE) programs. So this study aimed not only to investigate what activities the PTs' experience of sport club as an alternative way to develop the teaching competence for physical education, but also to interpret the educational meaning inherent in their experiences in the sport club. Methods This Study was designed by the qualitative method. Participants in this study were selected from PTs attended eagerly in the sport club on the campus. Eight PTs who have been taking the role of the executives in their club participated in this study. Data were collected by participant observation and in-depth interviews. Inductive analysis and constant comparison were used to analyze the data by go through the stages of transcription, the development and application of codes for each participants. Results The findings are as followings: First, the factors affect the PTs to choose and become the members of the sport club among other various clubs are linked separately to intrinsic motivation (such as 'the favorite exercise', 'the new experience') and extrinsic motivation (such as 'the recommendation of others'). Reinforcing the intrinsic motivation is the ultimate task in education process. Therefore it is needed to create conditions that stimulate pre service teachers' intrinsic motivation for doing physical activities so that they perform and challenge

continuously. Second, the main activities in the sport club are categorized as making relationship, doing exercise, strengthening the unity, and entering sport event. In contrast to other general clubs, the organic relationship existed in sport club. The difference is presumably based on the properties of sport and exercise. Participants are easily able to take something new in the site through seniors' advices which can be recognized as an apprentice. Lastly, the educational meaning of these sport club activities are interpreted as an extra-curricular activities, internalization of values in physical activities. Discussion Based on the results, It is very important to vitalize the sport club on the campus in that this sport club activities give the participants the chance to enrich their teaching expertise and teacher socialization. Therefore, It is necessary to give the administrative and financial help to the sport clubs, so that they attracts a lot of PTs to participate in. This abstract is a modified version of my published research in Korean Association of Sport Pedagogy Journal(Vol. 18(4), 19-38).

### **EXPECTATIONS OF PARENTS PARTICIPATION OF THEIR CHILDREN IN PHYSICAL EDUCATION LESSONS LIVING IN DIFFERENT REGIONS IN TURKEY**

Atan, T., Eliöz, M., Polatcan, İ.

*Ondokuz Mayıs University*

EXPECTATIONS OF PARENTS PARTICIPATION OF THEIR CHILDREN IN PHYSICAL EDUCATION LESSONS LIVING IN DIFFERENT REGIONS IN TURKEY Atan, T.1, Eliöz, M.1, Polatcan, İ.1. 1 Ondokuz Mayıs University, Yaşar Doğu Physical Education and Sports High School (Turkey) Introduction Parents decide for their child to participate in sport. Today, parents have more positive approaches to participate sports events than ever before (Tel, 2009). Therefore purpose of this study was to determine the expectations of parents from participation of their children in physical education lessons according to several variables (living city, living place and parents' gender). Methods For this purpose in 2010-2011 academic year, parents of second grade of primary school students participated the study whom live in Bursa and Diyarbakır, in Turkey. 120 and 116 parents live in Bursa and Diyarbakır respectively, totally 236 subjects filled the expectation questionnaire. The number of male and female parents was 143 and 93 respectively. Expectation Questionnaire (Öncü, 2007) was used to determine the expectation of parents from physical education lessons. Results Expectations of parents from physical education lessons were compared between Bursa and Diyarbakır city and 8 of the 18 expression were found significantly different. The expectations of parents were compared between the living place and significant differences were found in some items, especially between cities and villages. No significant differences were found between gender (mother and father) expectations except one expression. In this expression, female parents reported no sweating and easy exercise in physical education lessons more than males. Discussion All the parents' expectations from physical education lessons were positive. However, in some cases their expectations differ according to rural-urban settlements. In modern societies, sport is an integral part of social life while backward communities have ignored the importance of sports (Yetim, 2000). Due to urbanization, industrialization socio-cultural structure and economically developed places have more positive expect from physical education lessons. Living in the city has a positive effect on participation in sports (Pepe, 2003). Male and female parents' thoughts were parallel for physical education lessons. References 1. Tel, M. (2009). Çocuklarda Sosyalleşme Araçlarının Spora Yönlendirme Durumları, The First International Congress of Educational Research, Çanakkale. 2. Öncü E. (2007). Ana-Babaların Çocuklarının Beden Eğitimi Dersine Katılımına Yönelik Tutumları Ve Beklentileri. Gazi Üniversitesi Sağlık Bilimleri Enstitüsü Doktora Tezi, Ankara, 72-74. 3. Yetim, A. (2000). Sporun Sosyal Görünümü, G.Ü. Beden Eğitimi Spor Bilimleri Dergisi,5(1), Ankara. 4. Pepe, K., Can, S., (2003). Spor Branşlarına Katılımın Sosyoekonomik Boyutunun Araştırılması. Gazi Üniversitesi Beden Eğitimi ve Spor Yüksekokulu Beden Eğitimi ve Sporda Sosyal Alanlar Kongresi; Ankara). 484-490.

### **POSTURE AND BEHAVIOURAL DISORDERS IN INFANCY AND ADOLESCENCE: PEDAGOGICAL POINT OF VIEW AND POSSIBLE EDUCATIONAL AID**

Costantino, D.

*University of Palermo*

Introduction Posture is "attitude or position of the body", the way in which a person holds himself as he stands, walks or sits. Harmony in movements originates with a contraction of different skeletal muscles, all coordinated by "one nerve control tower". If there is a gap in this nerve-muscular connection, there is twist of correct postures. Science is improving knowledges, but it hasn't reached final goal. In research's field, it is very important to join medical with pedagogical competences, to field possible educational aids for young at primary and secondary school. Improving «education at movement» in our schools is health-conscious practical teaching, that aims at helping young to become aware of their bodies. Methods It is necessary to increase curricular time dedicated to «education at movement» in primary and secondary schools. On one hand physical trainer must follow gymnastic exercises of pupils, on the other he must increase and extend knowledges of pupils about nutrition and health. There are postural disorders originated with malfunction of eyes, and others originated with feet's malfunction. Expert physical trainer will adjust carefully physical exercises with skeletal structures of his pupils. To every man his due. Results Let's show two paradigmatic situations: 1. pupil in the last desk in the classroom. If he is nervous and follow lessons with effort (moving himself from left to right), maybe he has malfunction of eyes, that obstructs him in learning well. Physical trainer is under the obligation to contact pupil's parents and to suggest them to bring their son to doctor to have eye test; 2. pupil with a very frail skeleton structure goes to school with enormous school-bag on his shoulders. Physical trainer is under the obligation to talk to him, explaining that heavy weights must put down his young and frail back, and suggesting to use trolley-bag. Discussion Physical trainer, rich in medical and pedagogical competences, can help young at school in improving their wellness. Simple remarks, made at the right time, are able to cause health-conscious changing in habits and postures. The more physical trainer will use «pedagogical tact», the more his action will be incisive and successful. References AA.VV. (1992), Postura, occlusione, rachide: problematiche interdisciplinari, Associazione interdisciplinare di studio della postura. Barker V. (1998), Postura posizione movimento:..., Roma, Edizioni Mediterranee. Buzzi A. (1996), Guidi Fabbri C., Le metodologie posturali in funzione educativa e rieducativa, Roma, Armando. Guasti D. (2005), La postura corretta sui banchi di scuola..., Azzano San Paolo, Junior. Indaimo G. (2010), Salus: disciplina motoria e posturale, Brolo, Armenio. Le Boulch J., La ginnastica di postura, UNIEF. Pesci G. (1987), Educazione motoria: conoscenze, competenze e abilità dell'insegnante, Roma, Armando.

**PHYSICAL ACTIVITY AND ITS BUDGETARY CONSEQUENCES ON A SAMPLE OF THE SWISS POPULATION**

Rey, D.

*University College Thim van der Laan*

Physical activity and its budgetary consequences on a sample (n = 87) of the Swiss population Rey, D.1, Taeymans, J.2, Poortmans, J.3 1: Thim (Landquart, Switzerland), 2: BUAS (Berne, Switzerland), 3: ULB (Brussels, Belgium) INTRODUCTION: The last Swiss health survey testified that only 41% of the Swiss population showed sufficient regular physical activity (HEPA, 2007). If the health benefits of physical activity (PA) are well elaborated, the impact of PA on direct health care costs is less clear. The aim of this study was to compare the average costs to preserve capital-health between 'physically active' and 'physically inactive' Swiss adults. METHODS: Eighty-seven French and German-speaking Swiss participants (age = 51.0 ± 10.4 years and body mass index (BMI) = 24.9 ± 4.3 kg.m<sup>-2</sup>) with stable health status, volunteered in this cross-sectional stratified study. PA, gender, BMI, injuries associated with PA, lifestyle habits (such as fruit and vegetable intake (F&V), smoking status, alcohol consumption status and yearly health care costs were assessed using a questionnaire, administered by interview between November 2010 and 2011. Data were analysed using a linear regression analysis with health care costs as the dependent variable. In addition odds ratio's (OR) and 95% Confidence Intervals [95%CI] were calculated. Therefore, data were dichotomised using following cut-offs: BMI = 25 kg.m<sup>-2</sup>, F&V = 5 portions per day, alcohol consumption = 10 standard drinks per week and PA = 30 minutes moderate PA 5 times per week or 75 minutes vigorous PA once per week, smoking status = 0 cigarettes and PA-associated injuries was expressed as 0=no or 1=yes while for age and health care costs the mean was used as cut-off value. RESULTS: The average annual direct health care costs were 4333 ± 1580 CHF (3580 ± 1306 EUR) for the 'physically active' and 6559 ± 2638 CHF (5422 ± 2181 EUR) for the 'physically inactive' volunteers (p = 0.028). The best linear regression equation for health care costs was established as {-126.0 + (1815.7xPA) + (49.5xAGE) + (273.8xSMOKING)} (R<sup>2</sup> = 0.3413; RMSE = 1808; n = 87; p < 0.0001). OR for health care costs was for PA status = 0.2 [95%CI = 0.1 - 0.7], smoking status = 5 [95%CI = 1.2 - 19.2] and age = 2.9 [95%CI = 1.2 - 7.1] respectively. None of the other variables under investigations showed significant correlations with health care costs. DISCUSSION: These results suggest that the mean difference in the direct health care costs between the 'physically active' and the 'physically inactive' people may be confounded by age and smoking status (Pronk et al., 1999; Pratt et al., 2000). CONCLUSION: Independently of gender, BMI, alcohol consumption, injuries associated with PA or F&V intake the model showed that low physical activity, older age and smoking are risk factors for increased health care costs in this sample of Swiss inhabitants. REFERENCES HEPA (2009). OFSP, document de base. Pratt M., Macéira C., Guijing W. (2000). PSM, 28 (10), 63-70. Pronk N., Goodman M., O'Connor P., Martinson B. (1999). JAMA, 282, 2235-2239.

**STANDARDS OF CARE IN YOUTH SPORT IN ENGLAND AND WALES: EVALUATING LIABILITY**

Greenfield, S., Osborn, G.

*University of Westminster*

Sport, like many areas of civil society, has had to face up to the threat posed by claims for negligence brought on behalf of children injured whilst participating in sport. The potential for negligence claims to impact upon sport more broadly is well established; witness for example the case of Watson v BBC that effectively bankrupted the British Boxing Board of Control. The notion of the duty of care owed is an important one, and one that has been extended by case law in recent years to embrace match officials for example (Smoldon v Whitworth). In addition to this legal duty of care, the CPSU (2009) also talks of a moral duty of care that further develops what is expected of adults in positions of power and control. Whilst the notion of duty is important, it is in fact the extent of this duty, and whether those who owe a duty fall below the standard of care they ought to show, that is the fundamental question that forms the focus of this paper Using the seminal case of Caldwell v Maguire [2001] EWCA Civ 1054, as its point of departure, the paper will analyse the meaning and extent of the standard of care owed. In particular it will consider the impact of issues such as the sport's object, demands and dangers, but will in particular explore the impact of its rules, working culture, conventions and customs, to evaluate the factual matrix that must be considered in determining the standard of care owed in children's sport. CPSU (2009) 'Duty of Care' CPSU Briefing, available online via [www.cpsu.org.uk](http://www.cpsu.org.uk)

**SUPPORT FOR ELITE SPORTS STUDENTS IN HONG KONG SCHOOLS**

Sum, K., Ma, M.

*The Chinese University of Hong Kong*

The purpose of this study is to investigate schools policy or practices in helping Elite Sports Students (ESSs) and how ESSs manage their school/personal lives. The study aims at inductively developing a grounded theory of how ESSs manage their school/personal lives in relation to a conceptual framework based on the following interrelated concepts – such as: identity, socialization and training experiences. An inductive grounded theory methodology will be employed. Use of the techniques and procedures outlined by Strauss and Corbin (1998) enables the researcher to explore the richness and complexity of experiences of ESSs as expressed in their own words, their descriptions of their experiences and exploring the meanings of those experiences for them. Data for grounded theory methods will be collected, coded and related, with the intention of developing a theoretical understanding of the phenomenon, that is, how ESSs make sense of their schools' practices. Purposive sampling will be employed in the open coding stage so that ESSs with different personal and organizational backgrounds can be included. The sample (ten to twenty local schools) will be drawn from different secondary and primary schools in Hong Kong. The researcher can meet the student participants face-by-face and interact with them through semi-structured interviews and focus group interviews. This method allows for differences that unfolded between participants to be maximized, and consequently for relationships between categories to be more robustly tested and verified in the construction of theory. In addition, theoretical sampling will be used to maximize opportunities to enrich the theoretical development of the thesis and to tell the storyline. Two pilot interviews will be conducted to ensure that the interview questions are appropriate and to test the duration of each interview. After pilot interviews, feedback from participants will be collected and the interview questions will be refined and modified. All the interviews will be tape-recorded and transcribed. As triangulation will also be implemented in this study, memos will be used for validating the incoming data from the interviews. As already mentioned, the researcher will write memos to record suggested questions, thoughts, hypotheses and relationships, and diagrams will be drawn to track back through the emerging theory. Through systematic record-keeping and ongoing evaluation of theories and findings, confirmability of the research findings will be considered.

## MUSLIM MAGHREBIAN WOMEN IN CATALONIA INTERPRETING THE POSITION OF ISLAM INTO THE WOMEN'S PARTICIPATION IN SPORT

Nasri, K., Soler, S.

*Inefc - Barcelona*

So much the religious values like the procedure and traditional practices influence the muslim girls and women's daily lives, leisure and participation in sport (Pfister, 2004). On the other hand, many Muslims and not Muslims think that the woman cannot play sports for a wrong belief that Islam prohibits it. But, in effect, the Islam promotes it, the Prophet Muhammad was encouraging always the people to do any physical exercises (Jawad, 2011). From the religious Maghrebian vision, it is accepted and even he promotes the participation of the women in the physical activity (PA), but it conditions how muslim men and women have to do it, banning them to go out semi naked and /or to do it mixed (Nasri, Soler, Serra & Gaztelu; 2010). Departing from all that, we have dedicated to it a part of the fieldwork of the PhD, with the aim to know what the muslim maghrebian women (MMW) believe that it is the position of the Islam into the feminine practice in PA and how it influences in their attitudes and conduct. Which I will present it in this presentation. The data is gathered by a qualitative interviews to MMW in addition to a field-observation in a program of PA, when participate MMW. The results were that all the women believe that the Islam does not prevent them from playing sports, upside-down, it encourages them to do it. Likewise, they speak about the conditions that the Islam puts with regard to the clothes or the type of group. In this point there are different interpretations and positions, ranging from the consideration that if the men in the group are not muslims, it would be not so relevant, until to the coverage of the body even when there are only women. References: • Nasri, K., Soler, S., Serra, P., & Gaztelu, M. (2010). La invisibilidad de la mujer magrebí musulmana en el deporte: causas y perspectivas de cambio. *AEISAD*, Vol: 11, • Pfister, G. (2004). Género y multiculturalidad: la apropiación del cuerpo y la práctica deportiva de las jóvenes inmigrantes. In T. Lleixà & S. Soler (Eds.), *Actividad física y deporte en sociedades multiculturales. ¿Integración o segregación?* (pp. 57-80). Barcelona: Horsori. • Pfister, G. (2009). Equality and social missions: Muslim women and their opportunities to participate in sport and physical activities. *Sport Bilimleri Dergisi, Hacettepe J. of Sport Sciences* (19 (4)), 250-260. • Sagarzazu, I. (2007). Mujer inmigrante y deporte. In A. Miragaya, O. Tavares, C. Kennett & B. Cerezuela (Eds.), *Universidad y estudios olímpicos: Seminarios España-Brasil 2006* (pp. 52-62). Bellaterra: Centre d'Estudis Olímpics (Disponible a: [http://olympicstudies.uab.es/brasil/pdf/ebook\\_UABUGF.pdf](http://olympicstudies.uab.es/brasil/pdf/ebook_UABUGF.pdf)). • Jawad, H., Al-Sinani, Y., & Benn, T. (2011). Islam, women and sport. In T. Benn, G. Pfister & H. Jawad (Eds.), *Muslim women and sport* (pp. 25-40). London & New York: Routledge.

**13:45 - 14:45**

## Poster presentations

### PP-PM68 Sports Medicine 6

#### RELEVANCE OF ABSOLUTE KNEE LOADING DURING VERTICAL JUMP IN ELITE FEMALE ATHLETES

Malfait, B.1, Dingenen, B.1, Staes, F.1, Vanrenterghem, J.2, Verschueren, S.1

*1: KU Leuven (Leuven, Belgium), 2: LJMU (Liverpool, UK)*

**Introduction** Knee injuries are very common in dynamic sports such as football (FB), handball (HB) and volleyball (VB), particularly in women. Anterior cruciate ligament (ACL) injury is a debilitating injury which often influences the further career of athletes. ACL injury risk appears to be associated with knee abduction loading in tasks such as the drop vertical jump (DVJ), which is therefore commonly used as a functional screening test (Hewett 2005). However, previous research provides no clear consensus about the use and interpretation of either absolute or relative knee joint moments during DVJ tests. Therefore, the purpose of this study was to examine differences in absolute knee loading during DVJ tasks between athletes from different sports and whether these differences remain after normalization for anthropometrics. **Methods** 43 injury-free female athletes (22 FB, 11 HB and 10 VB) volunteered to participate (mean age=21.1±3.4yrs). All subjects performed 3 DVJs from 30cm after a warm-up protocol. Kinematics and kinetics were measured according to the lower limb trunk model (Vanrenterghem 2010) using a 6 camera motion analysis system (Vicon) and 2 separated force plates (AMTI). Peak external knee abduction moments (eKAM), external knee flexion moments (eKFM) and peak vertical ground reaction forces (vGRF) were calculated for each leg between touchdown and take-off. Jump height (JH) was calculated using the vertical displacement of the center of mass. **Results** Jump height was significantly higher in VB than in FB ( $p<0.001$ ) and HB ( $p<0.001$ ). In frontal plane, absolute dominant eKAM was significantly higher in VB compared to HB ( $p=0.034$ ). In sagittal plane, absolute dominant eKFM was significantly higher in VB compared to FB ( $p=0.014$ ). No significant differences in peak vGRF between groups were found. After normalization of eKAM and eKFM for body weight and height (%Nm), no significant differences in relative external knee moments between groups were found. Jump height was not significantly correlated with the external knee moments in all groups. **Discussion** The non-significant correlation between JH and external knee moments in FB, HB or VB suggests that jump height is not related to knee loading during a DVJ task. Body weight and height had a clear effect on knee loading. The VB showed a significant greater absolute eKAM and eKFM compared to the other groups and can therefore be considered to be at higher risk for ACL injury. This may, with respect to injury prevention, suggest that the absolute knee loading remains an important variable due to the strain produced by these loadings on static and dynamic restraints of the knee. **References** Hewett et al (2005). *Am J Sports Med* 33,492 Vanrenterghem et al (2010). *Gait&Posture* 31,517-521

#### THE EFFECTIVENESS OF A SPECIFIC WARM-UP PROTOCOL TO ENHANCE STATIC AND DYNAMIC POSTURAL CONTROL IN FEMALE TEAM HANDBALL PLAYERS

Steib, S.1, Zahn, P.1, Zech, A.2, Pfeifer, K.1

*1 University of Erlangen-Nuremberg, 2 University of Hamburg*

**Introduction:** Lower extremity (LE) injuries are very common in team handball, especially in female athletes. The risk of sustaining a LE injury has been associated with several internal factors, including poor postural control (Willems et al. 2005). The aim of this study was to investigate the effectiveness of a specific warm-up programme to enhance static and dynamic postural control abilities in female team handball players. **Methods:** An adapted version of 'The 11+' (Soligard et al., 2008), a warm-up programme for injury prevention in soccer,

was implemented in three German female handball teams (4th division). A total of 41 players were randomized into a control (n=20, age = 24.00 ± 5.59 years, height: 168.95 ± 4.57 cm, mass: 65.90 ± 6.77 kg) and an intervention group (n=21, age: 23.95 ± 6.27, height: 171.43 ± 7.02, mass: 65.52 ± 7.69). Subjects in the intervention group (IG) carried out the adapted protocol instead of their regular warm-up routine for 11 weeks. The programme consisted of seven exercises targeted at increasing joint and trunk stability as well as postural control, and was performed prior to each training session and before competition. The control group (CG) kept their regular training regime. The main outcome measures were: COP velocity (vCOP) in single-leg-stance, mean reach distance in the 'star excursion balance test' (SEBT) and the 'dynamic postural stability index' (DPSI) calculated from a unilateral jump-landing task. A two factorial linear mixed model (random intercept and slope) was specified for each of the main outcomes with 'group' and 'time' as fixed factors. Results: No significant differences existed in group demographics at baseline. After 11 weeks of training, subjects in the intervention group significantly (p<.05) improved in the SEBT (5.6%) compared to the control group (3.6%). The same trend existed for the reduction of vCOP (IG: -16.1%, CG: -7.1%) but this was not statistically significant. No significant changes were seen for the DPSI (IG: 2.9%, CG: -0.8%). Conclusions: A specific warm-up programme regularly incorporated prior to training and competition can be effective to enhance some aspects of postural control in female handball players. References: Soligard T, Myklebust G, Steffen K, Holme I, Silvers H, Bizzini M, Junge A, Dvorak J, Bahr R, Andersen TE. Comprehensive warm-up programme to prevent injuries in young female footballers: cluster randomised controlled trial. *BMJ*. 2008;337:a2469. Willems TM, Witvrouw E, Delbaere K, Philippaerts R, Bourdeaudhuij I de, Clercq D de. Intrinsic risk factors for inversion ankle sprains in females - A prospective study. *Scand J Med Sci Sports*. 2005;15(5):336-345.

## CHANGES IN POSTURAL SWAY IN GOLF PUTTING AMONG CHILDREN WITH AND WITHOUT DEVELOPMENTAL COORDINATION DISORDER

Chen, F., Wu, S., Tsai, C., Perng, W.

*National Pingtung University of Science and Technology*

**Introduction** Developmental coordination disorder (DCD) refers to developmental impairments of coordination and difficulties in movement skills that children exhibit, that are not derived from general intellectual, sensory or motor neurological impairment (APA, 2000). Previous research has reported group differences in the control of postural sway during stance (Geuze, 2003) when comparing children with DCD to typical developing children (TDC). More important, the differences in postural sway between the two groups was more noticeable in more challenging conditions (Tsai et al., 2008). Children with DCD frequently encounter difficulties while engaging in physical activities which demands on postural control. The present study assessed the effects of postural sway in golf putting among children with and without DCD. **Methods** Eight 11-to-12-year-old children with DCD and TDC participated in golf putting on an indoor practice green while standing on a force platform. There were two conditions of difficulties: Low (LD) and High (HD). The putting distance were 1.5 and 3.5 feet in the LD and HD conditions, separately. Postural sway data were collected using a Nintendo Wii balance board. Putting performance were recorded as the measured distance (cm) between the ball and the hole once the ball had come to a complete stop after being putted (successful shots recorded as 0 cm). **Results** Averaging across groups, postural sway in anterior/posterior axis decreased significantly from the LD to the HD condition. In addition, a Group × Task Difficulty interaction was significant for positional sway in the AP axis,  $F(1, 6) = 19.15, p < .05$ . The interaction effects revealed that children with DCD reduced less postural sway from LD to HD condition in anterior/posterior axis compared to TDC. That is, the effect of task difficulty (HD vs. LD) on postural activity differed for the two groups. **Discussion** Stoffregen et al. (2000) proposed a functional integration between postural activity and a suprapostural task: control of postural motion is not an aim in itself, but is valuable to the extent that it promotes success of other behavioral goals. Postural control is tuned to positively mediate performance of suprapostural tasks. Our experiments suggest that children with DCD seem less able to modulate their postural sway than their typically developing peers, when engaged in golf putting. It support the notion that and postural sway are not autonomous systems but are linked to the performance of physical activity. Our experiments bolster the proposition that DCD is a perceptual motor deficit characterized by a diminished perception-action coupling when a motor response is linked to tasks that demand increased perceptual effort. **References** American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed. 2000. Geuze RH. (2003). *Human Movement Science*, 22, 527-548. Tsai CL, Wu SK, Huang CH. (2008). *Human Movement Science*, 27, 142-153. Stoffregen TA, Pagulayan RJ, Bardy BG, Hettinger LJ. (2000). *Human Movement Science*, 19, 203- 220.

## EFFECT OF PARTICIPATION IN BOXING ON POSTURAL STABILITY AND COGNITIVE FUNCTION

Otomo, M.1, Iida, Y.2, Nakamura, C.2, Torii, S.2

*1) Graduated School of Sport Sciences, Waseda University 2) Faculty of Sport Sciences, Waseda University*

**Introduction** Brain concussion is considered as relatively mild type of head injury. Assessment of postural stability and cognitive function are often used to evaluate the severity of concussion. As boxing is the competition to damage the head and trunk of the opponent, head injuries including brain concussion occur frequently. Head blows are repeatedly given to boxers in training and matches, even if they are not diagnosed as concussion. Until now, there are few studies investigating the effects of repetitive blows on the brain of boxers. This study investigated the change of postural stability after the training and matches of boxing. In addition, we also investigated a one-year change of postural stability and cognitive function of boxers. **Methods** Participants were 25 collegiate boxers. Nine boxers were assessed by Balance Error Scoring System (BESS) before and after the training of boxing, eight boxers were assessed by BESS before and after matches, and 21 boxers were assessed as one-year survey by BESS and Standardized Assessment of Concussion (SAC). All boxers were surveyed their competition history and injury history by questionnaire. Moreover, we counted number of hit given to the participants from recorded video of the matches. **Analyses** A two-way analysis of variance was used to examine the relationship about the changes of BESS scores before and after training or matches (the timing factor). A Pearson's product-moment correlation coefficient was used to examine the relationship between the number of blow and BESS score, rate in the matches. A t test was used to compare one-year change of BESS score and SAC score. Statistical significance was set at  $P = .05$  for all analyses. **Results** A two-way analysis showed significant increase of BESS scores in the timing factor, suggesting decreased postural stability only after matches. The more blows given, the more increase in BESS scores. There was no significant difference in one-year change of both BESS and SAC. **Discussion** The training of boxing is conducted at conditional knock up and thus include few dangerous blows, resulting in no decrease in postural stability. On the other hand, the intensity of the blow in the match is considered stronger than training, bringing down decrease in postural stability. In addition, players given many blows to the head in the match demonstrated more decrease in postural stability, suggesting transiently decreased neural function even if they were not diagnosed as concussion. One-year survey showed that participation in boxing did not affect neural function such as postural stability and cognitive function.



### KNEE BIOMECHANICS DURING SIDE-STEP MANEUVERS IN ANTICIPATED AND UNANTICIPATED CONDITIONS

Saho, Y.1, Fukubayashi, T.1, Sakaguchi, M.1, Sanomura, M.1, Nakamura, C.1

1: Waseda University

**Introduction** In their video analysis, Koga et al. (2010) reported that non-contact anterior cruciate ligament (ACL) injuries occur 40 msec after foot contact. ACL injuries often occur during reactive movements, such as an unanticipated (UN) side-step, which are known to exert higher peak knee loads than those occurring during anticipated (AN) maneuvers (Besier 2001a,b). However, it is unclear whether UN situations produce higher initial loads that cause ACL rupture. This study aimed to investigate whether the UN condition is more risky than the AN condition during side-step tasks, with particular focus on the initial phase of foot contact. **Methods** Nine healthy male athletes performed 3 maneuvers after a standing broad jump—side-steps at 45° (S45) and 90° (S90) and crossover-steps at 45° (C45)—under AN and UN conditions. By using 3 LED signals, subjects were given cues for 1 of the 3 maneuvers in both conditions. Subjects received the cues before the trial during AN. During UN, subjects received a visual cue after jumping and before reaching the step position. Three-dimensional motion analysis system and force plate were used to record the three-dimensional marker positions of lower extremity and ground reaction forces. We calculated the knee joint angle by using the joint coordination system and external knee moment by using inverse dynamics. All subjects performed the stepping task with their right leg. Only S45 and S90 were analyzed in this study. **Results** During S45 maneuvers, the external knee abduction moment in UN until 40 msec after foot contact was significantly higher than that in AN ( $0.16 \pm 0.10$  Nm/kg vs.  $0.08 \pm 0.09$  Nm/kg,  $p < 0.05$ ). During S90, the external knee internal rotation moment in UN until 40 msec after foot contact was significantly higher than that in AN ( $0.28 \pm 0.49$  vs.  $0.12 \pm 0.08$ ,  $p < 0.05$ ). Knee flexion/extension, abduction/adduction, and internal/external rotation angle at the foot contact and peak values did not differ between conditions. **Discussion** Knee abduction and internal rotation moment are risk factors for knee ligament injury. Koga et al. (2010) reported that knee internal rotation and knee abduction angle increased until 40 msec, at which point ACL rupture has already occurred. Our results indicate that UN steps increase knee abduction and rotational moment at the initial phase and at peak value. This indicates that UN tasks may help identify the risk of knee ligament injury. Perhaps ACL rupture occurs in the early phase of foot contact. Therefore, it is important to note the early phase of foot contact and peak value. **References** Koga et al. (2007). *AM J Sports Med*, 38, 2218-2225. Besier TF et al. (2001a). *Med Sci Sports Exerc*, 33, 1168-1175. Besier TF et al. (2001b). *Med Sci Sports Exerc*, 33, 1176-1181.

### INCREASE IN CONTACT LENS USE BY WATER POLO PLAYERS DUE TO A CHANGE IN PRODUCT QUALITY: A 20-YEAR STUDY OF JAPANESE COLLEGE PLAYERS

Komori, Y., Kobayashi, D., Murase, Y., Enomoto, I., Takagi, H., Kono, I.

Doshisha University

**Introduction** Water polo is a heavy contact team sport, which is why it is also regarded as rugby football being played in water. According to the rules of water polo, players shall remove any articles likely to cause injury before taking part in a game. Therefore, wearing eye-glasses or swimming goggles is prohibited in principle. This rule forces players with low visual acuity to use contact lenses during play. However, the consequences of contact lens use by water polo players have not been reported. The purpose of this study was to investigate contact lens use by competitive water polo players from Japanese colleges in 1991, 1996, 2001, 2006, and 2011. **Methods** We investigated the following 5 groups of male water polo players from Japanese colleges: a group of 114 players in 1991, 118 players in 1996, 121 players in 2001, 118 players in 2006, and 130 players in 2011. Information about the use of contact lenses during play, the different types of contact lenses, and any previous cases of ophthalmopathy was obtained through a self-report questionnaire. **Results** Fifty-four percent of the players were using contact lenses during water polo play in 1991 ( $p < 0.01$ ); more than 74% in 1996; 89% in 2001; 84% in 2006; and 86% in 2011. While 96% of the contact lenses used by the players in 1991 were soft type (SCL), 74%, 92%, 86%, and 88% of the contact lenses used in 1996, 2001, 2006, and 2011, respectively, were disposable type (DSCL). The problem was that the players using contact lenses during play had sustained significantly higher corneal and conjunctival damage than players using vision correction devices in their daily lives and players without vision correction devices ( $p < 0.01$ ). **Conclusions** These findings demonstrate that a high percentage of players were using vision correction devices while playing water polo between 1996 and 2011. This may be correlated with the fact that many players were DSCL users. DSCL is currently considered the optimal vision correction device for water polo players. This study suggested that increasing contact lens use for water polo players may induce beneficial effects in terms of maintaining good vision. **References** 1) Komori Y, et al. (1998). Wearing contact lens might prevent corneal damages and keep visual functions during Water polo play. *Med sci sports exerc*, 30, s157. 2) Komori Y, et al. (2007). Contact lens use among water polo players at different age levels. *Jpn J Phys. Fitness Sports Med*, 56, 105-114.

### THE IMPLEMENTATION OF LATERAL TRUNK MOTION IN TWO-DIMENSIONAL VIDEO ANALYSIS DURING UNIPODAL FUNCTIONAL SCREENING TESTS IN ELITE FEMALE ATHLETES

Dingenen, B., Malfait, B., Verschueren, S., Staes, F.

KU Leuven

**Introduction** Two-dimensional (2D) video analysis is a valid and reliable method to measure knee valgus (KV) during functional screening tests (Munro et al., 2011). However, focusing only on this angle may be too limited and may lead to misinterpretations when assessing knee injury risk, as it is recognized that the lower extremity acts as a linked system of interdependent segments. Increased ipsilateral trunk motion (LTM) during unipodal tasks may influence hip adduction (HA) and knee abduction loading and therefore increase knee injury risk in female athletes (Hewett and Myer, 2011). The purpose of this study was to implement the measurement of LTM in 2D video analysis, and to examine the relationship between LTM, HA and KV during unipodal functional screening tests. **Methods** A total of 63 elite female athletes (35 soccer, 16 handball and 12 volleyball) who were injury- and pain free were tested (age:  $21.28 \pm 3.36$  years). LTM, HA and KV were measured during the deepest phase of the single-leg drop vertical jump (SLDVJ) and single-leg squat (SLS) with a standard digital camera. Smaller angles represent more LTM, HA and KV. Pearson correlations coefficients were calculated between angles within and between tests. **Results** In the SLDVJ test, LTM was significantly correlated with HA ( $r = -0.537$ ;  $p < 0.001$ ) and KV ( $r = -0.254$ ;  $p = 0.045$ ). In the SLS test, LTM was significantly correlated with HA ( $r = -0.527$ ;  $p < 0.001$ ) and KV ( $r = -0.367$ ;  $p = 0.004$ ). Furthermore, LTM ( $r = 0.315$ ;  $p = 0.015$ ), HA ( $r = 0.396$ ;  $p = 0.002$ ) and KV ( $r = 0.407$ ;  $p = 0.001$ ) were significantly correlated between SLS and SLDVJ. **Discussion** The results of the present study show that more LTM is significantly correlated with less HA and KV during unipodal screening tests, suggesting that LTM can be used as a compensation mechanism for poor hip and knee control. As a consequence, focusing only on KV angles can mimic knee injury risk, as an increased LTM can increase knee abduction load. The combination of more LTM and more KV, may lead to the

highest knee injury risk (Hewett et al., 2009). Furthermore, the amount of LTM, HA and KV was significantly correlated between the SLS and SLDVJ. This indicates that in general the same strategy was used to complete both tasks. These results support the fact that the knee does not function as an isolated joint, but as a part of the kinetic chain. Therefore, we suggest to implement the measurement of LTM in the 2D video analysis of functional screening tests. References Munro A, Herrington L, Carolan M. (2012). *J Sport Rehabil*, 21, 7-11. Hewett TE, Myer GD. (2011). *Exerc Sport Sci Rev*, 39, 161-166. Hewett TE, Torg JS, Boden BP. (2009). *Br J Sports Med*, 43, 417-422.

### THE INFLUENCE OF PHYSIOLOGICAL LOAD ON POSTURAL CONTROL- IS THERE A BALANCE THRESHOLD?

Ruzic, L.1, Prpic, T.2, Tudor, A.2

1: Faculty of Kinesiology (Zagreb, Croatia), 2: Clinic for Orthopaedic Surgery-Lovran (Rijeka, Croatia)

**Introduction** The postural control is an essential factor in prevention of falls and consequently prevention of injuries and an important ability for success in many sports. The aim of the study was to evaluate the influence of the physiological load on postural control. Special attention was directed towards the identifying the intensity level in which the major deterioration in static and dynamic balance abilities occurs. **Methods** Thirty subjects were randomly divided into two groups. We conducted multistage all-out exertion protocol of spiroergometric testing on cycle-ergometer until exhaustion with continuous measurement of objective ventilatory-metabolic as well as subjective parameters of fatigue. The each level of the protocol lasted for three minutes and was followed with three minute breaks during which the subjects underwent the static and the dynamic balance testing. In a control group, the protocol encompassed only balance testing procedures followed by 3 minute rest periods. After the completion of the testing procedures, the five intensity zones were determined according to the ventilatory-metabolic parameters at different loads. **Results** The significant differences in both static and dynamic balance tests were found in experimental, exercising, group between the test stages. The post-hoc analyses revealed the significant negative effect of fatigue on the static balance with three visible „balance thresholds“. The first threshold was at the rest to work transition, the second at the anaerobic threshold and the third at the maximal exertion level. The dynamic balance was also negatively affected with fatigue, however no „balance thresholds,“ were clearly identified. No significant changes in neither static nor dynamic balance abilities were observed in the control group so the changes in the experimental group could have been attributed to the fatigue. **Discussion** As already at the intensity 60-65% of HRmax the significant decrease of balance ability was found, that is the intensity level at which the patients in rehabilitation process should train their proprioceptive/balance. However, as in athletes the demands of the sport are usually higher and considering that the next decrease in balance was identified just above the anaerobic threshold, we could advise that in order to obtain the most of their balance training the athletes should aim to train intensity zones above the anaerobic threshold. **References** Yaggie JA, McGregor SJ.(2002). *Arch Phys Med Rehabil*,83,224-8. Holm I, Fosdahl MA, Friis A, Risberg MA, Myklebust G, Steen H.(2004). *Clin J Sport Med*,14,88-94. Nardone A, Tarantola J, Galante M, Schieppati M.(1998). *Arch Phys Med Rehabil*,79,920-4. Springer BK, Pincivero DM.(2009). *Gait Posture*,30(1),50-4.

### COMPARATIVE AND RELIABILITY STUDIES OF NEUROMECHANICAL LEG MUSCLE PERFORMANCES BETWEEN ELITE AND RECREATIONAL ATHLETES

Yin, N.H., Wang, H.K., Un, C.P., Lin, K.H., Shiang, T.Y., Chang, E.C., Su, S.C.

*School and Graduate Institute of Physical Therapy*

**Introduction** The aim of this study is to compare the neural profiles of leg muscles between elite and recreational athletes and to analyse the reliability and correlations between their profiles and biomechanical performances. **Methods** Two types of volleyball players were recruited to include 10 elite and 20 recreational athletes. The outcome measures were compared between the groups, including soleus H-reflex, first volitional (V) wave, normalised rate of electromyography (EMG) rise (RER) in the triceps surae muscles, and RER ratio for the tibialis anterior and soleus muscles, normalised root mean square (RMS) EMG in the triceps surae muscles, antagonist co-activation of the tibialis anterior muscle, rate of force development (RFD), and maximal plantar flexion torque and jump height. **Results** Neural profiles in the elite group showed greater normalised V waves, normalised RER 0–75 ms in the medial and lateral gastrocnemius, RER ratio, and normalised RMS EMG of the soleus and lateral gastrocnemius muscles and less antagonist co-activation of the tibialis anterior. The elite athletes showed greater maximal torque, absolute RFD at 0–100 ms and 0–200 ms and less in the normalised RFD at 0–30 ms, 0–50 ms and 0–100 ms of plantar flexion when compared to the results of the recreational group. Neural profiles correlated to fast or maximal muscle performances, except for RER ratios. **Discussion** There are differences in the descending neural drive and activation strategies in leg muscles during contractions between volleyball athletes competing at different levels (Aagaard et al., 2002; Holtermann et al., 2007). These measures are reliable and correlate to biomechanical performances. **References** Aagaard P, Simonsen EB, Andersen JL, et al. (2002). *J Appl Physiol*, 93,1318-1326. Holtermann A, Roeleveld K, Engström M, et al. (2007). *Eur J Appl Physiol*,101,301-312.

**13:45 - 14:45**

## Poster presentations

### PP-PM69 Sports Medicine 7

#### EFFECTS OF ENDURANCE TRAINING AND COMPETITION IN THE URINARY FUNCTION OF MARATHONERS

Puggina, E.F., Machado, D.R.L., Tourinho Filho, H., Barbantij, V.J.

*University of Sao Paulo*

**Introduction** Marathon is the longest running event in the Olympic calendar. The endurance training and competitions lead to many physiological changes and some of the least investigated are the kidney function and urine changes in endurance athletes during the training season and competitions. The aim of this study was to verify the renal function and urine changes induced by endurance training and a marathon using urine indicators. **Methods** Nine male marathoners (34.78±10.62 years, 70.54±7.88 Kg, 170.15±8.06 cm) participate in the study. Urine samples were collected in two moments of training (M1- beginning of the training program and M2- after 10 weeks of training) and in two moments of the competition (M3- before the competition and M4- after the 2010 São Paulo Marathon). Urine pH was

measured using reagent tapes, urine density with manual refractometer. Proteinuria was assayed by colorimetric method and red and white blood cells by microscopy. Results were analyzed using Kolmogorov and Smirnov test, One Way Anova and Tukey-Kramer to detect differences,  $p < 0.05$ . Results For urine pH and density were found values of  $6.62 \pm 0.51$  and  $1011.87 \pm 2.58$  in M1,  $6.61 \pm 0.50$  and  $1011.86 \pm 2.56$  in M2,  $6.63 \pm 0.53$  and  $1011.88 \pm 2.60$  in M3 and  $5.37 \pm 0.50$  and  $1030.62 \pm 1.76$  respectively. For the cell counts were found  $1.150 \pm 350.51$  and  $2087.5 \pm 180.77$  units/mL in M1,  $1087.5 \pm 180.77$  and  $2.150 \pm 226.78$  in M-2,  $1275 \pm 452.77$  and  $2137.5 \pm 199.55$  in M3 and  $56625 \pm 42.14$  and  $6437.5 \pm 4065.9$  for erythrocytes and leucocytes respectively. Finally, urine protein excretion revealed  $5.11 \pm 2.33$  mg/dL in M1,  $7.87 \pm 1.95$  in M2,  $6.53 \pm 2.44$  in M3 and  $30.75 \pm 12.73$  in M4. Differences were found when M4 was compared to the other collection moments for all variables studied. Discussion The changes in urine pH and density are indicators of dehydration during the marathon, as well indicators of acid metabolites excretion induced by the effort. Indicating that the hydration strategy adopted during the race was not effective. Proteinuria was observed after the marathon and this effect was probably due to changes in the glomerular permeability to plasmatic proteins and endocrine factors. For blood cells, the excretion of erythrocytes in urine is attributed to changes in the glomerular permeability and urinary tract damage caused by the successive strides during the race. Conclusion The training program for the São Paulo Marathon did not interfere in the hydration status and renal function of the athletes, probably due to the 24h rest between the last training session and the collections performed in M1, M2 and M3. However, the results found in M4 show an important impact of the competition in the hydration and in the kidney function and glomerular permeability to the macromolecules and cells.

### HEART RATE KINETICS DURING SYNCHRONIZED SWIMMING SOLO ROUTINES IN RELATION TO BREATH HOLDING AND BODY POSITION

Iglesias, X., Rodríguez-Zamora, L., Barrero, A., Chaverri, D., Erola, P., Irúrtia, A., Rodríguez, F.A.

*INEFC-Barcelona, University of Barcelona*

Introduction Performance times for synchronized swimming (SS) solo routines range from 2min for the technical solo (TS) to 3min for the free solo (FS) (FINA, 2009-2013). Homma (1994) found that the, on the average, 62.2% of this time is spent underwater, while Alentejano et al. (2008) reported a lower value (46%). It is known that synchronized swimmers experience diving bradycardia during breath holding (BH) bouts underwater (Gemma and Wells, 1987; Rodríguez-Zamora et al., 2012). This study aims to determine the frequency and duration of face immersion periods in relation with body position, and to characterize heart rate response in technical and free solo SS routines. Methods Eight elite synchronized swimmers ( $20.8 \pm 4.9$  years, 3 Olympic medalists) were monitored while performing a total of 11 routines during an official national championship in the technical (TS,  $n=5$ ) and free solo (FS,  $n=6$ ) programs. Heart rate (HR) was continuously monitored using a waterproof beat-by-beat monitor. All routines were recorded using a digital video camera (Panasonic AG-DVX100BE 3-CCD Mini-DV Cinema Camcorder, 50i PAL) at a rate of 50Hz and a frame rate of 50 frames•s<sup>-1</sup> with an interlaced resolution of 720x576, which allows a time resolution of 0.02s. By frame-by-frame video analysis, two face immersion conditions (face-in and face-out), and three body positions (horizontal, upright, and inverted position) were identified and timed. Results and discussion Mean HR during the 11 solos was  $153.2 \pm 16.4$  beats•min<sup>-1</sup>. HR peak was  $190.0 \pm 13.2$  beats•min<sup>-1</sup> with frequent interspersed bradycardic events down to  $80.7 \pm 31.3$  beats•min<sup>-1</sup>. Mean face-in HR (beats•min<sup>-1</sup>) was lower ( $150.1 \pm 31.7$ ) than face-out ( $156.1 \pm 28.0$ ) ( $P < 0.000$ ). HR range during the whole routine was  $109.4 \pm 27.3$  despite the high intensity of the exercise performed underwater. Mean HR at horizontal position ( $156.0 \pm 27.6$ ) was higher than at upright ( $155.2 \pm 28.1$ ) and inverted ( $147.4 \pm 33.6$ ) body position ( $p < .0001$ ). The time spent underwater (face-in) was longer (67.0%) than in previous reports (62.2%; Homma, 1994). Conclusions The autonomous nervous system plays a fine tuned regulation of HR in this unique type of exercise in which sympathetic and parasympathetic activation and inhibition are continuously interplaying according to the swimmer's body position, breath holding condition, and intense exercise. Our main finding is that the main cardiovascular response to face immersion (i.e. bradycardia) is powerful enough to counteract exercise tachycardia during the breath holding phases of intense exercise. References FINA. Synchronized Swimming Official Rules. [Code of points]. 2009-2013. Homma M. (1994). *Med Sport Sci* 39,149-154. Gemma KE, Wells CL. (1987). *Physi Sports Med*, 15(10),99-106. Alentejano TC, Marshall D, Bell GJ. (2010). *Int J Sports Physiol Performance*, 3(1),31-40. Rodríguez-Zamora L, Iglesias X, Barrero A, Chaverri D, Erola P, Rodríguez FA. (2012, 4-7 July). 17th annual Congress of the ECSS, Bruges (Belgium).

### DISTRIBUTION OF BONE AND MUSCLE MASS IN WATER POLO PLAYERS

Iizuka, S.I, Suguru, T.2, Yukako, I.2

*1: GRADUATED SCHOOL OF SPORT SCIENCES, WASEDA UNIVERSITY, 2: FACULTY OF SPORTS SCIENCES, WASEDA UNIVERSITY*

Introduction There are many previous studies demonstrating that different types of sports activity induce different distribution of bone and muscle in athletes. The knowledge about the composition of the elite athletes helps to build and maintain the body of young athletes. However, there is no report about the water polo players in Japan. In order to clarify the distribution on body composition of water polo players, we were compared with those in handball player and competitive swimmer. Methods 20 male water polo players (WP;  $19.7 \pm 1.3$  years) and 29 male competitive swimmers (SW;  $20.2 \pm 0.8$  years) and male handball players (HB;  $20.4 \pm 1.0$ ) were recruited to this study, all of them were collegiate athletes. Body composition was assessed using dual X-ray absorptiometry (DXA). We compared their bone mineral content (BMC), bone mineral density (BMD) and lean mass (LM). Bone mineral mass and lean mass was adjusted by body height. Results Bone mineral mass and density of the dominant arm of SM was significantly lower than those of WP and HD. However, those of the non-dominant were similar between three athlete groups. Thus, the side-to-side difference in arm BMC and BMD was lower in SM. For lean mass, there is no difference in each arm between the three athlete groups, and side-to-side difference in lean mass of the arm in WP was significantly larger than those of SW. On the other hand, BMC, BMD and LM of the leg of HD were significantly higher than those of SW and WP, and side-to-side difference in BMD of the leg was significantly larger in HD than those of WP. Discussion It is considered that the higher BMC, BMD and lean mass in dominant arm of WP and HD were gained by their throwing motion. However, the higher lean mass in legs of HD seemed to be attained by weight bearing activity such as running and jumping, those not involved in activity of WP and SW. These results suggest that the mechanical stress imposed to specific body sites stimulate site-specific modeling and accumulation of bone and muscle.

## CARDIAC TROPONINS IN YOUNG MARATHON RUNNERS

Traiperm, N., Gatterer, H., Wille, M., Burtscher, M.

*Department of Sport Science, Medical Section, University of Innsbruck*

**Introduction** Increases of troponins have been shown to be relatively common among adult marathon finishers with levels typically diagnosed in acute myocardial infarction (Fortescue EB et al., 2007). Especially less marathon experience and younger age seem to be associated with more pronounced elevations of serum troponins (Tian Y et al., 2006). Data on adolescent runners have only been reported for prolonged running in laboratory-based settings and after 21 km running (Fu F et al., 2009, Tian Yet al., 2006, Nie J et al., Frank H Fu et al., 2010) and are practically missing for a whole marathon distance. Therefore, the aim of this study was to investigate cardiac troponins in young marathon runners of both sexes. **Methods** Forty young Asian runners (20 healthy males and 20 females) aged between 13-17 years participated in this study. Blood samples were taken before, immediately after and 24 hours after a standard marathon race for determination of cardiac troponin T and troponin I. All participants had to undergo a routine physical examination, electrocardiogram (ECG) and provided a detailed training history. The experimental protocol was approved by the Khon Kaen University Ethics Committee for Human Research, and was performed as a PhD thesis at the Department of Sport Science of the University of Innsbruck. Results Thirty seven runners completed the race. In 30 out of 37 participants the levels of troponin T and/or troponin I exceeded the upper reference limit of 0.01 and 0.1 ng/mL immediately after the race and in 3 participants these levels were even higher than the reference range for acute myocardial infarction (>0.1 ng/mL and >0.5 ng/mL for troponin T and I, respectively). Twenty four hours after the marathon troponin levels of all participants returned below the upper reference limit. Troponin T values of male participants were negatively related to their training history (35±15 months of training). **Discussion** These findings imply also for young runners that elevated cardiac troponin levels after finishing a single marathon might rather be a physiological than a pathological response and that a preceding long period of regular running may be protective at least in young male runners. **References** Fortescue EB, Shin AY, Greenes DS, Mannix RC, Agarwal S, Feldman BJ, Shah MI, Rifai N, Landzberg MJ, Newburger JW, Almond CS. (2007). *Ann Emerg Med*, 49,137-143. Tian Y, Nie J, Tong TK, Cao J, Gao Q, Man J, Shi Q, Liu W. (2006). *J Sports Med Phys Fitness*, 46,481-488. Fu F, Nie J, Tong TK. (2009). *Int J Sports Med*, 30,168-172. Nie J, Tong TK, George K, Fu FH, Lin H, Shi Q. (2011). *Scand J Med Sci Sports*, 21,625-629. Frank H Fu, Jinlei N, Keith G, Tom K T, Hua L, Qingde S. (2010). *J Exerc Sci Fit*, 8,61-66.

## CHANGES IN PERIPHERAL BLOOD CELL SUBPOPULATIONS IN ELITE KAYAKERS DURING A TRAINING SEASON

Borges, G.F.1,4, Rama, L.1, Alves, F.2, Pedreiro, S.3, Paiva, A.3, Teixeira, A.M.2

*1:FCDEF-UC (Coimbra-Portugal), 2: FMH-UTL (Lisbon, Portugal), 3:HC (Coimbra,Portugal), 4: ISB-UFAM (Brazil).*

**Introduction** Prolonged strenuous exercise has been associated with a depression of immune function. The aim of this study was to investigate if changes in training load could affect peripheral blood leukocyte counts and percentage, including B, T, TCD4+, TCD8+ and Natural Killer (NK) lymphocytes in elite kayakers during a training season. **Methods** The sample comprised 8 male elite canoeists, 22±4.0 years old, 78.5 ±6.9kg body mass and 178.0±5.6cm stature. The control group were 6 health males, 18.1±5.0 years old, 73.0± 6.6kg body mass and 172.5±4.6cm stature. Blood samples were collected at different moments of the training season: at the beginning, after an off training period of 6 weeks (t0), at the 11th week after the application of high weekly training volumes (t1), at week 26 after a cycle of intense training (t2), at the 31th week at the end of a tapering phase (t3). Blood samples were collected from the non-athlete group at 3 time points: t1 early November, t2 late February and t3 early April. Lymphocyte subpopulations were determined by flow cytometry (FACSCalibur; BD, USA). Statistical analysis was done using ANOVA. Significance was set at P<0.05. **Results** At the time of increased training volume (t1) granulocytes counts decreased and remained lower until the end of the training season. The number of lymphocytes decreased at the time of higher intensity training (t2) but recovered to baseline values at t3. On the other hand no changes were for the lymphocyte subpopulations between baseline and the other time points, except for the CD3+CD56+CD8+ subpopulation that showed an increase at t2 and t3. However, at the end of the taper period (t3) total cell numbers in the CD3+, CD3+CD4+, CD3+CD8+, CD3+CD8-CD4-, CD3-CD19+, CD3-CD56+, CD3-CD56+CD8- and CD3-CD56+CD8+ subpopulations increased when compared to t1. No differences for the non-athletes were observed between the time points studied. At the beginning of the training season, both CD3+ and NK cell counts were lower in the kayakers than in the non-athletes. **Discussion** Our data suggests that increased training load leads to a decrease in lymphocyte counts at the periods of high training loads. When compared to the non-athlete group, lymphocyte numbers were lower in the kayakers at t0, t1 and t2. Although not significant we see a decrease in all the lymphocyte counts subpopulations when volume reaches it's highest values (t1). When the training season reaches the high intensity phase (t2) values are already increasing and will do so until the end of the season. Periods of heavy training have been associated with immune depression (t1) normally reversible by a tapering period. **References** 1. Gleeson M. & Bishop NC. (2005) *Ann Transplant*, 10: 43

## CORRELATION BETWEEN STRETCH RESISTANCE AND MUSCLE STRENGTH OF THE TRICEPS SURAE MUSCLE

Kudo, H., Sano, F.

*Mejiro University*

**Introduction** A tendon is known as a poor tensility tissue, and convey muscular tension to a bone. In recent years, it also turned out that a tendon generates power like muscles (Fukunaga,2005, 2009). On the other hand, it is not easy for many patients to return to the original athletic ability, although the sport return rate after an Achilles tendon rupture is high. Moreover, it has also been reported that viscoelasticity (resistance torque of passive ankle dorsiflexion) of Achilles tendon decrease in postoperative case (Kurata, 2010). Therefore, the purpose of this study was to elucidate that correlation between stretch resistance (resistance torque of passive ankle dorsiflexion) and muscle strength of the triceps surae muscle. **Methods** This study comprised 30 healthy college student volunteers (15 male and 15 female). In all volunteer, the muscle strength of the triceps surae muscle and the resistance torque of passive ankle dorsiflexion were measured using Isokinetic dynamometer BIODEX SYS-TEM 3 (Sakai medical co., Tokyo, Japan) in prone position with knee straight position. A correlation coefficient between the muscle strength of the triceps surae muscle and the resistance torque of passive ankle dorsiflexion was calculated in statistically analysis. **Result** In male volunteer, the correlation coefficient between the muscle strength of the triceps surae muscle and the resistance torque of passive ankle dorsiflexion had shown 0.546 in the right side, and 0.542 in the left side (p<0.05). The correlation coefficient in female volunteer had shown 0.552 (Rt.), and 0.534 (Lt.) respectively (p<0.05). Moderate positive correlation coefficient was shown both in male and female volunteer between muscular strength and resistance torque in calf muscle. **Discussion** The viscoelasticity in a muscle tendon complex is known that the viscoelasticity contributed to a sports performance via the stretch-shortening cycle. It is reported that viscoelasticity of the intramuscular tendon decrease due to disuse, and that also reported difficult to recover by retraining. The important factor to get high sport performance is not only muscle strength, but also the viscoelasticity

of the muscle tendon complex. On the other hand, the stretch resistance of the triceps surae muscle often decreased in postoperative case of Achilles tendon rupture. Therefore, it is not only muscle strength but also stretch resistance important to restore triceps surae muscle to a comfortably functioning state. References Fukunaga T. (2005). Training journal. 12-16. Fukunaga T. (2009). Sports Medicine. 110, 6-17. Kurata T, Koguchi A. (2010). Jpn.J. Clinical Sports Med. 18(4), 155.

### CHANGES IN CARDIAC INJURY BIOMARKERS IN RUNNERS AFTER ENDURANCE EXERCISE AND THE RELATIONSHIP WITH BIOMARKERS OF DEHYDRATION

Sierra, A., Ghorayeb, N., Dioguardi, G., Francisco, R.C., Benetti, M., Gabriel, E.A., Kiss, M.A.P.D.

*University of Sao Paulo*

**Introduction** The training can be considered the combination of negative influences (fatigue) with positive influences (conditioning). Some studies show, after endurance exercises, an increase of cardiac injury biomarkers such as BNP (brain natriuretic peptide) and troponins; however its physiopathology is not completely clarified as the changes in these biomarkers are usually related to cardiovascular disease. This study aims at analyzing the changes of these biomarkers, and their possible relationship with creatinine, weight, and water % after a marathon. **Methods:** We evaluated 32 male runners of São Paulo International Marathon, average age  $41.03 \pm 6.54$  years. A blood collection was performed 24 hours before and immediately after (imed) the marathon for dosing of troponin T, BNP, urea, and creatinine; and another dosing of troponin T 18 hours after the marathon. The bioelectrical impedance analysis was performed before and after the run to check the amount of water lost. For statistical analysis we used ratio, t-Student test, and Pearson's correlation. **Results:** Troponin T (TT) ( $\mu\text{g/L}$ ), BNP (pg/mL), creatinine (mg/dL) and urea (mg/dL) - (ratio; average  $\pm$  STDEV): TT 24h before - 6.25%;  $0.00187 \pm 0.0078$  TT imed - 34.37%;  $0.07531 \pm 0.30104$  -  $P < 0.01$  TT 18h after - 9.37%;  $0.02312 \pm 0.08618$  -  $P > 0.05$  BNP before - 0%;  $7.825 \pm 15.356$  BNP imed - 21.87%;  $71.021 \pm 80.217$  -  $P < 0.0001$  Creatinine before - 0%;  $0.921 \pm 0.087$  Creatinine imed - 53.12%;  $1.403 \pm 0.202$  -  $P < 0.0001$  Urea before - 9.37%;  $29.812 \pm 6.432$  Urea imed - 40.62%;  $39.031 \pm 7.756$  -  $P < 0.0001$  Water % and weight (Kg) (Average  $\pm$  STDEV) % of water before -  $66.48 \pm 1.823$  % of water imed -  $65.856 \pm 1.750$  -  $P > 0.05$  Weight before -  $70.24 \pm 9.185$  Weight imed -  $67.77 \pm 8.88$  -  $P > 0.05$  Weight loss -  $2.46 \pm 0.943$  Pearson's Correlation between Creatinine and BNP imed =  $+0.1415$  Creatinine and Water % =  $-0.3229$  Creatinine and Weight loss =  $-0.0045$  Urea and BNP imed =  $-0.0326$  Urea and water % =  $+0.1189$  Urea and weight loss =  $-0.2625$  **Conclusion:** We found significant changes in troponins imed, but these changes were not kept after 18 hours, as it happens in patients after acute myocardial infarction. Regarding BNP the imed had a significant increase, being that 21.87% had levels above 100 pg/mL, values which normally don't exclude heart failure. We found statistical difference between the levels of creatinine and urea imed and after the run, but no statistical difference between levels of water % and weight imed and after the run. There was a positive correlation between creatinine and BNP, and between urea and water % imed, a negative correlation between creatinine, water % imed and weight loss, and between urea, BNP and weight loss.

### THE EFFECTS OF AEROBIC TRAINING ON COGNITIVE FUNCTION IN ALZHEIMER'S DISEASE PATIENTS – A REVIEW OF RECENT LITERATURE

Praetorius, A.

*Ruhr Universität Bochum*

The effects of aerobic training on cognitive function in Alzheimer's Disease (AD) patients – a review of recent literature Praetorius, A.1, Hanakam, F.2, Platen, P.1 1Department of Sports Medicine and Sports Nutrition, Ruhr-University Bochum 2Department of Training and Exercise Science, Ruhr-University Bochum **Introduction** This literature review is evaluating the potential benefit of aerobic training on cognitive function in early stage AD patients. We hypothesized that aerobic training improves cognitive functioning in these patients. **Methods** We conducted systematic literature review from sources in Medline, Web of Science, PubMed and Biosis databases relating to AD and aerobic training. Recent studies published 2003-2012 and featuring pre- and post-tests, randomized and controlled study design, aerobic training intervention and assessment of cognitive functions have been selected for review. Studies were analyzed to answer the question whether the intervention group improved in cognitive function (outcome measure) compared to control group. The search query included the terms "aerobic", "fitness", "Alzheimer", "exercise", "training", "cognition", and "cognitive functioning". Results 7 studies met all inclusion criteria and were selected for further analysis. Duration of intervention ranged from 6-52 weeks. Training sessions were held from once per week up to once per day lasting from 30-120 minutes. All studies featured walking or moderate aerobic training exercises as intervention. Cognitive function tests used in the studies were Mini Mental State Examination (MMSE) (n=2), Alzheimer's Disease Assessment Scale (ADAS) (n=1), Rapid Evaluation of Cognitive Function (ERFC) (n=1), Cambridge Neuropsychological Test Battery (CANTAB) (n=1), Wechsler Adult Intelligence Scale (WAIS-R) (n=1), and Neuropsychiatric Inventory (NPI) (n=1). MMSE scores stabilized over 24 weeks in one study while controls deteriorated, but there were no improvements in MMSE in the second study. In the third study the exercise group scored better on the ERFC compared to the control group. Improvements in language abilities could be seen in the ADAS cognitive subscale in the training intervention group in the one investigation using this score. Attention and memory skills improved significantly in the training group in the one study utilizing CANTAB. WAIS scores remained stable during training intervention in the one selected study. NPI scores showed no significant changes during training in the respective study. **Conclusion** Aerobic training seems to positively influence progression of AD. Gains in language, orientation, memory, and attention skills could at least partly be achieved by aerobic training in 3 out of 7 trials although only moderate improvements were achieved. 2 further trials reported stabilization of cognitive function compared to control groups, while only one trial could not find any effect. Therefore, aerobic training should be recommended as therapeutic measure in AD.

### HIGH INTENSITY INTERVAL TRAINING INCREASES SKELETAL MUSCLE GLUCOSE UPTAKE

Eskelinen, J.J.1, Hannukainen, J.1, Savolainen, A.1, Heinonen, I.1, Virtanen, K.1, Kapanen, J.3, Nuutila, P.1, Knutti, J.1, Kalliokoski, K.1

*University of Turku*

**Introduction** Muscle insulin resistance and triglyceride content are strongly associated with obesity and type 2 diabetes. Aerobic exercise training (AET) is known to improve both whole-body and skeletal muscle insulin sensitivity. Recently, anaerobic high-intensity interval training (HIT) has gained popularity to get the benefits of exercise with less time commitment. It has been shown that HIT improves whole-body insulin sensitivity, but less is known of tissue-specific effects and of fat metabolism. In the present study we investigated the effects of high intensity interval training (HIT) on skeletal muscle glucose and fatty acid uptake (GU and FFAU) using positron emission tomogra-

phy (PET). In addition the effect of HIT on the amount of muscle triglyceride content was studied using magnetic resonance spectroscopy (MRS). Methods Eighteen healthy sedentary middle-aged men were recruited into the study. They were randomly divided into HIT group (n=9) and AET group (n=9). Within two weeks, the subjects in HIT group finished six training sessions each consisting of 4 to 6 times 30-seconds "all out" sprints (Wingate-type) with 4 min rest between sprints. Correspondingly the subjects in AET group did six training sessions consisting of 40-60 min of cycling at the intensity of 60% of max workload in VO<sub>2</sub>max -test. Quadriceps femoris muscle GU and FFAU were measured using PET and 18F-FDG and 18F-FTHA tracers before and after the exercise intervention. Intra- and extramuscular triglycerides (EMTG and IMTG) were measured from tibialis anterior muscle using MRS. VO<sub>2</sub>max-test until volitional exhaustion was performed before and after the last training session. Results All subjects managed to finish the exercise intervention well and without any complications. HIT enhanced VO<sub>2</sub>max by 5 % (from 33.9 ± 3.8 ml/kg/min to 35.5 ± 3.7 ml/kg/min, p = 0.019) and the maximal workload by 8 % (224 ± 31 W to 241 ± 31 W, p = 0.010) in the VO<sub>2</sub>max-test. Skeletal muscle GU during euglycemic hyperinsulinemic clamp increased by 38 % (4.4 ± 1.1 μmol/100 g/min to 6.0 ± 1.8 μmol/100 g/min, n = 6, p = 0.004), while whole-body glucose uptake increased by 11 % (p = 0.21). FFAU, EMTG and IMTG data are still under analysis. Discussion This preliminary data shows that skeletal muscle glucose uptake is increased more than the whole body glucose uptake after two weeks of HIT. Indirectly this suggests that HIT may decrease glucose uptake in other organs, but this needs confirmation.

### BLOOD LACTATE CONCENTRATION AT REST AS AN INDICATOR OF A CORRECT TRAINING LOAD IN YOUNG ATHLETES

Marinovic, M., Loncaric-Katusin, M.

*Faculty of Kinesiology, Split; Intensive Medicine and Pain Medicine, Karlovac*

Introduction "The practice of sport is a human right. Every individual must have the possibility of practicing sport in accordance with his or her needs" (Olympic Charter, Fundamental Principles). As coaches of young children we need to ensure that every child or young person who takes part in sports should be able to participate in a fun and safe environment and be protected from neglect and abuse. There is a large volume of research suggesting that the blood lactate response to exercise can be a good indicator of endurance performance, as well as indicator of homeostasis. Methods During sport diagnostics procedure 151 young athletes from three sports (tennis, swimming and soccer) from 10 to 14 years old were measured. All tests were performed in the morning, before the school or any exercise, expecting the young athletes to be rested. At the beginning of testing procedure finger-prick blood lactate samples were collected and analyzed using Accutrend lactate analyzer. Results Results of blood lactate concentration at rest were in range of 1.0 to 6.4 mmol/l. Only 16 (10.5%) young athletes had concentration less or equal to 1.6 mmol/l while 35 (23%) examinees had concentration between referential values. It is very interesting that 76.8% of the measured athletes had markers of acidosis at rest. Among them 24 (15.8%) had the same value higher than 3.5 mmol/l. Discussion Obtained results of blood lactate concentration very much differs of those expected at rest and presented in numerous articles. Only 35 (23%) examinees completed equilibrium between lactate concentrations in working muscles and blood. The lactate level depends on the intensity of exercise bouts, aerobic and anaerobic capacity of an athlete and the duration of rest intervals. Thus, knowing aerobic and anaerobic capacities and changing other two components it is possible to speed up or speed down lactate accumulation in the blood. These findings lead us to conclude that the training load can be incorrect, which can produce fatigue as well as the possibility for sport injuries. References Gaul CA, Docherty D, Cicchini R (1995). *Int. J. Sports Med*, 16, 451-455 Gladen L B (2004). *J Physiol*, 558, 5-30 Tolfrey K, Armstrong N (1995). *Br J Sports Med*, 29( 3), 196-199 Viru A., Viru M (2001). *Biochemical Monitoring of Sport Training. Human Kinetics*

**13:45 - 14:45**

## Poster presentations

### PP-PM70 Nutrition 5

#### PRO-ANTIOXIDANT RESPONSE TO INCREMENTAL EXERCISE AFTER INGESTION OF ANSERINE AND CARNOSINE

Zembron-Lacny, A.2, Slowinska-Lisowska, M.1, Kopec, W.3, Ostapiuk-Karolczuk, J.2, Kasperska, A.2, Rynkiewicz, M.2, Rynkiewicz, T.2

*1:USPE (Wroclaw, Poland), 2:USPE (Poznan, Poland) 3:UELS (Wroclaw, Poland)*

Introduction Dipeptides anserine and carnosine are contained in the skeletal muscles or brains of vertebrates in high concentrations. These substances may reduce muscle fatigue and improve learning ability because of an antioxidative effect, sarcoplasmic reticulum Ca<sup>2+</sup> regulation and buffering capacity. In spite of the large number of studies investigating the effects of pure anserine and/or carnosine, only a few studies concern the effectiveness of the natural extract containing dipeptides (Goto et al. 2011, Mishima et al. 2008, Sato et al. 2008, Suzuki et al. 2006). The present study was designed to evaluate the effects of supplementation with chicken breast meat extract (CBEX) containing anserine and carnosine on pro-antioxidant response during intense exercise. Methods Fourteen healthy untrained men and women at 21.3 ± 0.2 yrs were assigned to a CBEX drink group (CBEX containing total 2 g of carnosine and anserine) or a placebo drink group. The subjects ingested the prescribed drink (100 ml) twice daily for 16 days. The blood samples were collected on the first day of CBEX ingestion (initial study), and then on the fourteenth day immediately before incremental exercise and at 1 min, 30 min, 24 h and 48 h after exercise. In blood, hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), nitric oxide (NO), 8-isoprostanes (8-iso), antioxidant potential (AOP) and redox status (GSHTotal-2GSSG/GSSG) were determined. Myoglobin (Mb) concentration was measured as a marker of skeletal muscle damage. Results CBEX reduced H<sub>2</sub>O<sub>2</sub> concentration at rest and at 1 min and 30 min after exercise trial. No significant differences in NO and 8-iso concentrations were observed. AOP increased after CBEX ingestion and maintained on high level after exercise. CBEX elevated 2-fold redox status before and after exercise through reduction of oxidised glutathione (GSSG) level. CBEX did not effect on reduced glutathione (GSH) concentration. CBEX had not any effect on muscle damage induced exercise. Discussion/Conclusion These results confirm the antioxidant properties of extract containing anserine and carnosine, and suggest its use for modulation of blood antioxidant potential and redox status during intense exercise. References Goto K, Maemura H, Takanatsu K, Ishii N. (2011). *J Strength Cond Res*, 25, 398-405. Mishima T, Yamada T, Sakamoto M, Sugiyama M, Matsunaga S, Maemura H, Shimizu M, Takahata Y, Morimatsu F, Wada M. (2008). *Int J Sport Exerc Metab*, 18, 399-411. Sato M, Karasawa N, Shimizu M, Morimatsu F, Yamada R. (2008). *Food Chem Toxicol*, 46, 480-489. Suzuki Y, Nakao T, Maemura H, Sato M, Kamahara K, Morimatsu F, Takamatsu K. (2006). *Med Sci*

Sports Exerc, 38, 334-338. Acknowledgment This study was supported by a grant N R12 004006 from the Ministry of Science and Higher Education, Poland. We are grateful for successful cooperation with students at Faculty of Physiotherapy in Gorzow Wlkp.

### THE EFFECT OF A CAFFEINE CONTAINING ENERGY DRINK ON MUSCLE PAIN PERCEPTION, PERCEIVED EXERTION AND READINESS TO INVEST EFFORT DURING SUBMAXIMAL CYCLING

Hankey, J., Duncan, M.J.

*Coventry University*

**Introduction** The beneficial effect of caffeine ingestion on exercise performance is well established. Caffeine has been shown to attenuate leg pain during cycling (Gliottoni and Motl, 2008) and positively influence psychophysiological variables including readiness to invest effort during exercise (Duncan and Oxford, 2011). Caffeine containing energy drinks can also improve aerobic performance and the volume of training an individual can undertake (Hoffman et al., 2008). However, the data pertaining to psychophysiological responses to such energy drinks during exercise is limited. This study examined the effect of a caffeinated energy drink on leg pain perception and perceived exertion during and readiness to invest effort pre and post 60 minutes cycling exercise. **Method** Fourteen participants (7 males, 7 females, mean age 23.5, s = 3.5 years), completed 60minute cycling trials at 60% VO<sub>2</sub> max preceded by ingestion of solutions containing either a caffeinated energy drink (absolute dose of caffeine 179mg) or placebo using a double-blind design. During exercise, RPE (6-20 scale), leg pain (0-10 scale), heart rate (HR) were recorded. Pre ingestion, post ingestion/pre exercise and post exercise, participants completed measures of readiness to invest physical effort (RTIPE). Repeated measures ANOVA was used to assess differences in all variables and across time and treatments, with gender used as a between subjects variable. Results HR was significantly higher (P = .002) from 30-60minutes and RPE (P = .0001) and pain perception (P = .0001) were significantly lower from 20-60minutes in the energy drink condition compared to placebo. RTIPE (P = .001) increased significantly more from pre ingestion to post ingestion pre exercise, in the energy drink condition compared to placebo. No gender differences were evident (P > .05). **Discussion** Ingestion of a caffeine containing energy drink can favourably influence perceptual responses (RPE and leg pain) during 60minutes cycling at 60% VO<sub>2</sub> max, agreeing with previous research (Gliottoni and Motl, 2008). The greater RTIPE reported following energy drink ingestion, may also result in participants feeling more able to provide greater effort compared to placebo. This study assumes that caffeine is the most likely ingredient to explain these results, in line with other studies (Hoffman et al. 2008). However, the other ingredients within the energy drink may have contributed to these results. Overall, it can be suggested that energy drink ingestion has a positive effect on psychophysiological responses during submaximal cycling. **References** Duncan MJ, Oxford S. (2011) J Strength Cond Res, 25, 178-185. Gliottoni RC, Motl RW. (2008) Int J Sports Nut Exerc Metab, 18, 103-115. Hoffman et al.(2008) J Strength Cond Res, 22, 874-882.

### EFFECTS OF CAFFEINE ON FLUID BALANCE AFTER EXERCISE-INDUCED DEHYDRATION

Veniamakis, E.E.1, Nikolaidis, P.2

*Technological Education Institute of Crete*

The study assessed the effectiveness of caffeine compared with water on whole body rehydration during 5 hours of recovery after exercise-induced dehydration. Eight young subjects, 6 habitual caffeine users (200 – 300mg/d) and 2 occasional caffeine users (mean 23.3 ± 2.6yr and 77.5 ± 6.6kg), undertook a cycling exercise at 2w/kg in a warm environment (32.3 ± 1.3oC; 57.3 ± 2.7 % r.h) until 1.8% of their body weight was lost. An average of 1.63 ± 0.26kg was lost during the water trial and 1.59 ± 0.26kg during caffeine trial. After exercise subjects sat in a thermoneutral environment (24.8 ± 1.3oC; 50.2 ± 8.9% r.h) and consumed fluid volumes equal to 150% of body weight lost during exercise. Fluids were consumed in 4 boluses at 0min, 15min, 30min and 45min of the 5 hours rehydration period. The average amounts consumed were 2.44 ± 0.4L for the water trial and 2.38 ± 0.4L for the caffeine trial. The mean caffeine concentration in the drink was 455.5 ± 37mg. Urine samples were collected prior, immediately after, and once every hour for 5 hours after exercise, in order to assess fluid net balance and fluid retention. Urine production during the rehydration period was observed to be significantly greater during caffeine intake immediately (116.6 ± 81.4ml), 1 hour (689.3 ± 106ml), and 3 hours (164.5 ± 153.7ml) after the rehydration period compared to the water trial (57.5 ± 22.1ml, 452.2 ± 172.7ml, and 250.1 ± 188.3ml respectively: p<0.01). As a result, the cumulative urine output was significantly greater in the 2nd (806 ± 177ml vs. 509.7 ± 192.6ml: p<0.01), 3rd (1357 ± 296.2ml vs. 1033.3 ± 300ml), 4th (1521.8 ± 412ml vs. 1283.5 ± 379ml), and 5th (1624.4 ± 430ml vs. 1381.5 ± 423ml: p<0.05) hour of the rehydration period during the caffeine trial compared to the water trial. The volume of fluid retention after 5 hours of fluid replacement was lower during the caffeine trial compared to the water trial (32 ± 13.1% vs. 44.1 ± 11.5%, respectively; p=0.018). Subjects returned to a negative fluid balance 1 hour after water consumption and immediately at the end of the rehydration period following intake of caffeine. The findings suggest that caffeine is less effective than water as a post exercise rehydration drink. This remains the case even when the volume of fluid intake is greater than fluid loss. Subjects in both trials did not reestablish a positive net fluid balance. During the trial inappropriate electrolyte replacement occurred suggesting opportunities for further research to investigate the effects of caffeine in relation to sodium after exercise induced dehydration.

### THE INFLUENCE OF CARBOHYDRATE/PROTEIN SUPPLEMENTATION ON CENTRAL FATIGUE AND REACTION TIME

Seifert, J.G., Bloemendal, A.

*MSU (Bozeman, MT, USA)*

**Introduction** It has been well established that caloric supplementation can enhance endurance performance. However, it has not been clearly established if such feedings can enhance indices of central fatigue during exercise. Thus, the purpose of this study was to compare the effects of a carbohydrate/protein/caffeine sports gel (GEL) to a non-caloric placebo (PL) on reaction time and muscle power output. **Methods** Following IRB approval, 7 trained cyclists completed 2 - 70 min cycling trials followed by a 2 min power test (PT). Central fatigue was assessed by two auditory reaction time tests (RTT), completed pre and post exercise, and RPE. The simple RTT (RTTs) consisted of pushing a switch upon hearing an auditory beep. Subjects completed a specific movement pattern with their arms before they stopped the timer for the second RTT (RTTc). Treatments were a non-caloric PL or a sports GEL. Dosage for the GEL was 50.4g CHO, 8.4g PRO, and 280 mg caffeine/hr and was administered in equal doses following each 10 min interval. Subjects ingested 140 mL of the PL or of water + the GEL following each 10 min interval. Exercise consisted of cycling in intervals at 70% of maximal power output (MPO) for 8 min followed by 2 min at 90% MPO for a total of 70 min. Following the post exercise RTT, subjects completed a cycling PT for 2 min at 5% of BW, similar to a Wingate. Blood glucose was measured pre and post exercise. RPE and HR were recorded during each 70% interval. All subjects ingested their pre-exercise meal 3 hrs prior to exercise. Data were analyzed with t-tests and ANOVA with repeated measures. Data are listed as mean (+/-SD). Alpha level of significance was p<.05. **Results** The RTTs was significantly faster for the GEL (.171 (.029) sec) than the

PL (.180 (.022) sec). RTTc was also faster for the GEL (.565 (.111) sec) compared to the PL (.593 (.115) sec). Mean RPE during the GEL (11.7 (2.0)) was lower than PL (12.7 (1.7)). Mean HR was significantly lower during the GEL (142.9 (13.6) bpm) compared to PL (145.8 (13.8) bpm). There was a trend ( $p=.1$ ) for the GEL (5.10 (.49) W/kg) to produce greater relative power during the 2 min PT test than the PL (4.88 (.67) W/kg). No statistical differences were observed between trials for blood glucose (GEL: 4.7 (.4) mM/L; PL: 4.5 (.3) mM/L). Discussion Ingestion of the sports GEL led to significantly faster simple and complex reaction times and lower RPE and HR than PL. The 5% faster reaction times are comparable to improvements in endurance performance when CHO are ingested. In fed subjects, blood glucose levels did not impact reaction time following 70 min of exercise. The results of this study demonstrate that supplementing with carbohydrate, protein, and caffeine can improve reaction time and reduce perceived effort following endurance exercise.

### EFFECTS OF WHEAT GLUTEN HYDROLYSATE SUPPLEMENTATION WITH EXERCISE ON MUSCLE SIZE OF LEG IN MICE.

Shimmura, Y.

*Nisshin Pharma Inc.*

Effects of wheat gluten hydrolysate supplementation with exercise on muscle size of leg in mice. Yuki Shimmura<sup>1,2</sup>, Ichiro Goto<sup>1</sup>, Nobuhiro Yahata<sup>1</sup>, Junichiro Yamauchi<sup>2,3</sup> 1. Health care research center, R&D division, Nisshin Pharma Inc. 2. Graduate School of Human Health Sciences, Tokyo Metropolitan University, JAPAN 3. Future Institute for Sport Sciences, JAPAN [Introduction] Glutamine is an amino acid, involving as a substrate in many physiological processes as well as acting as a physiological regulator. It has been known that glutamine has effects of immunomodulatory, anti-catabolic and anabolic, intestine mucosal barrier-protective and antioxidant actions. Also, glutamine is known as an increase in the secretion of anabolic hormones, i.e. insulin and growth hormone. A beneficial anabolic action has been demonstrated in several pathological conditions associated with muscle loss. Therefore, glutamine supplementation may be of a potential interest to modulate muscle protein metabolism and to maintain muscle mass. Large amounts of glutamine are contained in wheat protein known as gluten. Because glutamine in wheat gluten hydrolysate (WGH) is bonded to other amino acids with peptide bonds, it is more stable and better utilized by the body as compared with free form L-glutamine. However, there is no research on the study of WGH supplementation with exercise on the muscle size. In this study, we investigated the effects of supplementation of WGH derived from wheat protein with exercise on muscle size of leg in mice. [Methods] Male mice (BALB/c CrIcrij) at 7 months age were randomized into three groups: 1) 10% casein with 4% WGH (WGH group), 2) 14% casein (CA group) and 3) 10% casein (CON group) diet. Mice were fed with a free wheel cage for 28 days. Voluntary exercise was provided by free access to running wheels fitted with odometers. Before and after the trial, body mass, exercise volume, liver mass, muscle mass of leg (quadriceps, triceps surae) and serum concentration of protein and amino acids were assessed, and they were then compared with each group. [Results] The mean food intakes of WGH, CA, CON groups were  $6.45 \pm 0.13$  g/day,  $6.57 \pm 0.08$  g/day and  $6.24 \pm 0.12$  g/day respectively, and not significantly different. Body weight and exercise volume of WGH and CA tended to be higher than that of CON, although there were no significant differences. WGH and CA significantly increased muscle volume of quadriceps as compared with CON, and these increases represent  $0.575 \pm 0.007$  g,  $0.576 \pm 0.0016$  g and  $0.523 \pm 0.013$  g ( $p<0.05$ ), respectively. Serum TP and albumin of WGH and CA were not significantly different from those of CON. [Conclusion] WGH is a good candidate for protein supplementation to increase skeletal muscle volume and may help to prevent catabolic effects of muscle with aged population.

### EFFECTS OF SHORT TERM GINSENG SUPPLEMENTATION ON GLYCOGEN SYNTHESIS IN EXERCISED HUMAN SKELETAL MUSCLE

Chen, H.W., Lu, H.C., Cheng, I.S.

*National Taichung University of Education*

Introduction The active components of ginseng are considered to be ginsenosides, a group of steroidal saponins. The root of ginseng is a commonly used as herbal medicine (Wang et al., 1998). Little studies are available regarding to whether 28 days ginseng supplementation can enhance muscle glycogen synthesis in exercised human skeletal muscle. Methods Nine healthy male subjects (aged:  $21.87 \pm 0.87$  yrs) completed crossover trials after a 60-min cycling exercise at 70–75%  $VO_2$  max separated by 28 days. Subjects consumed 400 mg of ginseng or placebo for 28 days. On the 29th morning, they consumed 400 mg of ginseng or placebo with high carbohydrate meals (2 g carbohydrate/ kg body weight, 80 % carbohydrate, 8 % fat, 12 % protein) for a 24-hour recovery following exercise. Muscle biopsy samples were collected from vastus lateralis immediately after exercise and 3h, 24h during recovery (Bergstrom et al., 1962). Blood samples were collected before the exercise, every 30 minute within 3 hours after the exercise and 24h. Results We found 28 days ginseng supplementation significantly lowered post-meal insulin and glucose response with similar carbohydrate meal supplementation compared to placebo. The synthesis rate of glycogen during the 3-hour recovery is significantly higher compared to placebo ( $P<0.5$ ). Discussion These results demonstrated the rate of glycogen synthesis in exercised human skeletal muscle was enhanced during 3h during exercise recovery accompanied with improvement in post-meal insulin sensitivity. The results of this are beneficial for athletes, who are training for competition, on muscle glycogen synthesis after exercise. References Bergstrom J. (1962). Scand J Clin Lab Invest, 68, 11-13. Engels H J, Kolokouri I, Cieslak T J, Wirth J C. (2001). The Journal of Strength & Conditioning Research, 15(3), 290. Wang L, Lee T. (1998). Planta medica, 64, 130-133.

### WHETHER ORAL FAT BURNER SUPPLEMENTATION CAN ENHANCE GLYCOGEN SYNTHESIS IN EXERCISED HUMAN SKELETAL MUSCLE

Tsao, J.P.1, Chiu, Y.C.1, Cheng, I.S.2

1: NTUPES (Taichung, Taiwan), 2: NTCU (Taichung, Taiwan)

Introduction The term 'fat burner' is used to describe nutrition supplements that are claimed to enhance fat oxidation, increase weight loss, or somehow cause long-term adaptations that promote fat metabolism (Jeukendrup et al., 2011). The most popular 'fat burner' supplements include caffeine, carnitine, green tea, conjugated linoleic acid, hydroxycitrate, forskolin, chromium, kelp and fucoxanthin. Little studies were found regarding to whether fat burners administration is expected to enhance glycogen synthesis in exercised human skeletal muscle. As glycogen serves as a main fuel source in the skeletal muscle for endurance performance (Ivy et al., 1988), the present study is to investigate whether hydroxycitrate, carnitine caffeine, and conjugated linoleic acid supplementation separately can enhance fatty acid oxidation, attenuate glucose utilization and results in more glycogen content in exercised human skeletal muscle. Methods Eight healthy male volunteers (age,  $22.0 \pm 0.3$  years) completed a 60-min cycling exercise at 70–75%  $VO_2$  max and received hydroxycitrate, carnitine, caffeine and placebo supplemented separately in a crossover design repeated after a 7 d washout period. They consumed fat



burners or placebo with a high-carbohydrate meal (2 g carbohydrate/kg body weight, 80% carbohydrate, 8% fat, 12% protein) for a 3-h post-exercise recovery. Muscle biopsy samples were obtained from vastus lateralis immediately and 3 h after the exercise (Bergstrom et al., 1962). Simultaneously, blood glucose, insulin, non-esterified fatty acid and glycerol, and expired gas analysis will be performed before and after exercise. Results The main findings of the study are: (1) oral Hydroxycitrate, carnitine, or caffeine supplementation significantly accelerated the rate of glycogen synthesis to twofold in exercised human skeletal muscle compared to placebo; (2) Hydroxycitrate and carnitine increase occurred in parallel with increased whole-body insulin sensitivity, evidenced by reduced post-meal insulin response. Discussion The results of the present study suggested that the greater glycogen synthesis rate were found in exercised human skeletal muscle after fat burners supplementation are mediated by either reduced carbohydrate utilization and increased fat utilization (glycogen sparing effect), evidenced by lower in respiratory exchange ratio during 3h recovery. The fruitful outcome from this study may suggest that fat burners may influence metabolic consequence, which in turn affects the glycogen re-synthesis in exercised human skeletal muscle. Since muscle glycogen is the main energy source for endurance competition, the results of this study will certainly benefit to athletes, who are training for competitions. References Bergstrom J (1962). *Scand J Clin Lab Invest*, 68, 11-13. Cheng I S, Huang S W, Lu H C, Wu C L, Chu Y C, Lee S D, Huang C Y, Kuo C H. (2011). *British Journal of Nutrition*, 1(1), 1-8. Ivy J, Katz A, Cutler C, Sherman W, Coyle E (1988). *Journal of Applied Physiology*, 64(4), 1480-1485

### ENERGY SUPPLEMENTATION INFLUENCED ENERGY AVAILABILITY, BUT NOT PHYSICAL ACTIVITY DURING 8 DAYS OF SUSTAINED PHYSICAL EXERTION

Tanskanen, M.6, Westerterp, K.R.2, Uusitalo, A.L.3, Atalay, M.4, Häkkinen, K.1, Kinnunen, H.5, Kyröläinen, H.1

1:University of Jyväskylä (Finland), 2:Maastricht University (The Netherlands), 3:Helsinki University Hosp. (Finland), 4: University of Eastern Finland (Kuopio, Finland), 5:Polar Electro Oy (Finland)

Introduction Energy balance is an important factor in sustaining training load and maintaining high performance during strenuous military training. Previous studies have shown an energy deficit during a strenuous military field-training course (TC). The purpose of this study was to determine the effects of energy bar supplementation on energy balance, physical activity (PA), physical performance and well-being and to define whether ad libitum fluid intake is sufficient during a wintertime 8-day military TC. Methods Twenty-six men (age  $19 \pm 1$  yr.) were randomly divided into two groups: The control group (n = 12) had traditional field rations and the experimental (Ebar) group (n = 14) had the same field ration plus additional energy supplement of 4.1 MJ/day. Food and water intake was recorded. Fat-free mass and water loss were measured with deuterium dilution and elimination, respectively. The energy expenditure (EE) was calculated using the intake/balance method and energy availability as (energy intake/estimated basal metabolic rate). PA was monitored using an accelerometer. Physical performance was measured and questionnaires of subjective well being were recorded before, during and after TC. Results During TC, Ebar had a higher energy intake and energy availability than the controls ( $p < 0.05$ ). However, decreases in body mass ( $-1.8 \pm 1.0$  kg) and fat mass ( $-2.1 \pm 0.7$  kg) were similar in both groups representing an energy deficit ( $p < 0.001$ ). No differences were observed between the groups in PA, water intake and changes in physical performance and fat-free mass. Water balance was negatively related to PA. The present study further demonstrated that a negative mood state before TC associated negatively with energy availability and PA. Discussion An easy-to-use energy bar of 4 MJ/day did not prevent energy deficit nor influence PA during an 8-day strenuous military TC. A satiation effect of the high content of protein in the bars might have induced a decreased energy intake from field rations. During strenuous TC, PA seems to be primarily affected by other factors than energy supplementation such as mood state.

### CORRELATION BETWEEN HYDRATION AND BASKETBALL PERFORMANCE

Vukasinovic-Vesic, M.1, Dikic, N.1,2, Andjelkovic, M.1, Radivojevic, N.1, Curcic, D.J.1, Antic, T.1, Baralic, I.1, Turner, R.2, Stokes, R.2, Gunter, H.2

*Sports Medicine Association of Serbia*1, *FIBA Europe*2

Introduction Many study results suggest that inadequate hydration is influencing sports performance by: impairing mental/cognitive performance, decreasing the motivation to exercise, increasing the rating of perceived exertion and decreasing the time to exhaustion. In basketball dehydration is correlated with overall basketball performance, jumps, shooting and number of shots that were attempted and made. The aim of our study was to analyze the influence of hydration on basketball performance. Method Ninety-six basketball players of eight national teams have assessed during official FIBA Europe U20 Championship Men 2011 - Division B held in Sarajevo in July 2011. In order to detect a correlation between hydration and basketball performance we measured body mass of all players before and after one game. This correlation was evaluated by percentage of dehydration (body mass loss/pre exercise body mass) x 100. Results Players age was  $19 \pm 0.79$  years. After the game percentage of dehydration was  $0.99 \pm 0.7\%$  ( $-1.25 - 2.95\%$ ). We found statistically significant negative correlation between percentage of dehydration with most valuable player index (MVP) ( $p < 0.01$ ), points scored ( $p < 0.01$ ), total rebounds ( $p < 0.01$ ), shooting percentage for 3 points ( $p < 0.05$ ), shooting percentage for 1 points ( $p < 0.05$ ), assists ( $p < 0.05$ ). Discussion We have found that dehydration considerably impaired basketball performance. Dehydration significantly impaired points scored, total rebounds, shooting percentage for 3 points, shooting percentage for 1 point, assists, except steals balls, turnovers and shooting percentage for 2 points. Most importantly, there is a significant negative correlation between hydration and the category of the most valuable player index (MVP). We decided to use the method of percentage of dehydration because we consider that this parameter can be used most efficiently and effectively on the spot by trainers to measure hydration level of players. The result of this study showed that dehydration is not only a physiological state, but also a very important factor for the total performance of one team, which requires sports personnel to be educated in order to be able to help contribute to a better overall sports performance. References Baker L., Dougherty K., Chow M., and Kenney L. Progressive Dehydration Causes a Progressive Decline in Basketball Skill Performance. *Medicine & Science in Sports & Exercise*. 2007.

### DOES CARBOHYDRATE SUPPLEMENTATION MAXIMIZE TENNIS MATCH PLAY PERFORMANCE?

Capitani, C.D.1, Gomes, R.V.2, Fernandez-Fernandez, J.3, Mendez-Villanueva, A.4, Moreira, A.2, Aoki, M.S.2

1University of Campinas, Campinas, Brazil; 2University of Sao Paulo, Sao Paulo, Brazil; 3Ruhr-University Bochum, Germany; 4 ASPIRE Academy for Sports Excellence, Doha, Qatar.

Introduction: The aim of the present study was to assess the effect of carbohydrate (CHO) supplementation on tennis match performance. Twelve young tennis players ( $18.0 \pm 0.8$  years) with national rankings among the top 50 in Brazil agreed to participate in the study. Methods: This study was conducted over a 5 day period in which each player completed 2 games of 3 hours simulated tennis match play

either supplemented with a CHO or placebo (PLA) drinking solution. A randomized, cross-over, double blind research design was used. The activity profile of each match was determined by filming each match with two video cameras. Each player was individually tracked for the entire duration of the match. Two experienced researchers watched the matches and performed a match analysis. The following variables were calculated: (1) games won or lost; (2) rally duration (s); (3) strokes per rally; (4) rest time between rallies (s); (5) effective playing time (%); (6) changes of direction per rally; (7) aces; (8) double faults; (9) first service in; (10) second service in; (11) first return in and (12) second return in. Results: There were no between-condition differences in any of the variables analysed. Conclusion: In summary, the key finding of this study was that CHO supplementation did not improve tennis match play performance.

**13:45 - 14:45**

## Poster presentations

### PP-PM71 Training & Testing 15

#### **EVENING WEIGHT-LIFTING PERFORMANCE AFTER TWO NIGHTS PARTIAL SLEEP DEPRIVATION; ARE "POWER NAPS" ON THE DAY OF COMPETITION USEFUL?**

Edwards, B.J., Moseley, S.E., Robertson, C., Waterhouse, J.

*Liverpool John Moores University*

Maximal gross muscular performance is unaffected by partial sleep deprivation, effects on repetitive gross muscular tasks (i.e. weightlifting) is unknown. Power naps have been reported to improve mood and physical performance following reduced sleep. Therefore, the purpose of this study was to determine the effects of partial sleep-deprivation (3h sleep for 2 consecutive nights) on weight-lifting and whether the use of a short post-lunch power nap could improve performance. Eight untrained males (Mean±SD: age, 20 ± 1.5 yrs; height, 184±6cm; body mass, 94±10kg; Bench Press 1 Rep Max (1RM), 81.25±10.7 kg; Leg Press 1RM, 270±27.8 kg) volunteered for the study. The subjects were familiarised before undertaking the main protocol, which consisted of completing 3 conditions administered in a counter-balanced fashion. The three conditions were: 1) Normal (N) retiring at 23:00 and rising at 06:30h, 2) Partial sleep deprivation (SD) retiring at 03:30 and rising at 06:30h; and 3) Partial sleep deprivation with 1h nap at 13:00h (SDN). Measurements of rectal and skin temperatures, tiredness and alertness, and Profile of Mood Scores (POMS) were made at 08:00, 11:00, 14:00 & 17:00h. At 17:00h subjects also performed 3 attempts (with 3-min rest between each attempt) at progressive sub-maximal (40, 60, 80% 1RM) Bench and Leg Press. A linear encoder (Muscle Lab) was attached to an Olympic bar (20kg, resting on steel racks, for bench press; 40kg and tilted for leg press). Perceived effort and ratings of perceived exertion for breathing, muscle effort and overall feeling were measured after each lift. Average force, power, velocity time-to-peak velocity and distance were also recorded for each lift. Data were analysed using ANOVA models with repeated measures. Alertness, tiredness, sleepiness and bench press (power, force and average velocity) was lower in SD than N and SDN. RPE for breathing and muscle feeling increased during SD for bench and leg press. General body feeling additionally increased in leg press (subjects perceived the task to be harder). Mood states for vigour, calm were lower and anger, tension depression and fatigue were higher in SD compared to N. A significant load (%1RM) effect was observed for bench and leg press (force, average velocity, time to peak velocity); similarly 'distance' increased (at 80% 1RM) and leg press power increased as load (%1RM) increased. Further, RPE for breathing, muscle and general body feeling increased between loads. Alertness, tiredness and sleepiness demonstrated a significant time of day effect and interaction with a 1-h power nap increasing alertness and reducing tiredness and sleepiness. Furthermore, rectal temperature values were lowest at 08:00 and highest at 17:00h (P<0.05). All other variables were insignificant (P>0.05). In summary, this study suggests that the use of a short post-lunch nap may improve performance to levels of that of normal sleep by increasing evening alertness, reducing tiredness and sleepiness and improving aspects of mood.

#### **THE EFFECTS OF RESISTANCE TRAINING OF THE ROTATOR CUFF ON SUBACROMIAL SPACE IN HEALTHY PEOPLE**

Kaji, K.1, Watanabe, H.2, Takahashi, M.2, Takahira, N.1

*1:Graduate School of Medical Science, Kitasato University (Kanagawa, Japan), 2: Kitasato University (Kanagawa, Japan)*

**Introduction** The rotator cuff (RC) of the shoulder contributes to stabilize and center the humeral head in the glenoid at the glenohumeral joint. A weakness or abnormal functions of the RC are associated with the shoulder injuries (Byram et al., 2010). In the RC, the supraspinatus has a one of the important functions to avoid inferior instability that is evaluated with subacromial space (SAS) as loaded to inferior direction (Cheng et al., 2008). The resistance training of the RC is also needed to prevent the shoulder injuries. However, there is little study that focuses on the effects of only resistance training of the RC. The purpose of this study is to investigate the effects of resistance training of the RC during 6 weeks on SAS. **Methods** 19 participants (3 men, 16 women) aged from 19 years to 25 years (mean age 21.1±1.4 years) with normal shoulder were examined. SAS was measured with the ultrasonography. The ultrasonographic measurement of the SAS was defined as the distance between the tip of acromion and the nearest aspect of humeral head. The subjects were seated with their arm drop to their sides in internal rotation, and were loaded to inferior direction by heavy bob (3kg or 5kg). The examiner measured SAS at rest, 3kg loaded or 5kg loaded. All subjects performed the resistance training of the RC during 6 weeks and abducted their shoulder from 0 degree to 30 degrees in scapular plane with external rotation. The resistance applied at the wrist with Thera-Band. Each of SAS (when rest, inferior loading of 3kg or 5kg) was measured both before and after resistance training of the RC. Results SAS before resistance training was 13.3±0.7mm at rest, 15.0±0.7mm at 3kg loaded or 15.7±0.8mm at 5kg loaded. On the other hand, SAS after resistance training was 13.9±0.7mm at rest, 15.5±0.8mm at 3kg loaded or 16.2±0.9mm at 5kg loaded. In all of the conditions, SAS was significantly increased after resistance training. **Discussion** A functional depression of the RC is associated with the shoulder injuries (Byram et al., 2010). We intended to identify the utility of resistance training of the RC to prevent the shoulder injuries for healthy people. In this study, SAS was widened after the RC training. The inability of the RC against the deltoid that pulls the humeral head proximally relates to superior migration of the humeral head (Weiner et al., 1970). Therefore, the results may be indicative to improve the balance between the RC and the deltoid. However, we couldn't confirm whether the balance of these muscles become altered actually. **Conclusion** The resistance training of the RC during 6 weeks widens SAS at rest and inferior loaded in healthy people. Reference Byram IR et al., (2010). *Am J Sport Med*, 38(7), 1375-1382. Cheng SC et al., (2008). *Skeletal Radiol*, 37, 161-168. Weiner DS et al., (1970). *J Bone Joint Surg Br*, 52(3), 524-527.

## RUNNING VERSUS CYCLING: IN WHICH MODE IS THE LACTATE THRESHOLD MORE USEFUL IN TRIATHLETES?

Fisher, S., Jenkins, D., Skinner, T., Osborne, M., van Rosendal, S., Emmerton, L.

*University of Queensland*

**RUNNING VERSUS CYCLING: IN WHICH MODE IS THE LACTATE THRESHOLD MORE USEFUL IN TRIATHLETES?** Fisher, S.I, Jenkins, D.I, Skinner, T.I, Osborne, M.I, van Rosendal, S.I, Emmerton, L.I 1: School of Human Movement Studies, The University of Queensland (Brisbane, Australia) 2: Queensland Academy of Sport (Brisbane, Australia) 3: School of Pharmacy, Curtin Health Innovation Research Institute, Curtin University (Perth, Australia) Introduction The weight of available evidence suggests that endurance performance is better predicted by the lactate threshold (LT) than by maximal oxygen uptake (VO<sub>2</sub>max). However, it is not clear whether exercise intensity at the LT is equal to the maximal exercise intensity able to be sustained during a time-trial (TT), nor whether exercise at either of these work rates elicits a 'maximal lactate steady state'. The purpose of the present investigation was to examine the relationships between the LT, constant-load exercise at the LT and TT performance in running and cycling. Methods Ten highly-trained male triathletes (age 27.5 ± 4.4 years, cycle VO<sub>2</sub>max 61.5 ± 3.8 mmol•L<sup>-1</sup>, run VO<sub>2</sub>max 59.9 ± 6.8 mmol•L<sup>-1</sup>) completed three trials for both cycling and running: 1) incremental tests to determine their LT; 2) 30 min constant-load (cycle) or speed (run) tests at their LT intensity; and 3) TT (40 km cycling and 10 km running). Results Strongest predictors of TT performance for running were LT speed (r = -0.92; p < 0.01) and VO<sub>2</sub>max (r = -0.89; p < 0.01), while for cycling, LT power output was the only significant predictor (r = -0.68; p < 0.05). Only four out of nine participants were able to run for 30 minutes at their LT speed; in contrast, all 10 participants were able to maintain their LT cycle power output for the same duration. During the running constant load trial, the average plasma [La] between 10 and 30 minutes was not in steady state; in contrast, during the cycle constant load trial, plasma [La] was in steady state between minutes 10 and 30. In the running trials, the LT speed (15.6 ± 1.2 km•hr<sup>-1</sup>) was significantly greater than the average TT speed (14.8 ± 2.0 km•hr<sup>-1</sup>) (p < 0.05) whereas in cycling, there was no difference between power output at LT (243.5 ± 35.2 W) and average TT power output (251.6 ± 33.5 W). Discussion The present data demonstrate that the run LT predicts 10 km TT performance yet over-predicts the highest sustainable running speed over a 30 minute duration. In contrast, the cycle protocol more accurately predicts the highest sustainable cycling workload over 30 minutes, in addition to predicting 40 km TT performance. The cycling LT protocol is more useful than the running protocol since it predicts a sustainable workload over 30 minutes in addition to the workload and performance time during a TT. References Faude, O., W. Kindermann, et al. (2009). 'Lactate Threshold Concepts How Valid are They?' *Sports Medicine* 39(6): 469-490.

## AEROBIC PARAMETERS IN FREE AND SEMI-TETHERED FIELD RUNNING TESTS

Ribeiro, L.F.P.1,2, Sousa, F.A.B.3, dos Reis, I.G.M.3, Belli, T.2, Beck, W.R.3, Papoti, M.4, Cunha, S.A.3, Martins, L.E.B.3, Gobbato, C.A.5

1: DCS/UESC (Ilhéus, Brasil), 2: IB/UNESP (Rio Claro, Brasil), 3: FEF/UNICAMP (Campinas, Brasil), 4: FCT/UNESP (Presidente Prudente, Brasil), 5: FCA/UNICAMP (Limeira, Brasil)

Introduction Resisted running is a common practice in sprinter's daily routine, but despite prior literature on its acute kinematic effects (Maulder et al., 2008; Paulson & Braun, 2011), the physiological consequences of such practice are largely unknown. In this study we investigated the effects of resisted running on aerobic parameters by comparing data derived from free (FR) and semi-tethered running (STR) tests in well trained athletes. Methods Nine male runners (21.1 ± 3.4 yrs; 70.6 ± 6.6 Kg; 180 ± 5 cm) volunteered to take part in this investigation and underwent graded exercise tests in both FR and STR conditions on a synthetic 400 m track using a portable gas analyzer (K4B2, Cosmed, Italy). In the STR athletes were attached by their waists to a specific apparatus that enabled a 4% body weight resistance to be set by means of a mechanical break. Studied variables included peak oxygen uptake (VO<sub>2</sub>PEAK), velocity at VO<sub>2</sub>PEAK (vVO<sub>2</sub>PEAK), peak heart rate (HRPEAK) and ventilatory threshold (VT). Comparisons were performed using t-tests and effect sizes (ES) were calculated. Results Although velocity at VT (12.59 ± 0.50 vs 11.42 ± 0.65 Km/h; ES = 2.0) and vVO<sub>2</sub>PEAK (16.9 ± 1.0 vs 14.8 ± 0.4 Km/h; ES = 2.5) were significantly greater in FR (P < 0.01), t-tests revealed no significant differences (P > 0.05) between FR and STR for VO<sub>2</sub>PEAK (3216 ± 306 vs 3377 ± 318 L/min; ES = -0.5), HRPEAK (194 ± 3 vs 192 ± 6 bpm; ES = 0.4) and VO<sub>2</sub> at VT (2792 ± 306 vs 2929 ± 250 mL/L; ES = -0.5). Discussion Extending previous findings showing deterioration in running mechanics in resisted sprinting (Maulder et al., 2008; Paulson & Braun, 2011), our data suggest semi-tethered running against a 4 % body weight resistance to reduce velocities at VO<sub>2</sub>PEAK and VT without changing metabolic rates at these intensities. In addition, these results provide initial support to the STR system as an interesting tool for evaluation and training purposes in resisted running. References Maulder PS, Bradshaw EJ, Keogh JWL (2008). *J Strength Cond Res*, 22, 1992 – 2002. Paulson S, Braun WA. (2011). *J Strength Cond Res*, 25, 1680-1685. This study was supported by FAPESP (2009 / 08535-5).

## RESPIRATORY MUSCLE ENDURANCE TRAINING WITH NORMOCAPNIC HYPERPNEA IMPROVES VENTILATORY FUNCTION AND EXERCISE PERFORMANCE IN TRIATHLETES.

Bernardi, E., Melloni, E., Pomidori, L., Mandolesi, G., Cogo, A.

*post graduate student in sport medicine*

**RESPIRATORY MUSCLE ENDURANCE TRAINING (RMET) WITH NORMOCAPNIC HYPERPNEA (NH) IMPROVES VENTILATORY FUNCTION AND EXERCISE PERFORMANCE IN TRIATHLETES.** Bernardi E.I, Melloni E.I, Pomidori L.I, Mandolesi G.I, Cogo A.I 1: Biomedical Sport Studies Center (University of Ferrara, Italy). Introduction: Recent studies show that RMET reduces dyspnea perception, improves endurance performance and decreases ventilation during exercise (Verges, 2008). At the best of our knowledge no information about the changes of oxygen consumption (VO<sub>2</sub>) and ventilation (VE) during incremental test is available in healthy subjects after RMET. Aim: To evaluate the effect of 5 weeks of RMET with NH by means of Spirotiger on respiratory function, cycling and running performance in triathletes. Materials and Methods: 15 M triathletes were randomly allocated to 2 groups: RMET (10 subjects; age 28 ± 6) and control (5 subjects; age 29 ± 4) group. At baseline (T0) all subjects underwent: pulmonary function tests (forced expiratory volume in first second, FEV<sub>1</sub>; forced vital capacity, FVC; maximal inspiratory pressure, MIP; maximal voluntary ventilation, MVV) and exercise tests (maximal incremental and endurance cardiopulmonary tests performed with both cycle ergometer and treadmill). Then, RMET group trained at home for 5 weeks: 20 min daily, with Spirotiger, at the same ventilation level measured at the respiratory compensation point (roughly corresponding to 50% of MVV) during incremental test. The same tests were repeated after 5 weeks (T1). Between T0 and T1 all subjects maintained the same level of daily physical activity. Result: No change was found in control group (data not reported). In RMET group MIP (T0: 93±29; T1: 97±25 cmH<sub>2</sub>O\*) and MVV (T0: 213±17; T1: 231±18 l/min\*) significantly increased. No differences were found in FEV<sub>1</sub> and FVC. Incremental test: maximum watt on cycle ergometer (T0: 389±106; T1: 429±119 watt\*) and maximum speed on treadmill (T0: 18±2; T1: 19±2 Km/h\*) signifi-

cantly increased. The trend of  $\text{VO}_2$ , VE and respiratory rate (RR) showed values significantly lower after RMET ( $p < 0.05$ , ANOVA test). The dyspnea Borg score during endurance tests on treadmill (T0: 7,2/10; T1: 6,5/10\*) and on cycle ergometer (T0: 7,3/10; T1: 6,7/10\*) showed a significant lower score. No differences were found in ventilatory pattern during both endurance tests. After RMET a significantly lower weight (-1 Kg\*) was measured. (\*  $p < 0.05$ ; T test) Conclusion: RMET significantly improves MIP and MVV in triathletes and increases exercise performance during incremental test. Furthermore the VE becomes more efficient as shown by the reduction of VE and RR during incremental test and by the lower dyspnea Borg score. Reference: Verges S, Boutellier U, Spengler CM. (2008). *Respir Physiol Neurobiol*, 161(1):16-22.

### EFFECT OF STAGE DURATION ON THE RELATIONSHIP BETWEEN PEAK RUNNING SPEED AND ENDURANCE PERFORMANCE

Machado, F., Kravchychyn, A.C.P., Peserico, C.S., da Silva, D.F., Mezzaroba, P.V.

*State University of Maringá*

**Introduction** It has been reported that the peak running speed ( $V_{\text{peak}}$ ) obtained during an incremental treadmill test is a good predictor of endurance performance (Noakes et al., 1990; Scott and Houmard, 1994; Stratton et al., 2009). However, the most appropriate protocol for the  $V_{\text{peak}}$  determination is still not established. Therefore, the purpose of this investigation was to examine the relationship between the  $V_{\text{peak}}$  determined during incremental tests of different stage durations and the endurance performance. **Methods** Thirty male, recreational, endurance trained runners (age:  $39 \pm 13$  years) of regional and local level participated in this study. Participants performed three continuous incremental exercise tests of different stage durations on a motorized treadmill until volitional exhaustion. Each protocol started at 8 km/h with increments in speed of 1 km/h every 1 min for the first protocol (P1), every 2 min for the second protocol (P2) and every 3 min for the third protocol (P3). The  $V_{\text{peak}}$  was defined as the highest speed that could be maintained for more than 90% of the stage duration during the incremental test. Thereafter, all the participants undertook two 5-km and two 10-km time trials on a 400-m track, which took place within a 15-day period after the laboratory testing. The best 5-km and 10-km time for each individual was recorded and their mean 5-km running speed ( $S_{5\text{km}}$ ) and 10-km running speed ( $S_{10\text{km}}$ ) from the best trials were calculated in km/h. **Results** The correlations between  $V_{\text{peak}}$  and  $S_{5\text{km}}$  were 0.86 (P1), 0.91 (P2) and 0.93 (P3). The correlations between  $V_{\text{peak}}$  and  $S_{10\text{km}}$  were 0.81 (P1), 0.87 (P2) and 0.88 km/h (P3). **Conclusion** The  $V_{\text{peak}}$  obtained during the incremental test with increments every 3 min presented the highest correlation with both  $S_{5\text{km}}$  and  $S_{10\text{km}}$ . Thus, the 3-min stage duration protocol is preferred than the 1-min and 2-min stage duration protocols for the determination of the  $V_{\text{peak}}$  to predict long distance running performance. **References** Noakes TD, Myburgh KH, Schall R. (1990). *Journal of Sports Sciences*, 8, 35-45. Scott BK, Houmard JA. (1994). *International Journal of Sports Medicine*, 15, 504-507. Stratton E, O'Brien BJ, Harvey J, Blitvich J, McNicol AJ, Janissen D, Paton C, Knez W. (2009). *International Journal of Sports Medicine*, 30, 40-45. Financial support: MCT and CNPq, Brazil.

### BODY COMPOSITION, HABITUAL PHYSICAL ACTIVITY AND BONE MEASUREMENTS IN MALES

Szmodis, M., Szóts, G., Bosnyák, E., Trájer, E., Tóth, M., Farkas, A.

*Semmelweis University, Faculty of Physical Education and Sports Sciences*

**Introduction** Osteopenia and osteoporosis are well known common diseases worldwide. The bone degeneration could be prevented or decreased and slowed down by regular physical activity. The aim of this study was to analyze relationships between sport events, some anthropometric parameters and bone stiffness in males. A quantitative ultrasound measurements could be easily used as a non-invasive method for evaluating bone status. **Methods** The subjects were Hungarian elite athletes (kayak-canoe,  $n=42$ ; triathlon/biking,  $n=16$ ) and non-athletic ( $n=48$ ) males of the same age range. In the anthropometric data collection the suggestion of the International Biological Program (Weiner and Lourie 1963) was considered. Body fat percentage was assessed by Pařízková's (1961) method, body composition by Drinkwater and Ross (1980), nutrition status was calculated by BMI. Calcaneal QUS parameters were examined with a Sonost 3000 bone densitometer. The measurements included speed of sound (SOS, m/s), broadband ultrasound attenuation (BUA, dB/MHz) and calculated the bone quantity index ( $BQI = \alpha \text{SOS} + \beta \text{BUA}$ ,  $\alpha, \beta$ : temperature corrections). We analysed the relationships of anthropometric variables and bone characteristics of total sample and subgroups. Differences of the respective subgroup means were tested by Tukey's post-hoc tests at the 5% effective level of random error when the overall F-test of one-way ANOVA was significant. **Results** There were moderate significant correlations between fat percentage, BMI and BUA, BQI in total sample. Compared the kayakers to the triathlete and non-athlete males the bone parameters did not differ but there was a constant tendency: triathlons and cyclists had the highest, non athletes had the lowest values. The differences of SOS and BQI means of triathlons and controls were significant: SOS ( $1512,91 \pm 20,80$  vs.  $1499,60 \pm 14,65$ ), and BQI ( $84,76 \pm 9,63$  vs.  $73,41 \pm 15,84$ ). **Discussion** The fact that active lifestyle can prevent degradation process of bones is proved in many international reports. Two of the bone parameters were different between triathlons and the controls but did not differ in kayakers and controls. It seems the quantity bone characteristics are highly dependent on sports events. The greater the mechanical load on the lower limbs the influence is stronger on bone stiffness or structure.

### INTRA-SESSION RELIABILITY OF RESPIRATORY PARAMETERS MEASUREMENT DURING SUBMAXIMAL EXERCISE ON CYCLE ERGOMETER IN AEROBICALLY TRAINED ADULTS

Dvorák, M., Balás, J.

*Charles University in Prague*

**Introduction** The aim of the study was to assess the intra-session reliability of the oxygen consumption, the carbon dioxide production and the expired minute volume during submaximal exercise test on cycle ergometer during repeated measures with the PowerLab/8M (ADInstrument Pty Ltd., Australia). **Methods** Eight aerobically trained participants (age  $24 \pm 3$  years) performed the submaximal exercise test on cycle ergometer. The first load was  $1.5 \text{ W} \cdot \text{kg}^{-1}$  (4 min) the second load  $2.5 \text{ W} \cdot \text{kg}^{-1}$  (4 min). The participants undertook 3 repetitions with 15 minutes recovery. The oxygen consumption, the carbon dioxide production and the expired minute volume were recorded by PowerLab/8M during the exercise and analysed with LabChart 7 (ADInstrument Pty Ltd., Australia). The average scores over the last minute in both loads were used for the calculations. Intra-class correlation coefficient ICC2.1 (Shrout & Fleiss, 1979) and standard errors of measurement SEM were used to address relative and absolute reliability. Repeated measures ANOVA were used to assess the systematic error between the three measurements. **Results** The ICC2.1 for the oxygen consumption was 0.92, for the carbon dioxide production 0.90, for the expired minute volume 0.94 at the first load ( $1.5 \text{ W} \cdot \text{kg}^{-1}$ ). The ICC2.1 for the oxygen consumption was 0.98, for the carbon dioxide production 0.98, for the expired minute volume 0.98 at the second load ( $2.5 \text{ W} \cdot \text{kg}^{-1}$ ). SEM for the oxygen consumption was 0.05

$L \cdot \text{min}^{-1}$ , for the carbon dioxide production  $0.05 L \cdot \text{min}^{-1}$ , for the expired minute volume  $1.28 L$  at the first load ( $1.5 W \cdot \text{kg}^{-1}$ ). SEM for the oxygen consumption was  $0.04 L \cdot \text{min}^{-1}$ , for the carbon dioxide production  $0.04 L \cdot \text{min}^{-1}$ , for the expired minute volume  $1.16 L$  at the second load ( $2.5 W \cdot \text{kg}^{-1}$ ). Discussion The coefficients of reliability ranged between 0.90 and 0.98. The values 0.90 and higher are considered as a good indicator of reliability in sport science literature (Baumgartner et al., 2006). The value of ICC is, however, influenced by the heterogeneity of the research sample. The indication of absolute reliability coefficient should be calculated. We choose the SEM which is one of the most used coefficients along with coefficient of variation and limits of agreement. We agree with Eng et al. (2004) who stated similar values of ICC and SEM for  $\text{VO}_2$  at submaximal load ( $1.1 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$ ). In conclusion, we found high reliability of ventilatory parameters measurement during submaximal cycle ergometry measured by PowerLab 8/M. References BAUMGARTNER, T. A., JACKSON, A. S., MAHAR, M. T. & ROWE, D. A. (2006). New York: McGrawHill. ENG, J. J., DAWSON, A. S., CHU, K. (2004). Arch Phys Med Rehabil, 85(1), p. 113-118. SHROUT, P. E. & FLEISS, J. L. (1979). Psych Bull, 86(2), p. 420-428

## COMPARISON OF UPHILL SPRINT TRAINING TO CYCLE SPRINT TRAINING

Jakeman, J.R.1, Lorimer, R.2, Babraj, J.A.2

1. Oxford Brookes University; 2. SPEC, University of Abertay, Dundee

High intensity training (HIT) involving 30sec sprints is an effective approach to improving aerobic performance. However much of this research is based on cycle ergometry, with access to equipment difficult, and the protocol non sport-specific. We investigated whether 30sec uphill running sprints could deliver similar improvements in aerobic performance as cycle HIT and the similarity of metabolic demand. Methods: Eleven recreationally active males ( $35 \pm 8$  y, weight  $82 \pm 10$  kg, BMI  $26 \pm 3$   $\text{kg} \cdot \text{m}^{-2}$ ) were recruited and allocated to either a cycle training group (CT n=5) performing two weeks of HIT, or a run training group (RT n=6) performing 2 weeks of uphill sprints on a 1:10 slope. The sprint intervention for both groups involved 4 x 30 sec sprints separated by 4 min active recovery, 3 x per week (totalling 6 sessions, with a total exercise time of 12 min). Before and after 2 weeks of training participants performed a  $\text{VO}_2$  max and time to exhaustion (TTE) test on a cycle or treadmill ergometer, with protocols seeking to produce similar TTE. On separate occasions 6 participants performed 2 uphill or cycle sprints with portable breath by breath analysis and blood lactate taken 1 minute after each sprint. Results: Two weeks of HIT resulted in an 11% increase in TTE in the RT group and a 6% increase in TTE in the CT group ( $p = 0.014$  and  $p=0.05$  respectively). The improvement in TTE was associated with an increase in the %  $\text{VO}_2$  max where  $\text{VCO}_2$  excess occurred (RT- pre  $66 \pm 10\%$ , post  $78 \pm 5\%$ ;  $p<0.01$  pre versus post; CT- pre  $53 \pm 2\%$ , post  $64 \pm 4\%$ ;  $p<0.05$  pre versus post). Further, blood lactate was significantly lower after the first uphill sprint compared to the first cycle sprint ( $5.1 \pm 2.4$  versus  $10.2 \pm 1.3$   $\text{mmol} \cdot \text{l}^{-1}$ ,  $p<0.001$ ). However blood lactate levels were similar after the second sprint ( $12.5 \pm 2.2$  versus  $14.1 \pm 1.7$   $\text{mmol} \cdot \text{l}^{-1}$ , NS). The first uphill sprint produced a greater area under the curve for heart rate,  $\text{VO}_2$  and  $\text{VCO}_2$  than the cycle sprint during the sprint and 4 minute recovery ( $p<0.05$  for all). However, only area under the curve for  $\text{VO}_2$  was greater for uphill sprinting compared to cycle for the second sprint ( $p<0.05$ ). Discussion: In the present study we demonstrate that uphill sprints can improve aerobic performance to a similar extent as a cycle HIT protocol. The magnitude of change in  $\text{VCO}_2$  excess is similar following RT and CT suggesting both protocols produce similar adaptations in lactate metabolism. There is a greater oxygen demand in the first uphill sprint which results in a lower blood lactate concentration suggesting a higher aerobic contribution to an uphill sprint compared to a cycle sprint. In conclusion uphill sprints are as effective as traditional cycle high intensity training to improve aerobic performance in recreationally active males.

## 13:45 - 14:45

### Poster presentations

#### PP-PM72 Training & Testing 16

##### EFFECT OF 6 WEEKS OF REPEATED SPRINT ABILITY TRAINING ON HEART RATE RECOVERY.

Sarabia, J.M.1, Sánchez-Sánchez, E., Torres, G.2, Guillen, S.1, Aracil, A.1, Moya, M.1

1: Research Group on Healthy Physical Conditioning, Centro de Investigación del Deporte, UMH (Elche, Spain).

Introduction Tennis is characterized by repeated explosive movements, followed by recovery periods of around 20-25 s. Post-exercise recovery is a key factor to determine the optimal training load in athletes. Heart rate recovery (HRR) is been used as a marker of post-exercise recovery (Lamberts et al., 2010). The aim of this study was to describe the HRR evolution during 6 weeks of a repeated sprint ability (RSA) training period in young tennis players. Methods During a 6-week intervention period, 9 young male tennis players performed two RSA training sessions per week in addition to their regular training schedule. Each RSA training session consisted in performing three series -of six repetitions each- of a high-intensity circuit, including hits, with 20-s self-paced recovery periods among repetitions and 3 min among series. Intensity was controlled by means of heart rate (HR) monitors (RR interval -Polar Team2-). For each session, HRR was estimated by measuring the HR after the last repetition of the last series immediately at the end of the repetition, and after 30", 1' and 2' of recovery. For each individual a sixth polynomial regression line was calculated for the whole intervention period, and after a post hoc analysis individuals were grouped depending on HRpeak tendency. Results Two groups were identified: a first group that showed stability in HRpeak (SP), and a second group that showed a decrease in HRpeak (DP). HRR range tended to maintain stable along the whole intervention period in SP group in comparison with DP group, in which HRR tended to decrease. These differences were found to be statistically significant at every moment studied (30",  $p = .011$ ; 1',  $p = .007$ ; 2',  $p = .005$ ; ANOVA). Discussion According to previously published work (Lamberts, et al., 2010) at the present report homogeneous groups based on their HRR tendency after high-intensity training could be identified. The fact that RSA training may produce different responses in a homogenous sample suggests that this type of training should be monitored and individualized. References Lamberts, RP., Swart, J., Capostagno, B., Noakes, TD & Lambert, M.I. (2010). Scand J Med Sci Sports, 20, 449-457.

## COMPARISON OF DIFFERENT METHODS FOR ESTIMATING TOTAL ENERGY EXPENDITURE FOR BRIEF BOUTS OF HIGH INTENSITY INTERVALS

Kilian, Y.1, Koehler, K.2,3, Wahl, P.1, Zinner, C.1, Sperlich, B.4, Mester, J.1,3

*German Sport University Cologne*

1 Institute of Training Science and Sport Informatics, German Sport University Cologne, Germany 2 Institute of Biochemistry, German Sport University Cologne, Germany 3 The German Research Centre of Elite Sport, Cologne, Germany 4 Department of Sport Science, University of Wuppertal, Germany Introduction: O<sub>2</sub> uptake remains the most popular method to estimate energy expenditure. Although O<sub>2</sub> uptake provides an excellent representation of aerobic ATP turnover, it does not represent the energy expenditure (EE) by rapid anaerobic glycolytic ATP turnover. The quantification of total EE for exercise and recovery includes the measurement of exercise O<sub>2</sub> uptake and excess post oxygen consumption (EPOC) along with anaerobic glycolytic ATP turnover. Scott et al. (2006) used and critically discussed these measurements to determine EE for a single brief bout of high intensity intervals. However the problems emerging with the used of these parameters might be even bigger when estimating the EE of several bouts of high intensive work due to the estimation of anaerobic EE from  $\Delta$ blood lactate levels. The aim of the present study was to compare the anaerobic and total EE calculated by different methods. Methods: Nine healthy competitive young cyclists took part in this study (14.4  $\pm$  1.1 years; VO<sub>2peak</sub>: 59.6  $\pm$  9.1 mL\*kg<sup>-1</sup>\*min<sup>-1</sup>; peak power output (PPO): 4.2  $\pm$  0.5 W\*kg<sup>-1</sup>). The high intensity training consisted of 4x4 min intervals at 90-95 % PPO separated by 3 min of active rest. Capillary blood from the earlobe was collected for the analyses of blood lactate pre, post warming-up (WU) and after each 4 min exercise bout. O<sub>2</sub> consumption was recorded continuously during the exercise. Aerobic, anaerobic EE and EPOC were calculated according to Scott et al. (2006).  $\Delta$ blood lactate was obtained by a) subtracting WU lactate from peak interval lactate concentration, b) subtracting the previous interval lactate from peak interval lactate, c) treating  $\Delta$ blood lactate obtained the first interval as representative for all intervals. In addition, EE of the first interval was multiplied by 4 (d). Results: Total energy expenditure was a) 1824  $\pm$  512 kJ, b) 1752  $\pm$  522 kJ, c) 1781  $\pm$  531 kJ and d) 1801  $\pm$  564 kJ. Significant differences were found between method a) and b). Based on a total work 334  $\pm$  73 kJ, average cycling efficiency was between 18.3% (b) and 19.1% (a). Conclusion: For estimating EE for repeated bouts of high intensity intervals it is possible to treat the first interval as representative for total EE. Even though there are significant differences between a) and b), these differences (72 kJ) are clinically not relevant. References: Scott, C.B. (2006). Estimating energy expenditure for brief bouts of exercise with acute recovery. *Appl. Physiol. Nutr. Metab.* 31: 144-149

## ENHANCEMENT OF POWER IN TAKE-OFF PHASE OF JUMPS ON FIRM AND FOAM SURFACE

Zemková, E., Vilman, T., Jelen, M., Hamar, D.

*Faculty of Physical Education and Sport, Comenius University*

Introduction It has been shown that activation of stretch-shortening cycle (SSC) during countermovement jump (CMJ) enhances power production in concentric phase as compared to squat jump (SJ). Such an enhancement of power in take-off phase of CMJ may be ascribed to utilization of energy accumulated in elastic tissues due to increase of braking force during eccentric phase. To some extent it may be also attributed to activation of stretch reflex by stimulation of proprioceptors by rapid increase of force in eccentric phase. However, it is unknown whether this enhancing effect is influenced by stability of support base. Therefore, the study compares the difference in peak power in take-off phase of CMJ and SJ on firm and foam surface. Methods A group of 34 physical education students (age 20.8  $\pm$  2.1 y, height 187.6  $\pm$  7.5 cm, weight 86.7  $\pm$  9.2 kg) performed in random order CMJ and SJ on force platform and on foam (Airex Balance Pad) placed on force platform, respectively. The strain gauge force platform (FITRONiC s.r.o., SK) with electronics, 12 bit AD convertor and software was used. Analytical software module was used for calculation of acceleration, velocity, vertical center of mass displacement, and power from force-time curve. Vertical force applied to the plate includes weight (product of body mass and gravitational constant) and inertia component (product of body mass and vertical acceleration). As a parameter of the capability to utilize elastic energy, the difference in peak power in take-off phase of CMJ and SJ was considered. Results Peak power in take-off phase of CMJ was significantly ( $p < .05$ ) higher on firm than on foam surface (1923.3  $\pm$  208.7 W and 1793.7  $\pm$  191.4 W, respectively). On the other hand, there were no significant differences in peak power in take-off phase of SJ on firm and foam surface (1710.7  $\pm$  143.1 W and 1635.7  $\pm$  117.8 W, respectively). Consequently, the difference in peak power between CMJ and SJ was significantly ( $p < .05$ ) higher on firm than on foam surface (212.6  $\pm$  39.2 W and 158.0  $\pm$  31.2 W, respectively). Further analysis showed that subjects produced significantly ( $p < .05$ ) higher peak force during CMJ on firm than on foam surface (4160.3  $\pm$  324.7 N and 3892.0  $\pm$  317.8 N, respectively) at maximal velocity of 2.9  $\pm$  0.08 m/s and 2.8  $\pm$  0.06 m/s, respectively. Discussion These results showed that the enhancement of power in concentric phase of jump due to CM is greater on firm than on foam surface. Similar finding has been shown in beach volleyball players during jumps on stable support base and unstable sand (Zemková et al., 2011). Taken this fact into account, in some sports such measurement of take-off power in jump under unstable conditions may provide additional information on force-velocity characteristics and may complement existing methods. References Zemková E, Vilman T, Uvaček M, Cepková A, Hamar D (2011). 7th Baltic International Sports Medicine Congress. Riga: Latvian Sports Medicine Association, 18.

## POWER PRODUCTION IN CONCENTRIC PHASE OF SQUATS ON UNSTABLE SURFACE AT DIFFERENT RANGES OF MOTION

Zemková, E., Hamar, D.

*Faculty of Physical Education and Sport, Comenius University*

Introduction It has been reported (Escamilla, 2001) that peak quadriceps EMG activity occurring at approximately 80-90° of knee flexion. Quadriceps activity remained fairly constant beyond 80-90° of knee flexion, hence descending beyond 90° flexion, may not enhance quadriceps strength. Therefore, practitioners are instructed to begin the up-phase once the upper leg is at a position parallel to the ground. Furthermore, the load of 80% of the maximum muscular strength is required for its enhancement in trained individuals (Kraemer et al., 2002). However, these requirements might not be met during instability resistance exercises. Full barbell squats on unstable support base are rather difficult to perform for subjects without experience in instability resistance training. Using higher weights during squats on Bosu ball may also lead to anxiety of falling, which might compromise the proper technique of movement. It has been suggested that velocity and range of motion (ROM) might be affected to an even greater degree than force by an unstable platform. Drinkwater et al. (2007) have found meaningful effect sizes when evaluating squat-depth changes moving from stable (floor) to unstable (foam and Bosu ball) conditions at most resistances. This study compares mean power in concentric phase of squats on Bosu ball at a knee angle of 90° and 135° while lifting different weights. Methods A group of 23 PE students (age 21.4 $\pm$ 1.8 y, height 176.9 $\pm$ 8.1 cm, weight

78.0±9.6 kg) performed in random order 3 reps of barbell squats on Bosu ball while lifting 40%, 60%, and 80% 1RM, respectively. Squats were performed from full extension to a knee angle of 90° or 135° using maximal effort in concentric phase of lifting. Since the depth of squats was determined from visual inspection, only trials with vertical range of 0.55-0.60 m and 0.35-0.40 m has been taken for the evaluation. A PC based system FITRO Dyne Premium was used to monitor force and velocity and to calculate power. Results There were no significant differences in mean power in concentric phase of squats with 40% 1RM at 90° and 135° of knee flexion (322.4±42.7 W and 305.5±41.4 W, respectively). Similarly, its values did not differ significantly during squats with 60% 1RM at 90° and 135° of knee flexion (394.6±45.8 W and 364.5±43.1 W, respectively). However, mean power in concentric phase of squats with 80% 1RM was significantly ( $p < .05$ ) lower at 90° than at 135° of knee flexion (429.4±50.2 W and 507.5±59.1 W, respectively). Discussion Power in concentric phase of squats on unstable Bosu ball was more profoundly compromised at knee angle of 90° than at 135°, however, only at higher weight lifted (80% 1RM). To avoid this drawback, smaller ROM when using higher weights or lower weights when exercising at greater ROM should be preferred. References Drinkwater et al. (2007). *Int J Sports Physiol Perform*, 2: 400-13 Escamilla R (2001). *Med Sci Sports Exerc*, 33: 127-41 Kraemer WJ et al. (2002). *Med Sci Sport Exerc*, 32: 364-80

## ACCURACY OF THE T2MINUTE METHOD FOR MEASURING ELITE ROWING TRAINING

Tran, J.I., Main, L.C.I., Rice, A.J.2, Gastin, P.B.1

1: Deakin University (Melbourne, Australia); 2: Australian Institute of Sport (Canberra, Australia).

Introduction Elite rowers undertake a combination of rowing-specific and non-specific modes of training, incorporating bouts of continuous and interval efforts, and low- and high-intensity work (Steinacker 1993). However, current training load measures are not suitable for measuring load in certain modes and intensities, e.g., heart rate monitoring is not valid during intermittent work (Achten & Jeukendrup 2003). To address these limitations, the T2minute method was developed to quantify rowing training loads. The method incorporates a modal weighting factor to account for differences in load imposed by training in various modes. The measure also includes intensity weighting factors based upon intensity zones standardised by the Australian Institute of Sport. The purpose of this study was to examine the accuracy of the T2minute method for quantifying elite rowing training loads, by comparing the method to Banister's TRIMP (Banister et al. 1975) and the Session-Rating of Perceived Exertion method (S-RPE; Foster et al. 2001) as criterion measures. Methods Fourteen elite Australian rowers (12 males, 2 females) participated in this study. Training load data was collected from 4 weeks of routine training. Athletes completed varied training, including rowing-specific (on-water and ergometer rowing) and non-specific sessions (cycling, running, swimming). Spearman's correlation coefficients ( $\rho$ ) with 90% confidence limits [CL] were calculated to examine the relationship between the criterion measures and the T2minute method. Inferences were drawn from effect sizes, calculated from the correlation coefficients. Results A strong correlation was observed between the T2minute and Banister's TRIMP ( $\rho \pm 90\% \text{ CL} = 0.59 \pm 0.43$ ,  $p < 0.05$ ). A moderate correlation was observed between the T2minute and S-RPE ( $\rho \pm 90\% \text{ CL} = 0.42 \pm 0.41$ ,  $p < 0.05$ ). The true effect was likely positive for both comparisons (92.1% likely for T2minute vs. Banister's TRIMP; 86.4% likely for T2minute vs. S-RPE). Discussion The T2minute method is sufficiently accurate for field measurement of elite rowing training loads from varied training. This method improves upon existing measures, providing a novel means to measure overall training and sessions of variable intensities. Future research should focus on incorporating the measurement of strength training loads, and on examining the method's applicability to other sports. References Achten, J., Jeukendrup, A. (2003). *Sports med*, 33(7), 517-538. Banister E, Calvert T, Savage M, Bach T. (1975). *Aust J Sports Med*, 7(3), 57-61. Foster C, Florhaug J, Franklin J, Gottschall L, Hrovatin L, Parker S, Doleshal P, Dodge C. (2001). *J Str Cond Res*, 15(1), 109-115. Steinacker J. (1993). *Int J Sports Med*, 14(Suppl. 1), S3-S10.

## TRUNK AND KNEE MUSCLE PERFORMANCE OF ROWERS

Grosdent, S., Demoulin, C., Gauthier, S., Croisier, J.L., Vanderthommen, M., Crielaard, J.M.

University of Liege

Purpose: The aim of this study was to assess trunk extensor and limb muscular performance of rowers. Methods: 12 rowers involved in national or international competitions (male, mean age  $22.8 \pm 8.5$  years, weight  $74.0 \pm 7.6$  kg, height  $181.4 \pm 6.0$  cm), 12 non-rowing athletes (male, mean age  $21.4 \pm 2.6$  years, weight  $70.7 \pm 6.7$  kg, height  $179.8 \pm 6.4$  cm) and 12 healthy sedentary males (mean age  $22.6 \pm 1.9$  years, weight  $71.6 \pm 7.7$  kg, height  $177.8 \pm 6.0$  cm) were included in the study. Trunk extensor performances were assessed by means of a maximum static strength test [consisting in maximal voluntary contractions (MVC)] and a dynamic endurance test [consisting in performing as much flexion-extension movements as possible using a load corresponding to 40 percent of MVC test] performed with a specific trunk dynamometer (David International Ltd., Vantaa, Finland). Moreover, a static endurance test [modified Sorensen test] was also performed. Knee flexors and extensors strength peak torques (PT) of the dominant leg were assessed, using a Cybex Norm dynamometer (Henley Healthcare, Sugar Land, Texas), at 60°/s and 240°/s in concentric and 30°/s in eccentric exertions. Muscle fatigue resistance was also measured (30 maximal concentric contractions at 180°/s). Results: Regarding trunk muscle performance, rowers had significant higher PT than sedentary males ( $P < .01$ ) and non-rowing athletes ( $P < .05$ ). By contrast, static and dynamic endurance did not differ between groups. However, during the dynamic endurance test, rowers moved a total load (number of repetitions accomplished x load) significantly higher than control subjects ( $P < .05$ ). Regarding knee muscles, rowers had higher extensors concentric PT at 60°/s ( $P < .05$ ) and flexors total work at 180°/s ( $P < .05$ ) than sedentary males. In contrast, no difference was shown between groups regarding flexors strength and agonists/antagonists ratios. Conclusion: This study showed some difference in trunk and knee extensors strength between rowers and control subjects as well as between rowers and non-rowing athletes. The increased performances of extensor muscles in elite rowers appear to be probably related to the specificity of this sport. In the drive phase of rowing, rowers sequentially push with the legs and then pull with the arms and lower back, requiring both muscular strength and endurance. However, no difference was shown between groups regarding dynamic and static trunk extensor endurance. Further study is required to clarify if trunk and knee muscle strength and/or endurance are related to rowing performance.

## EFFECT OF STAGE DURATION ON PHYSIOLOGICAL RESPONSES AT FIXED AND MODELLED PLASMA LACTATE MARKERS DURING INCREMENTAL TREADMILL RUNNING

Gavin, J.P., Myers, S.D., Clements, R.E., Willems, M.E.T.

University of Chichester

Introduction Incremental exercise with measurement of physiological responses at workloads equivalent to lactate threshold (LT) can be used to estimate training adaptation and endurance performance. Incremental protocol design has been extensively reviewed (Beniley et

al., 2007), yet the effect of stage duration on physiological responses corresponding to speeds at plasma lactate markers for incremental running of 4- and 8-min stages has not. Methods Fifteen men ( $23 \pm 4$  yr,  $178 \pm 5$  cm,  $73 \pm 11$  kg) performed repeat treadmill running trials of 4- and 8-min stages at a 1% gradient. Running commenced at  $8 \text{ km} \cdot \text{h}^{-1}$  with an incrementation rate of  $1 \text{ km} \cdot \text{h}^{-1}$ . Breath-by-breath oxygen uptake (VO<sub>2</sub>), and heart rate (HR) (Cosmed K4b2, Italy) were recorded for the final 30s of each stage with ratings of perceived exertion (RPE) and plasma lactate. Fingertip blood samples were analysed for plasma lactate (2300 STAT Plus™, YSI Life Sciences, USA) and analysis software (Newell et al., 2007) used to derive treadmill speed, HR, VO<sub>2</sub> and RPE at the markers: fixed 4.0 mmol.L<sup>-1</sup>, the initial 1 mmol.L<sup>-1</sup> rise, Dmax, LT and log-log LT. Differences between 4- and 8-min stages were analysed by paired samples t-tests. One-way repeated measures ANOVA with pairwise comparisons was used to assess mean plasma lactate and VO<sub>2</sub> for 4-min, 4-min at 8-min, and 8-min stages. Results Mean maximal running speed was faster for 4-min ( $14.4 \text{ km} \cdot \text{h}^{-1}$ ), in comparison to 8-min stages ( $12.6 \text{ km} \cdot \text{h}^{-1}$ ) ( $P=0.001$ ). There was no effect of stage duration on speed, HR, VO<sub>2</sub> and RPE at fixed lactate markers ( $P>0.05$ ). For 8-min stages, the treadmill speed was lower at modelled markers: Dmax, ( $-1.1 \text{ km} \cdot \text{h}^{-1}$ ;  $P=0.001$ ), LT ( $-0.9 \text{ km} \cdot \text{h}^{-1}$ ;  $P=0.008$ ) and log-log LT ( $-0.8 \text{ km} \cdot \text{h}^{-1}$ ;  $P=0.006$ ), yet RPE was higher and VO<sub>2</sub> lower for LT ( $1.1$ ,  $P=0.023$ ;  $-270.7 \text{ mL} \cdot \text{min}^{-1}$ ,  $P=0.013$ ) and log-log LT ( $1.4$ ,  $P=0.027$ ;  $-293.3 \text{ mL} \cdot \text{min}^{-1}$ ,  $P=0.002$ ). Mean plasma lactate and VO<sub>2</sub> were greater at  $8 \text{ km} \cdot \text{h}^{-1}$  for 4-min ( $P=0.008$ ), then similar until  $11 \text{ km} \cdot \text{h}^{-1}$  for 4- and 8-min stages ( $P=0.05$ ). At subsequent speeds, there was a trend towards higher plasma lactate concentrations for 4-min, in comparison to 8-min stages. Discussion These findings suggest that incremental treadmill running tests using stage durations of 8-min have the effect of reducing the speed, but increasing the perception of exercise intensity at the LT and log-log LT. When assessing physiological responses for incremental treadmill running, the use of these markers with protocols of longer stage duration may underestimate marker running speed. References Bentley DJ, Newell J, Bishop D. (2007). *Sports Med*, 37(7), 575-586. Newell J, Higgins D, Madden N, Cruickshank J, Einbeck J, McMillan K, McDonald R. (2007). *J Sports Sci*, 25(12), 1403-1409.

### EFFECTS OF LONG-TERM MILITARY FIELD TRAINING ON THE PHYSICAL PERFORMANCE OF CONSCRIPTS ON THE EXAMPLE OF A UNIT IN THE ESTONIAN ARMY

ANTSON, H., MÄRK, H.

*Tallinn University, Estonian Defence Forces*

Introduction Several studies indicate that the end of the soldiers' basic training course is the break-point in the progress of freshmen physical performance. The period following it is dedicated to practising specific military skills and knowhow not only in the habitual barracks environment but also in outdoor conditions. Conscripts' physical performance and fitness standard is especially influenced by long-term field training (with the duration of a week or more). Predominantly, body mass and waist circumference of the recruits have a tendency to shift upwards quite quickly. Therefore, soldiers' endurance and strength indicators cannot be maintained in accordance with the requirements of physical fitness test (PFT) any more. The current follow-up study continues the recent research among conscripts. The paper aims at eliciting influence of one-week military field training on comparative body mass and waist circumference and on conscripts' physical performance. Methods 727 male conscripts at the start of service in 2010 (mean age 21.5) participated in the study of the training cycle in years 2010-2011. Individual PFT (was taken before and after one-week field training period) results as well as their body measurement records were collected and stored in the data base and analyzed. Results The current study revealed the fact that both body mass and waist circumference of a significant number of conscripts tended to expand during the period of military field training. The rise of BMI is related either to the growth of muscle mass (then, waist circumference is not increasing) or the progression of fat mass (in that instance, waist circumference is increasing). Individuals' mean body mass increment was 3-5 % throughout a week. The decline in average 3.2-mile run results was 10-15 %. Discussion The field training period is characterized by irregular activities and outdoor nutrition regime without comfort. All major factors – health, weather, eating, ground difficulties etc – influence any conscript in the field over a week. The other key causes for the rise in conscripts' body mass are related to increased consumption of high calorie and nutrient-poor packed food and the method of cooking. There is an indirect evidence that the long-term absence of ordinary military environment may cause mental and bodily stress, which influences recruits' physical performance indicators (stamina, strength) towards decrease. Such trend might impose an unwanted influence on the conscripts' defence capacity and deployability during allied missions or war time. It is important, according to the present investigation, that field instructors should encourage conscripts to do appropriate relaxation exercises during training as well as during recreation time.

### INFLUENCE OF IVO<sub>2</sub>MAX DETERMINATION ON TIME SPENT AT VO<sub>2</sub>MAX DURING CONTINUOUS CYCLING TO EXHAUSTION

Merry, K.L.

*Loughborough College of Higher Education*

INFLUENCE OF IVO<sub>2</sub>MAX DETERMINATION ON TIME SPENT AT VO<sub>2</sub>MAX DURING CONTINUOUS CYCLING TO EXHAUSTION Merry, K.L.1, Glaister, M.2, Howatson, G.3, Van Someren, K.4 1: Loughborough College (Loughborough,UK), 2: St Mary's University College, (Twickenham,UK), 3: Northumbria University, (Newcastle Upon Tyne, UK), 4: English Institute of Sport, (Twickenham, UK) Introduction The minimal exercise intensity that elicits VO<sub>2</sub>max during a maximal incremental test (iVO<sub>2</sub>max) may allow the longest time spent at a high VO<sub>2</sub> ( $\geq 95\%$  VO<sub>2</sub>max) during continuous exercise to exhaustion (Billat et al., 1999). The purpose of this study was to compare the time to exhaustion (TTE) and time spent at a high level of oxygen uptake (VO<sub>2</sub>) during two continuous cycle ergometer exercises to exhaustion at iVO<sub>2</sub>max Methods Nine male triathletes (age  $31.6 \pm 10.2$  years, body mass  $73.3 \pm 6.1$  kg, height  $1.79 \pm 0.07$  m, VO<sub>2</sub>max  $3.52 \pm 0.49 \text{ L} \cdot \text{min}^{-1}$ ) attended the laboratory on four separate occasions over a period of 4 weeks. During trials 1 and 2, in a random order, participants performed two maximal incremental cycle ergometer tests with different stage durations (1 min and 3 min) for the determination of iVO<sub>2</sub>max(1 min) and iVO<sub>2</sub>max(3 min). During visits 3 and 4, participants performed two continuous cycles to exhaustion at iVO<sub>2</sub>max(1 min) (CONT1) and iVO<sub>2</sub>max(3 min) (CONT3) also in a random order. Results iVO<sub>2</sub>max(1 min) was significantly greater ( $P < 0.05$ ) than iVO<sub>2</sub>max(3 min) ( $337 \pm 36 \text{ W}$  vs.  $292 \pm 43 \text{ W}$ ) ( $P < 0.05$ ). There was no significant difference ( $P > 0.05$ ) between iVO<sub>2</sub>max(1 min) and iVO<sub>2</sub>max(3 min) for VO<sub>2</sub>max ( $3.59 \pm 0.48 \text{ L} \cdot \text{min}^{-1}$  vs.  $3.52 \pm 0.51 \text{ L} \cdot \text{min}^{-1}$ ). The mean TTE measured during CONT3 was significantly longer ( $P < 0.05$ ) than CONT1 ( $511.7 \pm 189.2 \text{ s}$  vs.  $224.9 \pm 54.2 \text{ s}$ ). The mean time spent at VO<sub>2</sub>max (T@VO<sub>2</sub>max) was significantly longer ( $P < 0.05$ ) during CONT3 than CONT1 ( $199.3 \pm 220.0 \text{ s}$  vs.  $11.6 \pm 26.8 \text{ s}$ ), and the mean time spent above 95% VO<sub>2</sub>max (T@95%VO<sub>2</sub>max) was significantly longer ( $P < 0.05$ ) during CONT3 than CONT1 ( $306.4 \pm 238.0 \text{ s}$  vs.  $64.3 \pm 61.2 \text{ s}$ ). Discussion In conclusion, these results show that when exercising continuously to exhaustion at iVO<sub>2</sub>max time spent at a high level of VO<sub>2</sub> is significantly longer when iVO<sub>2</sub>max(3 min) is used to determine iVO<sub>2</sub>max References Billat, V.L., Blondel, N., and Berthoin, S. (1999). *Eur J Appl Physiol*, 80, 159-161.



**EFFECT OF POLAR TRAINING LOAD-GUIDED VERSUS NON-GUIDED TRAINING IN RUNNERS**

Bruch, A., Kinnunen, H., Stapelfeldt, B.

*Albert-Ludwigs-Universität Freiburg*

Introduction Practical methods to quantify the individual training dose of an athlete have been studied earlier (1). Polar Training Load (TL) feature (Polar Electro Oy, Finland) aims at determining the balance between training and recovery. Input information for TL are gender, weight, VO<sub>2</sub>max, HRmax, HRrest, lactate threshold (LT), and anaerobic threshold (IAT). The training software (PPT.com) guides daily training based on individual cumulative TL values (CTL) with a colour based system (green, yellow, red). The purpose of this study was to quantify the effects of TL guidance and performance parameters among regularly training runners. Methods 24 male runners were randomised into a study group (PPT.com) and a control group (PPT). The average VO<sub>2</sub>max was 59 ml/min/kg in PPT.com group and 61 ml/min/kg in PPT group. Average weekly training time before the study was 7 h in both groups. The training was followed up for 8 weeks. PPT.com group trained with TL guidance and PPT group without guidance. At the beginning and end of the study a standardized incremental maximal exercise test was performed on a treadmill (h/p/cosmos sports & medical GmbH, Germany) with respiratory gas analysis. Test measurements included LT, IAT and VO<sub>2</sub>max. One subject was left out the analysis due to training data loss. Results Both groups trained 8.4 h/week, PPT.com with an average HR of 135 bpm, PPT group with an average HR of 133 bpm. Average CTL values before a training session were 43 and 60 in PPT.com and PPT groups, respectively, indicating a tendency towards better recovery status in PPT.com group when starting an exercise session ( $p = 0.08$ ). No differences were found in any other CTL values. Lab-tests showed no significant differences between groups in any performance markers. Discussion In runners who had been training 7 h weekly, users of TL feature didn't train differently compared to non-users. In contrast to this, a previous study (2) showed significant changes in training among cyclists who trained 15 h weekly. One reason for the present finding may be that most runners did not train too extensively in terms of TL parameters: even without using the TL feature their own training routines did not include high intensity sessions with poor recovery status. Additionally, three subjects in PPT.com group did not adapt their training according to the TL-rules which underlines the importance of personal motivation factors. References 1 BANISTER E.W., et al. (1992): Dose/Response Effects of Exercise Modelled from Training: Physical and Biochemical Measures. *Ann. Physiol. Anthropol.*; 11(3): 345-356. 2 BRUCH, A.; KINNUNEN, H.; STAPELFELDT, B. (2011): Effect of Polar Training Load-guided versus non-guided training in cyclists, in Cable, Tim N., George, Keith (Hg.): 16th Annual Congress of the ECSS, July 6-9, 2011: Book of Abstracts, Liverpool, S. 316.

**EFFECTS OF COMPRESSION SOCKS ON PAIN AND PERIPHERAL RESPONSES DURING AND FOLLOWING MARATHON RUNNING**

Babault, N.1, Deley, G.1, Gardon-Mollard, C.2, Benigni, J.P.2, Allaert, F.A.3

*Université de Bourgogne*

EFFECTS OF COMPRESSION SOCKS ON PAIN AND PERIPHERAL RESPONSES DURING AND FOLLOWING MARATHON RUNNING. Babault, N.1, Deley, G.1, Gardon-Mollard, C.2, Benigni JP.2, Allaert, FA.3 1: CEP (Dijon, France), 2: Phlebologists (France), 3: CEN (Dijon, France) Introduction Compression garments are now commonly used by athletes during training and competitions to delay fatigue, reduce pain during efforts (Chatard et al., 2004) and also to optimise recovery (Kraemer et al., 2001). They may favour peripheral circulation, blood flow return and therefore decrease metabolic toxin stasis. If many athletes regularly reported these effects, few data are available concerning their effects during marathon runs. Therefore this study aimed to assess the effects of wearing class II elastic socks (18-21 mmHg) on subjective ratings and peripheral circulation when applied during marathon runs. Methods This study was conducted during the "Marathon de Paris". Eighty-six comparable subjects (i.e., males/females proportion, marathon performance, body mass index, internal gastrocnemius vein diameter) were considered in this study ( $n = 43$  in each group). Their mean age  $\pm$  SD were  $43 \pm 8$  years old and none reported any venous insufficiency. Compression socks (18-21mmHg) were proposed to marathoner who accepted to wear them during the race (Compression Sock Group CSG) and compared to a control group who did not wear them (Control Group CG). Marathoners had a Doppler examination before and after the race and described their feeling at the end of the race and during the 4 following days using a visual analogic scale (from 0 to 100). Results At the end of the race and compared to CG, the CSG group described lower muscular pain  $33 \pm 25$  vs.  $49 \pm 28$  ( $p < 0.01$ ), lower muscular leg tiredness  $44 \pm 21$  vs.  $57 \pm 25$  ( $p < 0.01$ ) and lower leg swelling  $9 \pm 18$  vs.  $18 \pm 22$  ( $p < 0.01$ ). The diameter of the internal gastrocnemius vein was also lower  $5.1 \pm 1.4$  mm vs.  $5.7 \pm 1.5$  mm ( $p < 0.05$ ). While pain decrease was comparable during the 4 following days, recovery of muscular leg tiredness was significantly improved in the CSG group ( $p < 0.01$ ). Discussion These results clearly demonstrate the positive effects of wearing elastic compression socks during long duration efforts. The pain reduction during the marathon may reduce the risk of a premature stop and may contribute to the last supplementary effort at the end of the race. The additional positive effects on the recovery kinetic is also important for the runners' comfort and especially in elite athletes which may have to practice frequently with short recovery delays. In conclusion, wearing compression socks may contribute to increase muscular adaptation and recovery. References Chatard JC, Aïlaoui D, Farjanel J, Louisy F, Rastel D, Guezennec CY. (2004). *Eur J Appl Physiol*, 93, 347-352. Kraemer WJ, Bush JA, Wickham RB, Denegar CR, Gomez AL, Gotshalk LA, Duncan ND, Volek JS, Putukian M. (2001). *J Orthop Sports Phys Ther*, 31, 282-290.

**14:45 - 15:45****Poster presentations****PP-PM73 Physiology 19****RECOVERY KINETICS IN SOCCER GOALKEEPERS AND FIELD PLAYERS**

Nédélec, M.1, Berthoin, S.1, Dupont, G.1

*1: Université Lille Nord de France, UDSL, EA 4488, Lille, France*

Introduction During a soccer match, goalkeepers and field players perform running activities and actions leading to muscle damage which may impair physical performance (Byrne et al., 2004). In addition, a soccer match induces mental activities for both goalkeepers

and field players (Williams, 2000), and mental fatigue has been shown to reduce physical performance (Marcora et al., 2009). The purpose of this study was to analyze the recovery kinetics of physical and cognitive performance, as well as subjective ratings in goalkeepers and field players after a soccer match. Methods Eight goalkeepers (age:  $18.5 \pm 2.5$  yr; height:  $182.3 \pm 4.6$  cm; body mass:  $75.9 \pm 8.8$  kg) and eight elite field players ( $17.1 \pm 0.9$  yr;  $180.9 \pm 5.8$  cm;  $70.5 \pm 6.8$  kg) were tested immediately, 24 and 48h after a soccer match. The battery of test included squat jump (SJ) and countermovement jump (CMJ) on a force plate; mean power output (MPO) and mean speed (MS) during a 6-s sprint on a non-motorised treadmill; reaction and motor time during Vienna Reaction Test; number of stimuli, correct responses, incorrect responses and omitted responses during Vienna Determination Test; perceived level of recovery rating. Results Squat Jump and CMJ were both significantly ( $p < 0.01$ ) decreased 24h after the match, while only CMJ remained significantly ( $p < 0.05$ ) lower 48h after the match. Mean power output and MS showed no change ( $p > 0.05$ ) for goalkeepers throughout the protocol whereas MPO and MS were significantly altered for field players immediately after the match ( $p < 0.01$ ). No significant interaction was found for other variables between position and time ( $p > 0.05$ ). There was a main effect of time ( $p < 0.05$ ) for fatigue and muscle soreness. Fatigue increased immediately ( $p < 0.001$ ) and 24h after the match ( $p < 0.05$ ), whereas muscle soreness was increased immediately after the match only ( $p < 0.05$ ). Discussion A significant decrease in sprint was found only for field players. The different running profile of goalkeepers compared to field players (Rampinini et al., 2007; Di Salvo et al., 2008) could explain this finding. The decrement in jumps found in both goalkeepers and field players could be explained by activities leading to muscle damage (diving, tackling, changes of direction, jumps, deceleration). Results from the tests assessing some aspects of cognitive function did not show any change in goalkeepers and field players after a match. References Byrne C, Twist C, Eston R (2004). *Sports Med* 34, 49-69. Di Salvo V, Benito PJ, Calderón FJ, Di Salvo M, Pigozzi F (2008). *J Sports Med Phys Fitness* 48(4), 443-446. Marcora SM, Staiano W, Manning V (2009). *J Appl Physiol* 106, 857-864. Rampinini E, Coutts AJ, Castagna C, Sassi R, Impellizzeri FM (2007). *Int J Sports Med* 28, 1018-1024. Williams AM (2000). *J Sports Sci* 18(9), 737-750.

### MUSCLE RECOVERY TIME FROM EXHAUSTIVE WORK IN THE HEAT

Oksa, J., Rissanen, S., Mäkinen, T., Hyrkäs, H., Lusa, S., Lindholm, H., Rintamäki, H.

*Finnish Institute of Occupational Health, Oulu*

Introduction Insufficient recovery time from work may lead to a state of cumulative muscle fatigue which may be regarded as a precursor for musculoskeletal symptoms and disorders. The purpose of this study was to evaluate the time needed for wrist flexor muscles to recover from heavy work in the heat. Methods Fifteen voluntary firefighters participated in the study. They performed three 15 minute work bouts at  $35^{\circ}\text{C}$  (separated with 10 minute break at  $20^{\circ}\text{C}$ ). The work simulated smoke diving and clearance work and induced significant fatigue to wrist flexors. At baseline and at each time point maximal wrist flexion force and muscle tissue reoxygenation rate were measured. Recovery from fatigue was followed at 0, 20, 40, 60 minutes and 2, 4, 22 and 30 hours after cessation of work. Results Muscle reoxygenation rate had two recovery peaks, first occurring after 2 and second after 22 hours. Maximal wrist flexion force recovered after 4 hours but force production velocity did not recover during the 30 hour follow-up. Discussion In conclusion, muscle recovery time from heavy work in the heat is different depending on the measured parameter and may be longer than time between consecutive work days.

### THE EFFECT OF THREE DIFFERENT RECOVERY METHODS ON CYCLE PERFORMANCE IN THE HEAT

De Pauw, K., Roelands, B., Meeusen, R.

*Vrije Universiteit Brussel*

Introduction/purpose: Although the scientific information on recovery and cycle performance is abundant, little is known about the influence of recovery between consecutive cycle performances in the heat. Therefore the aim of this study is to determine the influence of active recovery (AR), passive rest (PR) and cold water immersion (CWI) on repeated simulated time trial performance in the heat. Methods: Nine trained male subjects (age:  $22.7 \pm 3.4$  yrs;  $\text{VO}_{2\text{max}}$ :  $62.1 \pm 5.3$  ml.min<sup>-1</sup>.kg<sup>-1</sup>) participated in this randomized crossover study, and they performed a max test, familiarization trial and 3 experimental trials interspersed by a 6-d rest period. Each trial consisted of two cycle performances in a warm environment ( $30^{\circ}\text{C}$ ; 45-55%) separated by one hour. The first cycle performance included a 60 min constant load trial (at 55%  $\text{W}_{\text{max}}$ ), followed by a 30 min simulated time trial (TT1). The second cycle performance comprised a 12 min simulated time trial (TT2) that started at 85%  $\text{W}_{\text{max}}$ . Immediately after TT1 AR (cycling at 80W), PR or CWI (water temperature set at  $15^{\circ}\text{C}$ , subjects immersed until sternum) was applied for 15 minutes. Outcomes: TT performance was used as primary outcome measure. Heart frequency (HF), blood lactate concentration [BLa], rating of perceived exertion (RPE), thermal comfort (TC), rectal temperature (T<sub>rect</sub>) and skin temperatures (T<sub>skin</sub>) were measured. Results: Compared to PR ( $13.23 \pm 1.25$  min) and AR ( $13.27 \pm 1.05$  min), CWI ( $12.71 \pm 0.71$  min) resulted in a 30 seconds faster TT2. It is noteworthy that after CWI [BLa] was significantly higher during TT2 compared to PR at 6 min ( $p = 0.011$ ), and compared to PR and AR at 9 min ( $p = 0.021$ ,  $p = 0.044$  respectively). HF on the other hand was significantly lower compared to AR at 0 min ( $p = 0.000$ ) and 3 min ( $p = 0.002$ ), and compared to PR at 0 min ( $p = 0.000$ ) and 6 min ( $p = 0.038$ ). CWI significantly reduced T<sub>rect</sub> and T<sub>skin</sub> during the recovery period and lower T<sub>rect</sub> and T<sub>skin</sub> were sustained during rest and TT2. Discussion/Conclusion: In a previous study from our lab (De Pauw et al, 2011) we observed no differences in a second cycle performance after applying different recovery interventions (PR, upper leg cooling, AR, AR + upper leg cooling). An interesting finding was the faster decrease of [BLa] during AR combined with upper leg cooling ( $15^{\circ}\text{C}$ ). In this study we immersed subjects until the chest and found better TT2 performance that can be contributed to an increased heat storage capacity. Subjects performed better during TT2 with a lower HF and a higher [BLa]. Thus, the present study provides evidence for the ergogenic effect of CWI as a recovery intervention between two exercise bouts in the heat. Reference: De Pauw K, de Geus B, Roelands B, Lauwens F, Verschuere J, Heyman E, Meeusen R. Effect of five different recovery methods on repeated cycle performance. *Med Sci Sports Exerc* 2011; 43(5): 890-897.

### NOVEL COMPRESSION STOCKINGS INCREASE TISSUE RE-OXYGENATION IN RECOVERY BOUTS DURING PROGRESSIVE INCREMENTAL EXERCISE

Hunter, S., James, D.C., Mileva, K.N.

*London South Bank University*

Introduction Investigations have shown equivocal benefits of wearing graduated compression garments for exercise performance (Sperlich et al 2010; Ali et al 2011; Menetrier et al 2011). New technology incorporated into compression stocking design has been developed. Therefore, the aim of the present investigation was to evaluate its effect on parameters relating to cardiorespiratory and lower limb tissue oxygenation indices during progressive incremental exercise. Method Twelve club runners participated in a 2-trial randomized protocol consisting of 5-stages (4.5min, 30s recovery) of incremental (1km/h) treadmill running (1% incline) wearing either compression

stockings (STO) or commercially available (PLAC) garments under standard football socks. Standard cardiorespiratory measures ( $\dot{V}O_2$ , HR, [BLa-]) were taken in parallel with continuous records of tissue haemoglobin indices (THI, TOI, HbO<sub>2</sub>, HHb) from the calf and the thigh using near-infrared spectroscopy (NIRS). The final 30s of stages corresponding to steady-state, threshold and maximal exercise, along with 30s recovery after these stages were analysed and subjected to 2-way repeated measures ANOVA corrected with Holm-Sidak post-hoc tests. An alpha level for statistical significance was set at 0.05. Results During exercise, cardiorespiratory and NIRS parameters showed significant change over time ( $p < 0.05$ ); but were not different between conditions ( $p > 0.05$ ). In the 30s recovery period between stages, significantly steeper changes in calf HHb and TOI were observed in STO ( $p < 0.05$ ) compared to PLAC, indicating faster muscle re-oxygenation during recovery. No condition effects ( $p > 0.05$ ) were observed in thigh muscle oxygenation rates. Discussion The findings of the present study demonstrate that wearing novel compression stockings during incremental intermittent exercise enhances tissue re-oxygenation during the recovery periods. This finding is in agreement with the observations of Menetrier et al. (2011) who reported increased calf tissue oxygen saturation during exercise recovery. They also support the findings of Ali et al (2011) and Sperlich et al (2010) in reporting that STO resulted in no cardiorespiratory or performance benefit during exercise. These findings merit further investigation into the effects of faster recovery tissue re-oxygenation on high intensity intermittent exercise performance. References. 1. Ali, A. et al. (2011). *J. Sports Sci.* 25 (4): 413-9. 2. Sperlich et al. (2010). *J. Sports Sci.* 28 (6): 609-14. 3. Menetrier et al. (2011). *Int. J. Sports Med.* 32 (11): 864-8.

### EVALUATION OF HYDROTHERAPY, USING PASSIVE TESTS AND POWER TESTS, FOR RECOVERY ACROSS A CYCLIC WEEK OF COMPETITIVE RUGBY UNION

Higgins, T.

*Australian Catholic University*

Evaluation of hydrotherapy, using passive tests and power tests, for recovery across a cyclic week of competitive rugby union Trevor R. Higgins 1, Mike Climstein 1, Melaine Cameron 1, Aaron Coutts 2 1)Australian Catholic University, Australia 2)University of Technology Sydney, AUSTRALIA Introduction In team sports, a cycle of training, competition, and recovery occurs weekly during the competitive season. This research evaluates hydrotherapy for recovery from a simulated game of rugby union and a week of recovery and training. Methods Twenty-four male players (mean age 19.46 SD± 0.82, weight 82.38kg SD± 11.12, height in centimeters 178.54 SD± 5.75) were divided into three groups: one received (n=8) cold water immersion therapy, another (n=8) received contrast bath therapy, and the control group (n=8) received neither. The two forms of hydrotherapy were administered following a simulated game of rugby union. Testing was conducted one hour prior to the game and at five intervals after it: one hour, 48 hours, 72 hours, 96 hours, and 144 hours. Dependent variables included countermovement jump (CMJ), 10 and 40 meter sprints, sessional rating of perceived exertion (RPE), flexibility, thigh circumference, and delayed onset muscle soreness (DOMS). Results A significant difference in DOMS was found at 72 hours post ( $p=0.03$ ) and 96 hours post ( $p=0.04$ ) between the control and contrast bath groups, and at 48 hours post ( $p=0.02$ ) between cold water immersion and contrast bath groups. Cold water immersion and contrast baths scores for Sessional RPE showed a significant difference at time points 72 hours post and 96 hours post ( $p=0.05$ ) between the two groups. Discussion Athletes' perceptions of muscle soreness and sessional RPE scores for training were greater in the contrast bath group after the simulated game and throughout the training week. Although results from passive and power tests were inconclusive in determining whether cold water immersion or passive recovery was more effective in attenuating fatigue, they showed that contrast baths had little benefit in enhancing recovery during a cyclic week of rugby union. Trends identified through effect sizes indicated that cold water immersion offered more in attenuating the effects of fatigue when athletes' perceptions of muscle soreness and perceptions of training loads were measured. Indications are that cold water immersion offer more for players in terms of recovery from the cyclic activity of game and training associated with rugby union. References Alexiou, H. and A.J. Coutts, *International Journal of Sports Physiology and Performance*, 2008. 3: p. 320-330. Gill, N.D., C.M. Beaven, and C. Cook, Hamlin, M.J., et al., *Journal of Science and Medicine in Sport*, 2008. 11: p. 593-599. Higgins, T.R. and T. Heazlewood. 2008 ASICS Conference of Science and Medicine in Sport Ingram, J., et al., *Journal of Science and Medicine in Sport*, 2009. 12: p. 417-421. Rowsell, G.J., et al., *Journal of Sports Sciences*, 2009. 27(6): p. 565-573.

### EFFECT OF COLD WATER IMMERSION USED BETWEEN GAMES ON MUSCLE POWER AND BIOCHEMICAL PARAMETERS ON RUGBY PLAYERS

Takeda, M., Sato, T.1, Kawamoto, A.1, Aizawa, S.1, Kato, H.1, Suhara, Y.1, Yamaguchi, Y.2, Radak, Z.3

*Laboratory of Exercise Physiology, 1: Doshisha Univ. (Kyoto, Japan), 2: Yamaguchi Orthopedic Hospital (Kyoto, Japan), 3: Semmelweis Univ. (Budapest, Hungary)*

Introduction Recently, cold water immersion (CWI) has been used in many athletes to facilitate recovery from the fatigue after the athletic training or competition. However, despite the facts that there are some evidences demonstrating the positive effects of CWI on athletic performance (Eston, 1999; Vaile, 2008), there are pros and cons regarding the effect of CWI on athletic performance. Particularly, effect of CWI on muscle power after the athletic competition accompanied by muscle damage with severe body contact like rugby game has not been clarified. This study examined the effect of CWI used between 7th rugby simulation trainings including severe body contact on muscle power and biochemical parameters on rugby players. Methods Thirty top level of Japanese university rugby players aged 21.0 ± 1.8 years old randomly assigned to any of 3 groups, i.e. 5 minutes CWI group (5-min. CWI, n = 10), 10 minutes CWI group (10-min. CWI, n = 10) and no CWI group (control, n = 10). Seventh rugby simulation training was performed including 1 severe tackle within 20 m dash, totally 12 tackles with 1,300 m dash. Total time of this training was 16 minutes (two 7 minutes consecutive training including 2 minutes half time rest). Ten seconds maximum bicycle pedaling power, 10 m dash time, vertical jump, grip strength, reaction time, and 20 seconds side step and biochemical parameters such as lactate dehydrogenase, creatine kinase,  $\gamma$ -glutamyltranspeptidase, creatinine, sodium, chlorine, potassium, and white blood cell, and subjective fatigue were measured at pre training, post training, and post CWI with 2 hours rest. Results Analysis of variance revealed no significant deteriorated effect of 7th rugby simulation training (pre training vs post training) in all variables in all 3 groups. As to the changes from post training to post CWI, only creatinine significantly reduced from post training to post CWI in 10-min CWI (-0.138±0.041) group compared 5-min CWI (-0.097±0.041) and control (-0.075±0.037) groups. There were no significant differences in any of other variables. Discussion Although significant decrease in creatinine at post CWI in 10-min CWI group might be positive effect of CWI in 2 hours break between 7th rugby simulation training. However, our study strongly demonstrated that there no positive physiological and subjective effects of CWI used in 2 hours break time between 7th rugby games. References Eston R, Peters D. (1999). *J Sports Sci*, 13(7), 231-238. Vaile J, Halson S, Gill N, Brian D. (2008). *J Sports Sci*, 26(5), 431-440.

## THE EFFECT OF ACTIVE RECOVERY AND COLD WATER IMMERSION ON THE SUBSEQUENT KNEE EXTENSION AND FLEXION STRENGTH

Strejcova, B., Konopková, R.

*Faculty of Physical Education and Sport*

**Introduction** It is generally accepted that good recovery enables better performance and decreases the number of injuries in athletes. Athletes routinely employ post exercise strategies or practices in a bid to speed up recovery (Bleakley & Davison, 2010). Currently cold-water immersion recovery and active recovery have emerged as one of the most popular intervention enabling faster recovery. The aim of the study was to compare the effect of three kinds of recovery (active recovery, cold water immersion, passive recovery) on the medium-term knee strength in the extension and flexion. **Methods** Fourteen athletes at the age of  $26.6 \pm 4.4$  years performed, in a random cross-over design, 3 sessions with 3 repeated medium-term isokinetic tests. As active recovery we used walking for 10 minutes on the treadmill of  $5.5 \text{ km}\cdot\text{h}^{-1}$  speed and a gradient was depended on the HR to achieve 60-65% of individual HRmax. As cold water therapy the participants were immersed up to their hips in the cold bath ( $13 \pm 1^\circ\text{C}$ ) for  $3 \times 2, 5 \text{ min}$  with 2 min out of the bath, repeated twice as intermittent protocol. The effect of active recovery, passive rest and cold water immersion were assessed by the  $3 \times 3$  (time x recovery) repeated-measure ANOVA, respectively. **Results** We found significantly lower absolute differences between first and third trial in knee extension for peak torque after the active recovery ( $\uparrow 0.9 \text{ N}\cdot\text{m}$ ) than after the cold water immersion ( $\downarrow 14.6 \text{ N}\cdot\text{m}$ ) or the passive recovery ( $\downarrow 13.9 \text{ N}\cdot\text{m}$ ). The decrease of the average power was significantly lower differences after the active recovery ( $\downarrow 5 \text{ W}$ ) than after the cold water immersion ( $\downarrow 23.7 \text{ W}$ ) or passive recovery ( $\downarrow 25.9 \text{ W}$ ). Maximal heart rate (HRmax) was significantly higher during the active recovery than during the cold water immersion and the passive recovery ( $173 \pm 14, 166 \pm 14$  and  $167 \pm 14 \text{ bpm}$ ). We have found significant differences in the average heart rates (HRavg) during active recovery, cold water immersion and passive recovery ( $124 \pm 8, 97 \pm 9$  and  $107 \pm 12 \text{ bpm}$ ). **Discussion** The active recovery was the only method which showed lower decrease of knee strength in extension compared to passive recovery and cold water immersion. The fact that the current literature is not consistent in this topic is probably caused by the different localization of load and its subsequent effect on the blood circulation (Draper, Bird, Coleman, & Hodgson, 2006). **References** Bleakley, C. M. & Davison, G. W. (2010). What is the biochemical and physiological rationale for using cold-water immersion in sports recovery? A systematic review. *British Journal of Sports Medicine*, 44, 179-187. Draper, N., Bird, E. L., Coleman, I. & Hodgson, C. (2006). Effects of active recovery on lactate concentration, heart rate and RPE in climbing. *Journal of Sports Science and Medicine*, 5(1), 97-105.

## EFFECT OF COOLING DURING THE RECOVERY FROM CYCLING ON PHYSIOLOGICAL AND COGNITIVE RESPONSES.

Gaetz, M., Brandenburg, J.P.

*University of the Fraser Valley*

**Introduction** During the recovery from exercise, particularly when the time is limited (e.g. half-time), cooling strategies are utilized to accelerate the recovery of physiological variables (e.g. body temperature) and aid subsequent performance. This study examined the effects of cooling following 30 minutes of vigorous cycling on the recovery of brain function, measured using the electroencephalogram (EEG), and cognition, measured using the Stroop test. **Methods** Nine active males ( $21 \pm 3 \text{ y}$ ;  $76.9 \pm 7.7 \text{ kg}$ ;  $179.6 \pm 3.8 \text{ cm}$ ) completed two trials in a randomized order: control recovery (CTL) and cooling recovery (COOL). In each trial, subjects performed 30 min of cycling at a constant power output ( $2.4 \pm 0.2 \text{ W}\cdot\text{kg}^{-1}$ ). Following the cycling protocol subjects either received cooling (from a combination of a cooling vest, neck collar, and fan) (COOL) or received no cooling (CTL) throughout a 30-min recovery period. Heart rate (HR), core (TC) and tympanic (TTY) temperatures, Stroop test, and EEG were assessed pre- and immediately post-cycling as well as throughout the recovery period. In both trials subjects ingested water to match sweat losses while cycling. Air temperature ( $\sim 23^\circ\text{C}$ ) and humidity ( $\sim 50\%$ ) were similar in both trials. **Results** HR, TC, and TTY at the end of the 30 minutes of cycling were similar in CTL and COOL ( $165 \pm 15$  vs.  $164 \pm 17 \text{ b}\cdot\text{min}^{-1}$ ;  $38.1 \pm 0.5$  vs.  $38.1 \pm 0.4^\circ\text{C}$ ;  $37.2 \pm 0.2$  vs.  $37.2 \pm 0.3^\circ\text{C}$ , respectively) as was the change of body mass ( $-0.1 \text{ kg}$ ). During recovery, HR decreased by  $81 \pm 10$  and  $85 \pm 9 \text{ b}\cdot\text{min}^{-1}$  in CTL and COOL. TC decreased by about  $0.7 \pm 0.2^\circ\text{C}$  in both trials. TTY recovered by  $0.9 \pm 0.2^\circ\text{C}$  in CTL and  $1.0 \pm 0.3^\circ\text{C}$  in COOL. There were no differences between CTL and COOL in the degree of recovery of any of these variables. Mean blood glucose levels during recovery ( $\sim 4.8 \text{ mmol}\cdot\text{l}^{-1}$ ) were also similar between trials. No differences were observed for Stroop test variables (errors and reaction time) or EEG between CTL and COOL trials. A multivariate ANOVA did reveal differences in EEG ratios of low/high frequency over the 30-min recovery period (e.g. theta/beta1 activity  $F(2,7) = 6.74, p=0.023$ ). **Discussion** The combination of a cooling vest, cooling collar, and fan did not significantly improve the cardiovascular, thermal, or cognitive recovery from 30 min of vigorous cycling. Changes in EEG ratios of low/higher frequency activity were sensitive to, and paralleled, the changes in physiology that occurred during recovery but were not aided with the use of cooling strategies. Perhaps the degree of thermal strain during cycling was not sufficient for the cooling strategies to be effective. Alternatively, the combined cooling strategies may have been excessively cold, thus inducing peripheral vasoconstriction and blunting any potential cooling and subsequent benefits.

## PARADOXICAL EFFECT OF RESISTANCE TRAINING AND HIGH PROTEIN DIET ON PLASMA MYOSTATIN RESPONSE TO EXERCISE

Paoli, A.1, Pacelli, Q.F.1, Toniolo, L.1, Bianco, A.2, Faggian, D.3, Plebani, M.3, Reggiani, C.1

*University of Padova and University of Palermo*

**Introduction** In recent years, a mounting amount of evidence has suggested that contracting muscle can act as a cytokine producing organ that may influence metabolism (Pedersen 2010). Myostatin (MSTN) relationship with body fat amount, training status and nutrition has been widely investigated but with conflicting results. Although MSTN inhibits the Akt/mTor pathway some studies have shown also an counterintuitive positive correlation between MSTN and muscle mass (myostatin paradox). Moreover MSTN has been shown to reduce IGF-1 stimulated AKT phosphorylation in a dose-dependent manner. We investigated the influence of two months of resistance training (RT) and high protein diet on plasma myostatin, IL1, IL6, TNF- $\bullet$  and IGF-1. **Methods** Eighteen healthy volunteers participated in an upper limbs progressive resistance training. Subjects were divided in two groups: an high protein group (HP;  $1.8 \text{ g/Kg bw/day}$ , n. 9) and normal protein group (NP  $0.9 \text{ g/Kg bw/day}$ , n. 9). MSTN, IGF-1, IL1, IL6 and TNF- $\bullet$  were analyzed before and after the first training session and before and after the last training session (after 8 weeks). Lean body mass and muscle mass were analyzed through skinfolds methods, arm muscle area with MNR, strength with 1 RM test and an isometric pullgrip. ANOVA statistical analysis and linear regression were performed. **Results** MSTN showed an unexpected significant increase ( $p < 0.001$ ) after the last training in the HP group ( $\text{ng/ml}$ ) compared to NP group ( $\text{ng/ml}$ ) and to the samples taken after the first training ( $\text{ng/ml}$ ). There were no significant differences (time x treatment) in IGF-1, IL1, IL6 and TNF- $\bullet$ . Interestingly IGF-1 showed a positive correlation with MSTN in HP after the last training ( $r^2=0.6456$ ;  $p=0.0295$ ). No

correlation were found with other blood parameters nor with muscle mass and muscle strength changes. Moreover no significant differences were found between treatment group in strength performance and muscle mass. Conclusions Taken together this findings indicate a "paradoxical" response of plasma myostatin to high protein diet after 8 weeks of RT. It is noteworthy that IGF-1 which activity is down regulated by MSNT is increased in HP group after the last training and it correlates significantly with MSNT increase. This double increase of opposite mediators could explain the substantial overlapping of muscle mass increases in the two groups. We can argue that high protein diet influence metabolic regulation of IGF-1 and MSNT upstream the same pathway. Our findings are not in agreement with those of Hulmi et al (2009) that found a decrease in MSNT with protein ingestion whilst instead are in line with those of Dalbo et al (2011) that found a paradoxical MSNT response to RT in older individuals compared to younger individuals. Taken together this data show a complex and not yet well understood MSNT release mechanism. More studies are needed to explain this paradoxical response to nutrition and RT exploring also muscle signalling molecules as mTor and Akt.

### EFFECT OF RESISTANCE TRAINING UNDER SYSTEMIC HYPOXIA ON GENE EXPRESSIONS IN HUMAN SKELETAL MUSCLE

Kon, M., Ohiwa, N., Honda, A., Matsubayashi, T., Ikeda, T., Suzuki, Y., Akimoto, T., Hirano, Y.

*Japan Institute of Sports Sciences*

Introduction: It has been reported that resistance training under hypoxic condition caused greater increases in muscle size and strength compared with that of normoxic condition (Nishimura et al. 2010). We recently demonstrated that resistance exercise induced a greater anabolic hormone response under hypoxia than that under normoxia (Kon et al., 2010). However, the influence of hypoxic resistance training on skeletal muscle gene expressions related to muscular hypertrophy is still not clarified. Here, we examined the effect of resistance training under systemic hypoxia on gene expressions in human skeletal muscle. Methods: Sixteen healthy male subjects were randomly assigned to either the normoxic resistance training group (n = 7) or the hypoxic (14.4% oxygen) resistance training group (n = 9); they performed 8-wk resistance exercise training. The resistance exercise consisted of two consecutive exercises (bench-press and bilateral leg-press), each with 10 repetitions for 5 sets at 70% of one-repetition maximum. All the sets and exercises were separated by 90-s rest intervals. Muscle biopsy samples from the vastus lateralis muscle were analysed for insulin-like growth factor 1 (IGF-1), IGF-1 receptor (IGF-1R), myostatin, androgen receptor (AR) mRNA expressions. Results: There were no significant differences in the mRNA expressions of IGF-1, IGF-1R, myostatin, and AR between the groups, although the mRNA expressions of IGF-1 and AR were significantly increased, and the mRNA expression of myostatin was significantly reduced after training in both the groups (P < 0.05). The IGF-1R mRNA expression was unchanged after training. Discussion: Present results are consistent with the results of the previous studies (Kim et al. 2007, Lamon et al. 2009). However, resistance training under hypoxic condition did not affect IGF-1, IGF-1R, myostatin, and AR mRNA expressions in human skeletal muscle compared with that of normoxic condition. Hypoxia may not influence the responses of IGF-1, IGF-1R, myostatin, and AR mRNA expressions to resistance training. References Nishimura A, Sugita M, Kato K, Fukuda A, Sudo A, Uchida A. (2010). *Int J Sports Physiol Perform*, 5(4), 497-508. Kon M, Ikeda T, Homma T, Akimoto T, Suzuki Y, Kawahara T. (2010). *Med Sci Sports Exerc*, 42(7), 1279-1285. Kim JS, Petrella JK, Cross JM, Bamman MM. (2007). *J Appl Physiol*, 103(5), 1488-1495. Lamon S, Wallace MA, Léger B, Russell AP. (2009). *J Physiol*, 587(Pt 8), 1795-1803.

### DEVELOPMENT OF FORCE-VELOCITY CHARACTERISTICS IN SOCCER PLAYERS

Nikolaidis, P.T.1, Veniamakis, E.E.2

*1: Laboratory of Human Performance and Rehabilitation, Hellenic Army Academy (Athens, Greece), 2: Department of Nutrition and Dietetics, Technological Educational Institute of Crete (Sitia, Greece)*

Introduction Although the contribution of anaerobic power in soccer performance is widely recognized, this parameter of physical fitness has not been well studied in young players. The aim of this study was to investigate the force-velocity (F-v) components of anaerobic power across adolescence. Methods Male adolescent players (n=561; aged 10-22 yr), classified in six two-year age groups, all members of competitive soccer clubs, performed the F-v test. The participants performed four sprints, each one lasting 7 sec, against incremental braking force (2, 3, 4 and 5 kg) on a leg cycle ergometer (Ergomedics 874, Monark, Sweden), interspersed by 5-min recovery periods. Results Positive correlation between age and theoretical maximal velocity (v0, r=0.57, p<0.001), theoretical maximal force (F0, r=0.53, p<0.001), maximal anaerobic power in absolute (Pmax, r=0.68, p<0.001) and relative to body mass values (rPmax, r=0.47, p<0.001) was found, while there was negative correlation between age and v0/F0 (r=-0.37, p<0.001). With regard to Pmax, rPmax, v0 and F0, each age group had higher score than the respective younger and lower score than the older groups, while there was no difference between the age group under 18 yr (U18), U20 and U22. Conclusions An important finding was that while force and velocity increased across adolescence, the ratio v0/F0 decreased significantly (e.g. from 19.5 rpm.kg<sup>-1</sup> in U12 to 11.8 rpm.kg<sup>-1</sup> in U18), indicating changes in the force-velocity profile of soccer players. The v0 to F0 ratio decreased with age, but there was no difference between U16, U18, U20 and U22 with regard to this trait. While our results about the development of anaerobic power across adolescence were in general agreement with previous studies, we identified different patterns of development of the F-v components of anaerobic power, which was a novel finding.

**14:45 - 15:45**

## Poster presentations

### PP-PM74 Physiology 20

#### DOSE ACUTE MODERATE-INTENSITY 7:30 PM EXERCISE AFFECT FOLLOWING SLEEP?

Ganeko, M.1, Shioda, K.1, Kojima, T.1, Uchida, S.2

*Waseda University*

Introduction Although many studies investigated the effect of acute exercise on sleep EEG, it had only a small effect. Recently many interests are focused more on peripheral parameters such as heart rate or core body temperature during sleep after exercise. The purpose of the study was to simultaneously record EEG sleep and peripheral physiological parameters, and to investigate their relationships. Meth-

ods 6 Healthy young male subjects, who are sedentary nonsmokers, underwent the 2 experimental conditions (no-exercise, exercise) consisting of 2 nights. The first night was an adaptation for both conditions. Sleep time was 8 hours (11pm-7am). On the exercise condition, subjects started 60-minutes cycle ergometer exercise at 60%VO<sub>2</sub>max at 7:30pm. On the no-exercise condition, subjects relaxed by watching TV and reading books. We recorded PSG including sleep-EEG, heart rate, respiratory rate, and rectal temperature. In addition, blood glucose level, blood lactate level, sleepiness, and subjective fatigue were measured before and after exercise and sleep. Results There were no significant differences in any PSG sleep parameters. Heart rate was higher during the first 2 sleeping hours in exercise condition than in no-exercise condition. On the blood glucose level before and after sleep, a significant main effect for condition was observed. Discussion Although no significant differences were observed in PSG sleep parameters, heart rate was significantly increased. This result indicates that night moderate exercise may increase sympathetic nerve system during sleep without having an impact on sleep quality. Furthermore the statistical results on the glucose level seem to indicate that night moderate exercise may have an impact on carbohydrate metabolism during sleep. Now we have finished six subjects. Complete results and discussion will be presented at the meeting

### **INFLUENCE OF SMOKING STATUS ON PHYSICAL PERFORMANCE ADAPTATION AND ENDOCRINE AND INFLAMMATORY MARKERS DURING INITIAL MILITARY TRAINING**

Siddall, A., Bilzon, J., Thompson, D., Greeves, J., Izard, R., Stokes, K.

*University of Bath*

Influence of smoking status on physical performance adaptation and endocrine and inflammatory markers during initial military training Siddall, A.1, Bilzon, J.1, Thompson, D.1, Greeves, J.2, Izard, R.2, Stokes, K.1. 1: Department for Health, University of Bath, BA2 7AY, UK. 2: Department of Occupational Medicine, Army Recruiting and Training Division, SN9 6BE, UK Habitual smoking has been associated with reduced physical performance adaptation, increased risk of injury and failure to complete military training, but the underlying mechanisms remain unclear. We examined physical performance and resting endocrine (cortisol, testosterone, insulin-like growth factor-1) and inflammatory (C-reactive protein (CRP), interleukin-6) markers in British infantry trainees during 14 weeks of military training. A validated lifestyle questionnaire was administered to 46 male trainees (age 21 ± 4 yr; mass 76.3 ± 8.3 kg; height 1.78 ± 0.07 m) for determination of smoking status. Waking fasted blood samples and physical performance measures (chest press, seated row, leg press, static lift and jump exercises) were obtained at weeks 1, 5 and 10 of training. Performance in military physical fitness tests (press ups and sit ups in two minutes, 2.4-km run) at weeks 1 and 14 were also recorded. At weeks 1 and 10, lower-leg muscle and adipose cross-sectional area (CSA) and density were measured by peripheral Quantitative Computed Tomography (pQCT, XCT2000L, Stratec Pforzheim, Germany). Two-way repeated measures ANOVA was used to identify differences over time between non-smokers (NS, n=22) and habitual smokers (S, n=24). There were no significant differences in endocrine and inflammatory markers, or in physical performance measures (main group effect; P>0.05). Higher CRP concentrations in S approached significance (mean (SD); NS, 1.80(2.06); S, 2.83(3.29) mg•L<sup>-1</sup>; P=0.059). Military training, irrespective of smoking status, significantly improved physical performance in all parameters (main time effect; P<0.05) except vertical jump height. An interaction effect existed whereby improvement in bench press performance was significantly greater in S than NS (P=0.031). Performance in 2.4-km run improved more in S than NS, but this was not significant (P=0.069). There were significant changes from weeks 1 to 10 in muscle CSA (8232(831) and 8604(901) mm<sup>2</sup>; P<0.001), total density of muscle and fat (66(4) and 67(4) mg•cm<sup>-3</sup>; P<0.001) and fat/muscle CSA ratio (22(8) and 20(7)%; P=0.012) as a result of training. No effect of smoking was evident on muscle and adipose characteristics of the lower leg (P>0.05). Physical performance improved with 10 weeks of military training irrespective of smoking status, with the exception of greater improvement in bench press performance in smokers. Therefore, it appears that smoking, while chronically elevating resting CRP, does not have a marked effect on physical performance improvement in the early stages of military training.

### **ALTERED CIRCADIAN RHYTHMICITY IN BLOOD PRESSURE WITH SPINAL CORD INJURY IS NOT EXPLAINED BY DIFFERENCES IN PHYSICAL ACTIVITY**

Jones, H.1, Groothuis, J.T.2,3, Verheggen, R.H.M.2, Thompson, A.1, Hopman, M.T.E.2, Atkinson, G.1, Thijssen, D.H.J.1,2

1. *Liverpool John Moores University*; 2. *Department of Physiology, Radboud University Nijmegen Medical Centre*; 3. *Department of Rehabilitation, St Maartenskliniek, Nijmegen*

Introduction: Individuals with spinal cord injury (SCI) demonstrate attenuation or absence of nocturnal reductions in blood pressure (BP) and heart rate (HR) (Rosado-Rivera et al., 2011; J Spinal Cord Med, 34, 395). Diminished rhythmicity is associated with increased incidence of cardiovascular disease and mortality (Verdecchia et al., 1993; Circ, 88; 986). Differences in the levels of physical activity (PA), due to impaired motor functioning in SCI, may contribute to these findings. Therefore, the purpose of this study is to examine the impact physical activity on the circadian rhythms in BP and HR in paraplegics and tetraplegics. Methods: Ten healthy able-bodied controls, 9 paraplegic (spinal cord lesion between T4-T12) and 6 tetraplegic (spinal cord lesion between C4-C7) SCI individuals underwent simultaneous 24-h ambulatory BP, HR and activity monitoring. Blood pressure and HR were measured every 15 min and a diary of events was kept throughout this period which included time of sleep and time of waking. Ambulatory accelerometry was used to measure changes in PA across 15 min periods preceding each BP/HR-measurement. Data were then averaged hourly and re-ordered to the time of waking for each individual. Systolic (SBP) and diastolic (DBP) and HR were analyzed with within-subject generalized estimating equations, and then covariate controlled for changes in PA. Data are presented as mean±SD. Results: Significant interactions between time of day and group factors were evident for SBP, DBP, HR and PA. Generally, SBP was 14±8 mm Hg and HR 15±4 beats.min<sup>-1</sup> lower in tetraplegics compared to paraplegics. Significant interactions remained for SBP, DBP and HR after controlling for physical activity (P<0.05). SBP was significantly lower in tetraplegics compared with paraplegics 5, 6, 13, 14 and 21 hrs post-waking (range 13-20 mmHg) and controls 5, 6, 9 and 13 hrs post-waking (range 16-35 mm Hg). DBP was significantly lower in tetraplegics than paraplegics 6, 9, 11, 22 and 23 hrs post-waking (range 8-14 mmHg) and controls 1, 22 and 24 hrs post-waking (range 10-12 mmHg). Importantly, Paraplegics and controls were not different following covariate control for activity. Conclusions: Differences in the level of physical activity between SCI individuals compared with healthy controls do not explain the altered circadian rhythmicity of BP and HR. The elevated cardiovascular incidence is likely due to inherent changes in the autonomic nervous system as a direct result of the injury.

## INFLUENCE OF PHYSICAL TRAINING ON COLD-INDUCED VASODILATION OF FINGER

Sugawara, M.

*Nagasaki University, Faculty of Education*

INFLUENCE OF PHYSICAL TRAINING ON COLD-INDUCED VASODILATION OF FINGER SUGAWARA, M.1, TAIMURA, A.2 1:Department of Exercise Physiology, Faculty of Education(Nagasaki, Japan) 2:Natural Environmental Conservation, Faculty of Environmental Studies(Nagasaki, Japan) [Introduction] The following two aspects will be considered in this paper. First, in order to elucidate the effects of experimental increase of heat production on the cold-induced vasodilation(CIVD), we examined 20males in CIVD before and after each exercise. Second, in terms of the difference in CIVD between trained and untrained individuals, 160 trained and 34 untrained males were examined. [Methods] The CIVD test was performed by Yoshimura's method: A thermister was attached to the dorsal side of the distal phalanx of the middle finger of the non-dominant hand, and the finger skin temperature was measured during immersion (30 minutes) in iced water. [Results] The CIVD after one hour's outdoor exercise was enhanced in comparison with that before exercise. After exercise, the temperature before water immersion(TBI), mean skin temperature(MST) and temperature at first rise(TFR) during immersion were significantly higher, and the time to temperature rise(TTR) during immersion was significantly shorter. The amplitude of temperature(AT) was likewise significantly higher. These scores were calculated into resistance indices(RI) by Yoshimura's method and Nakamura's method(3 point method and 5 point method). As a result, the RI by Yoshimura's method was significantly higher after exercise while that by Nakamura's method showed no difference. This suggests that a transient increase of heat content by physical exercise is ignored in the latter method. In regard to the features of CIVD in the trained as compared with the untrained, TBI, MST, TFR and AT were higher, and TTR was shorter and RI was significantly higher. There was a significant positive correlation between the years of experience of sports and RI. The CIVD was higher in those trained in outdoor sports than in indoor sports. The RI, classified by sport events was the highest in swimming followed in decreasing order by rowing, karate, baseball, track and field, judo, tennis, rugby, basketball, soccer, kendo, badminton, volleyball and table tennis. [Conclusion] This order was almost the same even after eliminating the effects of the years of experience of sports. Thus, it follows from this observation that the RI was higher in the trained in outdoor sports than in the trained in indoor sports. This result may be attributed to the fact that outdoor sportsmen have more opportunities to be exposed to outdoor cold as compared with indoor sportsmen. [References] Lewis T. (1930). *Heart*, 15, 177-208. Yoshimura H, Iida T. (1950), *Jap. J. Physiol*, 1, 147-159.

## EVIDENCE OF HIGH BODY TEMPERATURE DURING MEN'S STAGE-RACE CYCLING IN TEMPERATE ENVIRONMENTAL CONDITIONS

Ross, M.L.R.1,2, Stephens, B.1, Abbiss, C.R.2, Martin, D.T.1, Laursen, P.B.2,3, Burke, L.M.1

*Australian Institute of Sport*

EVIDENCE OF HIGH BODY TEMPERATURE DURING MEN'S STAGE-RACE CYCLING IN TEMPERATE ENVIRONMENTAL CONDITIONS Ross, M.L.R.1,2, Stephens, B.1, Abbiss, C.R.2, Martin, D.T.1, Laursen, P.B.2,3, Burke, L.M.1 1:AIS (Canberra, Australia), 2:ECU (Joondalup, Australia), 3:HPSNZ (Auckland, New Zealand) Introduction Hyperthermia, hypohydration and carbohydrate (CHO) depletion have been recognized as likely factors influencing fatigue during prolonged endurance cycling. However, there is currently limited field-based research examining the occurrence of hyperthermia and real-life fluid and fuel practices of athletes, especially during exercise in temperate conditions. Therefore, the aims of this study were to observe the thermoregulatory stress, fluid balance and voluntary CHO intake of highly competitive road cyclists during a multiday multiple-stage race in temperate conditions. Methods Ten internationally competitive male cyclists competed in two cycling stage-races (2009 Tour of Gippsland; n=5, and 2010 Tour of Geelong; n=5) in temperate conditions (15.8±1.4°C; 54±12%r.h., and 13.2±2.1°C; 80±8%r.h., respectively). Body mass (BM) was recorded immediately before and after each stage. Peak gastrointestinal temperature (TGI) was recorded throughout each stage. Cyclists recalled the types and volumes of fluid and food consumed throughout each stage. Results Overall general classification of cyclists ranged from 1st to 97th placing with 5 stage wins in the Tour of Gippsland, and 3 stage wins in the Tour of Geelong. The mean change in BM during stages of the Tour of Gippsland, was -1.3±0.2%, with only 5 out of 43 occasions where subjects were observed to exceed a deficit of >2% BM. There was a very large negative correlation (r=-0.8) between fluid deficit and stage finish time. Mean fluid consumption was 771-1658 ml (0.41-0.64 L/h) during road, and 210-432 ml (0.24-0.27 L/h) during criterium stages. There was a large correlation (r=0.95, and r=0.88) between fluid intake and stage distance observed in both tours. Mean CHO consumption was 85-200g (44-77 g/h or 1.18-2.84 g/kg BM) during road, and 24-37 g (28-29 g/h or 0.34-0.52 g/kg BM) during criterium stages. 67% and 73% of peak TGI observed during the Tour of Gippsland (mean peak TGI=38.9±0.7°C) and the Tour of Geelong (39.3±0.4°C) were >39°C. Discussion This study captured novel and insightful data on the thermoregulatory stress, fluid balance and voluntary CHO intake of highly competitive cyclists during a multiday multiple-stage road race performed in temperate conditions. In the present study we consistently observed TGI associated with hyperthermic-induced fatigue. Further, cyclists in this study experienced only mild fluid deficit and matched recommended rates of CHO consumption during exercise, however interpretation of fluid balance on cycling performance is made difficult by race tactics. Further research is required to determine the impact of elevated body temperature on cycling performance in temperate conditions.

## CRITERION VALIDITY OF A PORTABLE URINE REFRACTOMETER AND THE EFFECTS OF SAMPLE STORAGE

Sparks, S.A., Close, G.L.

*Edge Hill University*

Introduction: The assessment of urine osmolality has been used extensively as an index of hydration status. In applied sport settings, such measurements are regularly made before and after training. Over the past decade the use of a portable means of testing the osmolality of urine samples has been widespread, but no studies have assessed the validity of this means of measurement. Furthermore, where samples are collected and stored at -80 degrees C prior to analysis, it is unclear what effect this may have on osmolality. Method: 68 males and 18 females of mean (±SD) age 24.5±7.6yrs, height 1.76±0.1m and weight 77.4±12.2kg, gave informed consent to take part in this study. Participants were required to attend the laboratory in either a well hydrated state or following an overnight nil by mouth fast. Mid flow urine samples were then collected and analysed via both freeze point depression (FPD) and refractometry (RI). Once analysis had taken place, 68 of the samples were frozen at -80 degrees C and then thawed prior to re-analysis using both analytical techniques. Differences between analytical methods and storage were determined using Wilcoxon's Signed Rank test. Confidence intervals (CI) typical error (TE) and 95% limits of agreement (LoA), were used to determine validity. The effects of storage was further analysed using Spearman's Rank Correlation Coefficient, Chronbach's  $\alpha$  and TE. All statistical procedures were performed using PASW 18 for Windows. Results: A significant difference in urine osmolality between FPD and RI (p=0.008) was observed (678.6±328.1 and

657.9±312.1mOsm/l respectively). The mean (±SE) difference was 20.67±48.83mOsm/l with CI of 75.72 and 117.72 for lower and higher levels respectively. TE was 0.24 and LoA were ±156.6 mOsm/l. Storage at -80 degrees C significantly reduced the mean osmolality of urine samples for both the FPD (629.7±338.7 pre and 618.9±331.4mOsm/l post storage, p=0.002, CI=3.69 and 17.86 for lower and higher respectively) and the RI methods (611.3±322.5 pre and 620.0±326.2mOsm/l post storage, p=0.017, CI =-18.80 and 1.45 for lower and higher respectively). Despite these effects of storage, samples were still highly related to their pre-freezing values (r=0.996, p<0.001, α=0.998, TE=0.06 and r=0.992, p<0.001, α=0.996, TE=0.09 for the FPD and RI methods respectively). Conclusion: Despite mean differences between methods and as a result of storage, the small differences observed although statistically significant, are physiologically trivial and therefore the use of RI appears to be a valid measurement tool to determine urine osmolality.

## THE EFFECTS OF ISCHEMIC PRECONDITIONING ON SKELETAL MUSCLE DEOXYGENATION DURING AN EXHAUSTIVE CYCLING TEST.

Jenner, W.J., Gyori, A., Fallan, C., Cunniffe, B., Montgomery, H.E., MacAllister, R.J., Cardinale, M.  
*University College London, British Olympic Medical Institute*

**Introduction** Ischemic preconditioning (IPC) is a physiological phenomenon whereby non-lethal intermittent ischemia induces protection against lethal ischemic episodes. IPC also improves tolerance to intense exercise resulting in improved power output and increased VO<sub>2</sub> max (de Groot et al. 2010). Based on the potential of IPC to modulate blood vessel and skeletal muscle function, we aimed to study whether IPC improves muscle oxygenation during incremental exercise in well-trained individuals. **Methods** Thirteen well-trained male club cyclists (aged 33±6 years, height 180±6cm, weight 78.5±4.0kg, [mean±s.d.]) were randomised to IPC or sham IPC using a crossover design. IPC was induced using three 5-minute cycles of inflation and deflation of a blood pressure cuff on the thighs to suprasystolic blood pressure. Sham IPC was induced using a subdiastolic cuff pressure, and the crossover interval was 7 days. The inflations were followed by an incremental exercise test on a cycle ergometer; 4 minutes of warm-up at 150W followed by 50W/min increases at a constant cadence until exhaustion. Muscle oxygenation was assessed in-vivo by means of near-infrared spectroscopy (NIRS - InSpectraTM 650, Hutchinson Technology). From the NIRS signal, the ratio of oxygenated haemoglobin to total haemoglobin in the micro-circulation was calculated and used for analysis (StO<sub>2</sub>). Repeated measures ANOVA was used to analyse the data (P<0.05 deemed significant). Results IPC reduced StO<sub>2</sub> to a higher degree than sham during cuff inflations (P=0.001). StO<sub>2</sub> was significantly reduced during exercise in both treatment groups (P<0.0001). There was a trend for IPC to preserve muscle oxygenation during exercise compared with the sham intervention, which was observed in 11 of the 13 subjects (P=0.07). **Discussion** The IPC protocol employed in this study was effective in producing ischemia and reperfusion in the vastus lateralis muscle. Despite not reaching statistical significance, IPC showed potential to ameliorate the reduction in StO<sub>2</sub> during exercise in an incremental cycle ergometry exercise compared with sham. Whether IPC improves oxygen delivery to skeletal muscle or increases metabolic efficiency remains to be determined. Further work aims to identify whether IPC can influence additional outcomes of sporting performance. Reference de Groot PCE, Thijssen DHJ, Sanchez M, Ellenkamp R, Hopman MTE. (2010). *Eur J App Phys*, 108(1), 141-146

## A CONCENTRIC/ECCENTRIC KNEE EXTENSION/FLEXION PROTOCOL UNTIL EXHAUSTION – PILOT STUDY

Sousa, M.1, Brito, J.1, Carvalho, P.2, Guimaraes, J.T.3, Teixeira, V.H.2,4, Soares, J.1

1: CIFI2D (Porto, Portugal), 2: FCNAUP (Porto, Portugal), 3: FMUP (Porto, Portugal), 4: CIAFEL (Porto, Portugal)

**Introduction** The aim of this study was to test if a protocol until exhaustion on an isokinetic dynamometer is intense enough to induce alterations in muscle functional and biochemical variables and monitor these alterations for 24 h. **Methods** Six trained male participants (25.2±7.0 years; 176.2±6.8 cm; 70.0 kg, 65-94 kg) completed 3 maximal eccentric repetitions at a constant angular velocity of 60°/s to determine the maximal peak torque of the knee extensors (PTE). Afterwards, a exhaustion protocol was conducted which consisted of 3 bouts of a concentric/eccentric knee extension/flexion exercise at 60°/s with a 200-sec rest time between sets. The 1st and 2nd sets were composed by 100 repetitions; in the 3rd set, subjects performed n repetitions until the PTE of 3 consecutive repetitions fall below 25% of the initial value. The range of motion was from 50° to 110° flexion in the knee (0° = full knee extension). Maximal eccentric PTE was also determined after the exhaustion protocol to evaluate force decrease. Blood samples were collected before (moment 1), 2 h (moment 2) and 24 h (moment 3) after the exhaustion protocol and analysed for lactate dehydrogenase (LDH), creatine kinase (CK), C-reactive protein (CRP) and aspartate aminotransferase (AST). A visual analogue scale (VAS; 0-100) was used to determine the delayed onset muscle soreness (DOMS) before the exercise, immediately after, and 2 and 24 h after the protocol. Data were analyzed by one-way repeated-measures ANOVA and by paired sample t-test. One participant was excluded from data analysis due to high initial value of CK (622 U/L). **Results** There were significant changes in LDH levels with the exercise protocol (p=0.010), being the differences between moments 1 and 2 (165.8±14.7 vs. 193.4±16.1 U/L; p=0.009). There was no significant changes in serum CK activity (p=0.077). No differences were found for AST (p=0.063), and for CRP (p=0.173). There was a significant decrease of the eccentric PTE after the protocol (352.0±57.1 vs. 181.1±61.4 N m; p=0.007). For DOMS (p<0.001), differences were found between the reported values before and immediately after the protocol (2.0±4.5 vs. 64.4±22.6; p=0.039) and before the protocol and 24 h after (2.0±4.5 vs. 48.8±12.3; p=0.003). **Discussion** Taking into account that there were significant changes in LDH, DOMS and eccentric PTE, it can be concluded that this exhaustion protocol is capable of inducing muscle damage. It is known that CK has a high biologic range of response; therefore, the CK non-significant result may be due to the small number of subjects. As no differences were found for AST, liver damage can be excluded. Regarding the results for CRP, probably there is a need for a more specific inflammatory biomarker.

## 2-MINUTES BOUTS OF PHYSICAL ACTIVITY ARE BETTER ASSOCIATED WITH CARDIORESPIRATORY FITNESS THAN LARGER IN CHILDREN AND ADOLESCENTS

Lopez, I.1, Raya, J.F.1, García-Fernandez, J.C.1, Barrera, J.E.1, Torres, G.2, Dorado, M.G.1, Chinchilla, J.M.1, Carnero, E.A.1

1. University of Malaga. 2. University of Jaén.

**Background** A high cardiorespiratory fitness (CF) is an important determinant of health for children and adolescents. Physical activity (PA) is the main stimulus to promote an increase of CF. Although, there is some PA specific recommendations for children and adolescents, mainly regarding the volume of moderate-vigorous PA (MVPA); there are not guidelines focused on patterns (bout time) and optimal doses of PA to improve CF. Accelerometers (ACL) can assess all parameters of external load of PA, so they are useful tools to analyze the relationship between patterns and doses of PA and CF. The primary purpose of this study was to explore the relationship between CF and patterns of PA assess with ACLs. **Methods** Ninety-three children and adolescents were included in this cross-sectional analysis (age,



13.8±2.1 ages; 21.2±3.6 kg/m<sup>2</sup>; VO<sub>2</sub>max, 37.1±7.0 ml/kg/min). Body mass index (BMI) was used as adiposity index. One week of total daily physical activity was recorded using ACLS. Cardio-respiratory fitness (CF) was assessed with a progressive step test until volitional fatigue. Data collections of PA with 2, 4, 5, 6, 8, 10, 12 and 14 bouts (B2, B4, B5, B6, B8, B10, B12 and B14) were calculated (minutes/day), also time expended on moderate and vigorous PA (MVPA) was integrated. Partial correlations were carried out in order to analyze the association between CF and bouts of PA; MVPA was used as control variable. Results Our data showed that shorter bouts better association with CF (B2, r=0.43; B4, r=0.33; B5, r=0.23; B6, r=0.24; P<0.001), after control for total minutes per day of MVPA. Also, the time expended on 2 minutes bouts and CF were the only variables, which had got a negative correlation with BMI (r=-0.23 and r=-0.24, p<0.05; respectively). Finally, Pearson's correlations between daily time for vigorous PA and bouts, were positive and higher for shorter bouts than larger bouts (B2, r=0.36; B4, r=0.30; B5, r=0.29; B6, r=0.29; P<0.001). Conclusions Our main finding was that the shorter bouts of PA had got higher correlations than larger bouts with CF and BMI. We speculated that it should be related with the higher intensities of PA performed during shorter bouts. These results may be important to analyze the relationship between health variables and PA guidelines; so they suggest that short (<2 minutes) and intense PA should be a recommendation for a improved CF. Moreover, bouts shorter than 5 minutes may be explored in future researches in order to clarify completely this issue.

### EFFECT OF 4 WEEKS SWIMMING TRAINING WITH CHEST WALL RESTRICTION ON AEROBIC POWER, CARDIO-RESPIRATORY FUNCTIONS AND SWIMMING PERFORMANCE OF ELITE FEMALE SWIMMERS

Azizi Masoule, M., Razmjou, S., Rajabi, H., Ahmadi, P.

*Department of Physical Education, Karaj Branch, Islamic Azad University, Karaj, Iran.*

Effect of 4 weeks swimming training with chest wall restriction on aerobic power, cardio-respiratory functions and swimming performance of elite female swimmers. Mitra Azizi\*, Sahar Razmjou\*, Hamid Rajabi\*\*, Pezhman Ahmadi\*\*\*\* \* Department of Physical Education, Karaj Branch, Islamic Azad University, Karaj, Iran. \*\* Department of Physical Education, Tarbiat Moalem University, Tehran. \*\*\* Department of Physical Education, Share-Ray Branch, Islamic Azad University, Tehran, Iran Introduction Respiratory muscle fatigue is a physiological effect which has been witnessed in both maximal and submaximal exercises [1]. Therefore, considerable attention has been paid to the potential benefits that respiratory muscle training may have in improving athletic performance. Some studies have reported variations in blood lactate, heart rate and ventilation following respiratory muscle training [2]. Some studies, however, reported no variations in these factors [3, 4]. Therefore, this study is aimed to evaluate the effect of 4 weeks swimming training with chest wall restriction on aerobic power, cardio-respiratory functions and swimming performance of elite female swimmers. Method 24 elite female swimmers volunteered to participate in this study and were randomly divide into two groups: experimental group 1 (swimming training without chest wall restriction) and experimental group 2 (swimming training with chest wall restriction). Both groups were in a monthly swimming program (they trained 3 times a week for a total of 4 weeks). They swam almost 3.5 to 4 km/d with 70–85% of HRmax. Carotid test, Spirometry, Modified Balk test and T-20 were used to measure aerobic power, pulmonary parameters, time to exhaustion and swimming performance respectively. To analyze data, student t test was used. Result The results showed that Time to exhaustion increased in group training with chest wall restrictor (P=0/012). T-20 test results showed improvements in group 2 (average speed (P=0/028), average time for each 100 m (P=0/012), average distance (P=0/018)). No significant difference was observed in VO<sub>2</sub>max, MVV, FVC, and FEV1/FVC in two groups. Also there was no significant difference between the groups. Discussion The results showed that using chest elastic band (chest wall restriction) in order to impose more stress on respiratory muscles during exercise leads to some adaptations in these muscles and it is associated with some improvements in exercise performance. Respiratory muscles, like skeletal muscles, respond to specific training so that training increase respiratory muscles strength and endurance. References [1] M. E. Lomax, A. K. McConnell, J Sports Sci., 2003, 21, 8, 659-64. [2] A. D. Gething, M. Williams, B. Davies, Br J Sports Med, 2004, 38, 6, 730-736. [3] D. A. Sonetti, T. J. Wetter, D. F. Pegelow, J. A. Dempsey, Respir Physiol, 2001, 127, 2-3, 185-199. [4] O. Inbar, P. Weiner, Y. Azgad, A. Rotstein, Y. Weinstein, Med Sci Sports Exerc. 2000, 32, 7, 1233-1237.

## 14:45 - 15:45

### Poster presentations

#### PP-PM75 Training & Testing 17

#### RUNNING ECONOMY AND STRIDE FREQUENCY IN EXPERIENCED AND NOVICE RUNNERS

de Ruijter, C.J.1, Werker, W.A.N.1, Zuidema, M.J.1, Verdijk, P.W.L.1, de Haan, A.1,2

*1 Research Institute MOVE, VU University Amsterdam, The Netherlands*

Running economy and stride frequency in experienced and novice runners. C.J. de Ruijter<sup>1</sup>, W.A.N. Werker<sup>1</sup>, M.J. Zuidema<sup>1</sup>, P.W.L. Verdijk<sup>1</sup>, A. de Haan<sup>1,2</sup> <sup>1</sup> Research Institute MOVE, VU University Amsterdam, The Netherlands <sup>2</sup> Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University, Manchester, United Kingdom It is believed that self-optimization of the stride frequency improves with running experience. At optimal stride frequency (SF<sub>opt</sub>) oxygen consumption is minimal, at least for speeds below anaerobic threshold. For most experienced endurance runners their preferred stride frequency (SF<sub>pref</sub>) is also the most economical stride frequency. We hypothesized that the difference between SF<sub>pref</sub> and SF<sub>opt</sub> would be larger in inexperienced compared to experienced runners. Ten physically active men who were not involved in regular running exercise (23.8±1.7 yr.) and ten trained runners (25.0±3.3 yr; 10 km times: 34min 53s ± 85s) participated. The anaerobic threshold speed (RER=1) was determined for each subject. They subsequently ran on the treadmill at 80% of this speed, at 7 imposed stride frequencies (2 min bouts) ranging from -18% to +18% of SF<sub>pref</sub> with steps of minimal 6% applied in random order. All frequencies were imposed with a metronome and assessed with an acceleration sensor (1000 Hz) taped on the right foot. SF<sub>opt</sub> was determined by fitting a second order polynomial function through the data points of measured oxygen uptake (second minute of each bout) during the runs at different imposed frequencies, with the minimum signifying SF<sub>opt</sub>. This oxygen consumption was subsequently compared to the oxygen consumed at SF<sub>pref</sub>, also taken from the fitted function. On a different day this protocol was repeated keeping the order of stride frequencies the same within participants. Between days coefficients of variation (%) for SF<sub>opt</sub> were 2.5±2.2 for inexperienced and 1.4±1.3 for trained runners. Those for SF<sub>pref</sub> respectively were 1.0±0.6 and 0.7±0.5. Trained runners ran at (averaged values across days) a speed of 12.6±1.0 km/hour and were more (p<0.05)

economical ( $1.90 \pm 0.13$  VO<sub>2</sub> ml/kg/m) at SF<sub>pref</sub> than inexperienced runners ( $1.239 \pm 0.031$  VO<sub>2</sub> ml/kg/m) who ran at  $9.6 \pm 1.0$  km/hour. As hypothesized, for inexperienced runners SF<sub>pref</sub> ( $77.8 \pm 2.8$  strides/min) was significantly different from SF<sub>opt</sub> ( $84.9 \pm 5.0$ ), whereas both values were similar for trained runners:  $84.5 \pm 5.3$  and  $87.1 \pm 4.8$  strides/min ( $p > 0.05$ ). The improvement in economy while running at SF<sub>opt</sub> instead of SF<sub>pref</sub> did not differ between inexperienced ( $1.3 \pm 1.9\%$ ; range: 0.0-5.2%) and trained runners ( $0.6 \pm 0.5\%$ ; range: 0.0-1.4%). In conclusion, trained runners selected a stride frequency closer to the frequency that minimized cost of running than inexperienced runners. Moreover, although some inexperienced runners clearly reduced oxygen consumption when they increased their stride frequency, others already ran at optimal stride frequency.

### THE EFFICIENCY OF J-STEP FOOTWEAR ON INDOOR WET FLOOR

Moon, K.D.1, Chae, H.J.1, Shin, K.O.2, Kim, C.H.3, Cha, J.H.2, Cho, J.Y.4, Cho, I.H.2

1. *J Step Incorporation*, 2. *Korea National Sport University*, 3. *Korea National Sport University*, 4 *Korea National Sport University*

The footwear including unique out sole made by J step footwear shows two distinct features such as weight dispersion and non-slip function, which prevent slip or/and fall related injuries on indoor wet floor. However, this footwear still has not been tested as ergogenic aids. Therefore, the purpose of this study was to investigate the effects of J-step footwear on power output of lower extremities and aerobic capacity on indoor wet floor. Eight female handball athletes (age:  $20.0 \pm 1.31$  yrs, height:  $171.38 \pm 2.70$  cm, weight:  $63.0 \pm 3.07$  kg, career:  $10.37 \pm 3.24$ ,  $n = 8$ ) were participated and underwent a dynamic electromyography (EMG). During side step, power output of lower extremities was significantly higher in J-step handball footwear compared to normal handball footwear ( $p < 0.05$ ). In addition, running time in J-step handball footwear was much shorter than that of normal handball footwear. Finally, HR and VO<sub>2</sub> were significantly higher in J-step footwear compared to normal handball footwear in 1000 m running ( $p < 0.05$ ). These results indicated that wearing J-step footwear could be possible for handball athletes to increase their performance or prevent knee or ankle injuries via slip and fall on wet floor.

### ALTERED RELATIONSHIP BETWEEN R-R INTERVAL AND HEART RATE VARIABILITY IN OVERTRAINED ENDURANCE ATHLETES

Kiviniemi, A.M.1, Tulppo, M.P.1, Hautala, A.J.1, Vanninen, E.2, Uusitalo, A.L.T.2,3

1: *Verve Research (Oulu, Finland)*, 2: *Kuopio University Hospital*, and *University of Eastern Finland (Kuopio, Finland)*, 3: *University of Helsinki and Helsinki University Hospital (Helsinki, Finland)*

**Introduction** The correlation between R-R interval length (RRi) and vagally mediated heart rate variability (HRV) varies in young healthy subjects within 24-hour recording ( $R^2: 0.31 - 0.97$ , Kiviniemi et al., 2004). It is not known whether overtraining syndrome (OT) affects this relationship. Thus, the aim of the present study was to assess the relationship between RRi and HRV over 24-hour recording among OT and control endurance athletes. **Methods** Ambulatory 24-h ECG monitoring was performed for 9 OT (age:  $28 \pm 7$  years, 5 women) and 10 control endurance athletes (age:  $27 \pm 6$  years, 5 women). Overtrained athletes 1) had suffered from an unexplained long-term decrement in physical performance and fatigue, the symptoms being continued even after a recovery time of weeks to months, 2) were otherwise healthy, and 3) had a suitable training history for overtraining (Uusitalo et al. 2006). Ambulatory 24-h ECG monitoring was successfully repeated for 8 OT and 10 control athletes after 6 months. The power of low (LF, 0.04-0.15 Hz) and high frequency (HF, 0.15-0.4 Hz) oscillations of RRi were analyzed in 5-min epochs over the whole 24-hour recording. The 5-min values of HF power were transformed into natural logarithm (ln) and plotted against corresponding mean RRi. Due to the expected saturation of HRV at time of long mean RRi, quadratic regression was performed between RRi and HFln to obtain  $R^2$  between these measures separately for each subject. **Results** The mean RRi, HFln and LFln were similar between OT and control athletes ( $865 \pm 73$  and  $867 \pm 79$  ms;  $7.4 \pm 0.6$  and  $7.2 \pm 0.8$  ln ms<sup>2</sup>;  $7.6 \pm 0.6$  and  $7.7 \pm 0.5$  ln ms<sup>2</sup>, respectively,  $p = ns$  for all). LF/HF-ratio tended to be lower in OT compared with control athletes ( $1.2 \pm 0.3$  vs.  $1.8 \pm 0.8$ ,  $p = 0.063$ ). The  $R^2$  between RRi and HFln was higher in OT athletes compared with controls ( $0.87 \pm 0.04$  vs.  $0.78 \pm 0.11$ ,  $p = 0.031$ ). This difference was vanished 6 months later ( $0.78 \pm 0.12$  and  $0.78 \pm 0.07$ , respectively,  $p = ns$ ). **Discussion** The overtraining strengthens the relationship between RRi and vagally mediated HRV without altering the mean RRi and HRV in endurance athletes. This indicates prevailing RRi being more tightly controlled by vagal activity in overtrained athletes compared with control athletes. Lower correlation between RRi and HRV in control athletes manifests other mechanism, potentially sympathetic activity as suggested by slightly higher LF/HF-ratio, affect the prevailing RRi more in non-OT than in OT athletes. **References** Kiviniemi AM et al. (2004). *Am J Physiol Heart Circ Physiol.* 287(5):H1921-7. Uusitalo AL et al. (2006). *Int J Sports Med.* 27(9):702-8.

### ANAEROBIC POWER AND CADENCE CHARACTERISTICS OF ELITE CROSS-COUNTRY AND DOWNHILL MOUNTAIN BIKERS

Hurst, H.T., Swarén, M., Hébert-Losier, K., Ericsson, F., Holmberg, H.C.

*University of Central Lancashire; Mid Sweden University; Swedish Cycling Federation*

**Introduction** Mountain biking (MTB) is composed of several sub-disciplines, with Olympic Cross-Country (XCO) and Downhill (DH) being the most popular. Much of the current research on MTB pertains to the aerobic demands of XCO racing, with comparisons often made to road cycling. No studies have compared elite level XCO and DH bikers. Therefore, the aim of this study was to investigate the anaerobic power and cadence characteristics of elite XCO to DH riders. **Methods** Twelve male elite mountain bikers ( $n=6$  XCO,  $n=6$  DH; age  $21.83 \pm 3.71$  yrs; stature  $179.67 \pm 4.40$  cm; mass  $72.50 \pm 5.45$  kg) took part in this study. An inertial load cycling test was performed as described in previous studies(3), on an SRM cycle ergometer instrumented with a scientific version SRM Powermeter. Inertial load was adjusted to ensure riders achieved 130-150 revs.min<sup>-1</sup> within 4-7 s. Peak power (W<sub>peak</sub>), cadence at W<sub>peak</sub> (CAD<sub>opt</sub>) and power to weight ratio (W.kg<sup>-1</sup>) were calculated for each rider as the mean from 3 trials. Statistical differences between XCO and DH were determined using independent t-tests with significance set at  $p \leq 0.05$ . **Results** A significant difference between DH and XCO was found for CAD<sub>opt</sub> ( $114.93 \pm 5.41$  and  $107.96 \pm 4.63$  revs.min<sup>-1</sup>,  $p < 0.05$ ), respectively. No other differences were revealed between groups. The mean recorded values for DH and XCO were  $1137.76 \pm 135.84$  and  $1113.86 \pm 75.22$  W for W<sub>peak</sub> and  $15.21 \pm 2.05$  and  $15.95 \pm 0.75$  W.kg<sup>-1</sup> for power to weight ratio, respectively. **Discussion** The findings of comparable W<sub>peak</sub> between groups may indicate that high anaerobic power is not a prerequisite for success in elite DH. However, significant differences were found in CAD<sub>opt</sub>, where DH riders had a higher cadence when producing W<sub>peak</sub> compared to XCO riders. This may reflect training specificity and the greater emphasis on repeated accelerations in DH(2) and the lower cadences elicited by XCO riders(1). Further research is therefore warranted to compare laboratory and field-based performance in these two population groups. **References** 1. Gregory, J., Johns, DP. and Walls, JT. (2007) Relative vs. absolute physiological

measures as predictors of mountain bike Cross-Country race performance. *J of Strength and Cond Res*, 21(1), 17-22. 2. Hurst, HT. and Atkins, S. (2006) Power output of field-based downhill mountain biking. *J of Sports Sci*, 24(10), 1047-1053. 3. Martin JC, Wagner BM, Cyle EF (1997) Inertial load method determines maximal cycling power in a single exercise bout. *Med Sci Sports Exerc* 29:1505-1512.

### RELATIONSHIP BETWEEN STRENGTH QUALITIES AND 800 M PERFORMANCE IN FEMALES

Argeitaki, P., Katsikas, C., Douskas, T., Kesoglou, I., Smirniotou, A.

*National & Kapodistrian University of Athens*

**Introduction** The aim of this study was to investigate the relationship between strength and power parameters and 800m performance as well as to explore if these relationships varied between the first and the second 400m of the race distance. **Methods** One hundred eight university female students of physical education (age 19, 2±0, 6 years, height, 167, 9±0, 6 cm, body mass 59, 6±0, 7 Kg and BMI 21,1±0,2) were timed over the distance of 800m and also the intermediate lap-400m was considered (photocells, Microgate, It). The following tests were evaluated: countermovement jump (CMJ), 15 second repeated jump (RJ) and power output (PO) (Ergojump, Bosco) To examine the relationship between strength qualities and the 2 laps of 800m performance, a correlational approach was used (SPSS). Results CMJ and RJ showed low but significant correlations ( $r = -0,24$  and  $-0,27$ ,  $p < 0,05$  respectively) with the 800m performance times. However, both CMJ and RJ showed moderate correlations in the first 400m of the race ( $r = -0,26$  and  $-0,30$ ,  $p < 0,01$  respectively). In addition, no significant correlation was found between CMJ, RJ and performances in the second 400m of the race. The power output (PO) was not significantly correlated either with 800m or both laps of the race. From the anthropometric characteristics only the BMI was significantly correlated with the 800m performance ( $r = -0,26$   $p < 0,01$ ). **Discussion** The present findings suggest that CMJ and RJ affect only the first 400m of the race but not the second therefore strength qualities as tested in the present study proved to be poor predictors of 800m performance. These preliminary results should be validated in future research using trained athletes of different levels and both genders. **References** Bosco C, Luhtanen P, Komi PV. (1983) *Eur.J.Appl.Physiol.Occup.Physiol.* 50:273-282. Smirniotou A, Katsikas C, Paradisis G, Argeitaki P, Zacharogiannis E, Tziortzis S. (2008). *J. Sports Medicine Phys. Fitn.* 2008 Vol 48 N.04 p. 447 Miguel P, Reis VM, (2004), *New Studies in Athletics*, Vol 19, Issue 4 p 39-45

### DETERMINATION OF GLUCOSE THRESHOLD USING BLOOD GLUCOSE METER AND COMPARISON OF THE LACTATE THRESHOLD

Togashi, G.B.1,2, Sousa, N.M.F.1,3, Ferraresi, C.3, Rodrigues, M.F.C.3, Arakelian, V.M.1,3, Pieroni, R.P.3, Oliveira, J.C.3, Azevedo, P.H.S.M.3,4, Perez, S.A.3, Baldissera, V.1,3

*1: Programa de Pós Graduação Interunidades Bioengenharia/USP; 2: Faculdade Anhanguera de Bauru; 3: Universidade Federal de São Carlos; 4: Universidade Federal de São Paulo*

**Introduction** The objective of the present study was to determine and to compare the lactate threshold (LT) and glucose threshold (GT) during treadmill running. **Methods** 14 individuals were selected for the study, with mean age of  $29.7 \pm 8.8$  years, mean weight of  $74.2 \pm 9.4$  kg, mean height of  $174.9 \pm 5.9$  cm, and mean body fat of  $21.1 \pm 2.8\%$ . Incremental treadmill test was applied, and the initial speed was  $8.0 \text{ km}\cdot\text{h}^{-1}$  followed by increment of  $1.0 \text{ km}\cdot\text{h}^{-1}$  every 3 minutes until the subject became exhausted. Blood samples were collected from the earlobe for determining both glycaemia and lactaemia. LT and GT were determined through visual inspection. Initially, Shapiro-Wilk test was applied for analysing the normality of the sample. Because data were found to be normal, parametric statistic test was used. Data are expressed as mean values and standard deviation. Results No statistically significant difference was found between the velocity values ( $\text{km}\cdot\text{h}^{-1}$ ) for LT ( $10.3 \pm 1.7$ ) and GT ( $10.3 \pm 1.9$ ) ( $P > 0.05$ ). A strong correlation was found between LT and GT velocities ( $r = 0.93$  and  $R^2 = 0.87$ ). A high concordance was observed between methods (Bland and Altman analysis). One may conclude that the glucose threshold may substitute the lactate threshold. **Discussion** The main finding observed in the present study was that it is possible to assess the aerobic capacity by determining the glucose threshold with a portable glucose meter. Such a methodology was made more accessible due to the use of low-cost devices, thus allowing this important physiological marker for both functional evaluation and exercise intensity to be more easily determined. Thus, it was possible to determine the lactate and glucose thresholds during incremental test on a treadmill. No statistically significant differences were found between LT and GT velocities, thus demonstrating that LT determination may be substituted by GT as long as the same methods are applied in a comparable group of healthy subjects. **References** Gladden LB (2008). *Med Sci Sports Exerc*, 40, 477-85. Oliveira JC, Baldissera V, Simões HG, Aguiar AP, Azevedo PHSM, Poian PAFO & Perez SEA (2006). *Rev Bras Med Esporte*, 12, 333-338. Robergs RA, Ghiasvand F & Parker D (2004). *Am J Physiol Regul Integr Comp Physiol*, 287, R502-16. Rose AJ & Richter EA (2005). *Physiology (Bethesda)*, 20, 260-70. Simões HG, Campbell CS, Kushnick MR, Nakamura A, Katsanos CS, Baldissera V & Moffatt RJ (2003). *Eur J Appl Physiol*, 89, 603-11.

### VALIDATION OF A PROTOCOL OF HIIT WITH HYDROBIKE: TRIATHLETES VS GROUP CONTROL

COLLU, G., MILIA, R., ROBERTO, S., MIGLIACCIO, G.M.

*LABORATORIO FISILOGIA DELLO SPORT*

**Introduction:** Based on international scientific literature (ref 1-2) which indicates HIIT as an excellent method for improving  $\text{VO}_2\text{max}$ , and continuing with a research effected in precedence with Triathletes (ref 4), it was decided to propose the same protocol to a new group of Triathletes (TA) and to a Group of Control (CG). **Methods** 16 male Italian Triathletes at national level agreed to participate in this study. They was divided in two groups from 8: TA (age  $37.2 \pm 2.9$  years, weight  $68.5 \pm 5.9$  kg, height  $170 \pm 4.99$  cm) and CG (age  $40.8 \pm 6$  years, weight  $75.5 \pm 7.2$  kg, height  $180 \pm 5.33$  cm). At first both groups performed an incremental test up to exhaustion using a Hydro Bike (HydroRider Italy). The test consisted of a linear increment of pedaling frequency (RPM) every 2 mins. During the test they wore a portable metabolic device ( $\text{VO}_22000$  MedicGraphics USA) able to collect data of maximal oxygen uptake ( $\text{VO}_2\text{max}$ ,  $\text{VO}_2/\text{Kg max}$ ), maximal heart rate (HRmax) and to calculate anaerobic threshold (AT),  $\text{CO}_2$  Excess, VE max and Wmax. The TA then participated in 12 sessions of Hydro Bike HIIT (training: 30 mins- frequency: 3 times /week - duration: 4 weeks) following a well-established protocol of training: 4 mins 90% HR max + 3 mins 70% HR max for 4 times. The CG followed a free training reducing and limiting the volume and the loads of training. After such a period both groups repeated the incremental test up to exhaustion. **Results** The statistic analysis effected with t Student for coupled data, has statistically underlined a significant reduction of the  $\text{VO}_2/\text{Kg max}$ ,  $\text{VO}_2 \text{ max}$  on the CG after e period of a month of reduced activity, while the other variables have not statistically meaningful differences in both the groups in the two moments of the tests. **Discussion** The element underlined in the CG, in which a reduction of the ability of performance is observed reveals that a protocol of training with Hydro Bikes performed with HIIT- low duration protocols, can be recommended to Triathletes as an alternative practice in

low activity phases or in times of reduced training and to contrast some common detraining effects. References Iimpellizzeri F, Marcora S, Castagna C, Reilly T, Sassi A, Iaia F, Rampini E, Physiological and Performance Effects of Generic vs Specific Aerobic Training in Soccer Players, *Int.J.Sports Med* 2006,27(6):483-92 2. Helgerud et Collegues, Aerobic High Intensity Intervals Improve VO2max More Than Moderate Training - *Med Sci Sports Exerc*. 2007;39(4):665-71 3. Mujika, S. Padilla, Cardiorespiratory and metabolic characteristics of detraining in humans - *Med Sci Sports* 2001 Mar;33(3):413 4. Collu, R. Milia, Fara, Four Weeks Aqua Cycling Training for Tri-athletes Vs Detraining effects: study of the cardio metabolic parameters - *ECSS* 2011

### INCIDENCE OF BACK PAIN IN TRACK AND FIELD ATHLETES: A TRASVERSAL STUDY

Mondoni, M.

*Università Cattolica Sacro Cuore*

INCIDENCE OF BACK PAIN IN TRACK AND FIELD ATHLETES: A TRASVERSAL STUDY Mondoni M.1, Casolo F.1, Bottini L, Negrini S. 1, Ajani A.1, Scirè S. 1 Faculty of Education Science: degree in physical education and sport - Università Cattolica del Sacro Cuore di Milano INTRODUCTION AND OBJECTIVES Back pain is better localized at the lumbar spine and sciatica can become if not prevented or cured. The purpose of this research is to identify if the incidence of back pain is more common in athletes who practice different disciplines in Track and Field (throwing, jumping, speed and middle distance race), compared to persons who do not practice this sport. MATERIALS AND METHODS The groups examined are: track and field group (TaFg), mean age 23.5 years, comprising 160 athletes (m and f) and control group (CP), mean age 26.5 years, comprising of 80 persons (m and f) that do not practise TaF. All subjects were given an anonymous questionnaire to assess the incidence of back pain in physical activity. RESULTS The data collected showed that 65% of throwers and jumpers suffer from back pain and that 68% have never suffered from sciatica and has never stopped the pain. The TaF group suffers most from low back pain (60.56%), compared with the CP (39.44%) and both groups said they were not suffering from sciatica pain and it never stopped the pain. The 76.92% of TaFg said they did not suffer from back pain while filling out the questionnaire and 60% said they had back pain over the last 30 days and the throwers said to suffer more back pain than other athletes. The TaFg said to suffer back pain once every 6 months, especially the jumpers and throwers have reported suffering from back pain more than once a month. Confronted with the CP, showed that the TaFg undergoes more medical visits for low back pain resulting in rehabilitative therapy. In the TaFg 69% said they had never suffered back pain before starting the competitive activity, 74% of the 'test sample' thinks that the sporting activity has been affected quite to develop of back pain, 58% said they suffer from back pain during training before the competitive season. CONCLUSIONS The research shows that in TaF increasing incidence of low back pain, especially in males. The disciplines that cause more back pain are the throws and jumps. Comparing the TaFg with the CP, we can say that competitive athletes suffer more back pain than the CP. The throwers and jumpers said they frequently suffer from back pain, more often than once a month. From our observations we found that the TaFg underwent further medical examinations and treatments (drugs or otherwise), especially the throwers and jumpers, compared to the CP. The last part of the research, dedicated only to TaFg, it was found that subjects had never suffered from back pain before the race and think that has influenced the start of racing onset of back pain, especially for the sprinters, jumpers and throwers, also claimed to suffer more back pain during athletic training in the competitive season. REFERENCES Thesis of Sarah Scirè, Milan, 2010

### REST INTERVAL BETWEEN JUMPS DURING TRACK AND FIELD JUMPING COMPETITIONS

VELIGEKAS, P., BOGDANIS, G.C., STABOLITIS, C., FRANTZIS, D.

*University of Athens, GREECE*

Introduction Field jumping events may be categorized as horizontal jumps (long and triple jump) and vertical jumps (high jump and pole vault). In the horizontal jumps each athlete performs three jumps and the eight athletes with the best valid performances are allowed three additional trials. Vertical jumps are "open ended", and an athlete may commence at any height and may continue to any subsequent height, until failure (IAAF, 2012). Analysis results from Olympic Games and World Championships (IAAF competition archive, www.iaaf.org) showed that high jumpers and pole vaulters performed on average  $9 \pm 2$  jumps and  $8 \pm 1$  vaults. However, it is now known if the recovery time between the jumps is always adequate. The aim of this study was to record the time interval between trials during official competitions in the four field jumping events (long, triple, high jump and pole vault). Methods Data acquisition was performed during three different indoor competitions (one of them was the National Championships). The total number of athletes in all three competitions was 63 males and 61 females for the horizontal jumps and 54 males and 52 females for the vertical jumps. The time elapsed from the end of each trial until the start of the next was recorded for every athlete by two observers. Results In the long and triple jump, the rest interval between the first three jumps was  $10.0 \pm 0.2$  min, while it increased to  $12.5 \pm 0.5$  min between jumps 3 and 4. This was due to the change in the order that the athletes jumped after the third trial, where only 8 athletes continued to compete. The rest intervals before the last two jumps were decreased to  $6.85 \pm 0.2$  min. In the high jump and pole vault, the rest interval between the first two jumps was on average  $6.8 \pm 0.5$  min and declined steadily until the sixth jump to about  $4.0 \pm 0.4$  min. Thereafter, the rest interval declined by a small amount, depending on the number of participants left. Discussion The main findings of this study were that there is significantly less time between trials in the horizontal compared with the vertical jumps. Thus, athletes who compete in the vertical jumps have about 40% less time for recovery between their jumps while every subsequent trial must be done at a higher height. The relatively short recovery time in the vertical jumps indicates that some athletes may not be metabolically ready to perform maximally during the later stages of the competition (Dawson et al., 1997). These findings may have implications for the design of specific training programs that simulate competition, especially in the vertical jumps and also for competition tactics. References IAAF (2012). Competition Rules 2012-2012. Dawson B, Goodman C, Spriet L, Preen D, Polglaze T, Fitzsimons M. (1997). *Scand J Med Sci Sports*, 7, 206-213.

### THE RELATIONSHIP BETWEEN MAXIMAL FAT OXIDATION RATES AND BLOOD LACTATE THRESHOLDS IN RUNNERS.

Orme, D., Relph, N., Sparks, S.A.

*University of Cumbria*

The relationship between maximal fat oxidation rates and blood lactate thresholds in runners. Orme<sup>1</sup>, D., Relph<sup>1</sup>, N., and Sparks<sup>2</sup>, S.A. 1 Sport and Physical Activity, University of Cumbria, Lancaster, UK 2 Department of Sport and Physical Activity, Edge Hill University, Ormskirk, UK. Introduction: As aerobic exercise increases in intensity the relative oxidation rates of carbohydrate and fat have been shown to change (Van Loon et al., 2001). The rate of maximal fat oxidation (Fatmax) has been shown to be closely related to the increase in plasma lactate during incremental cycle ergometer exercise (Achten and Jeukendrup 2004). To date no studies have looked at this relationship in whole body exercise. The aim of this study was to evaluate the relationship between the exercise intensity which elicits Fatmax and three

methods of determining blood lactate thresholds during treadmill running. Method: Fifteen moderately endurance trained male recreational runners of mean ( $\pm$ SD) age  $35.0 \pm 8.98$  yr, body mass  $75.2 \pm 5.21$  kg and height  $1.76 \pm 0.05$  m, completed a discontinuous graded exercise test to exhaustion on a treadmill, using 1km/h increments every four minutes. Respiratory gases were measured throughout the test and used to calculate Fatmax via indirect calorimetry. Capillary whole blood lactate samples were collected at the end of each stage for the determination of the exercise intensity (speed in km/h and % of VO<sub>2</sub> peak) at which three thresholds LT, D-max (DM) and Modified D-max (MDM) occurred. Correlation analysis was performed using Pearson's and Spearman's rank correlation coefficients for parametric and non-parametric data respectively. Differences were determined using t-tests. Significance was accepted at  $p < 0.05$ . Results: No significant correlations were observed between the speed at Fatmax and the speed at which LT, DM or MDM occurred. There was however a significant correlation between Fat Max Speed and Fat Max % of VO<sub>2</sub> peak ( $r = 0.608$ ,  $p = 0.016$ ). Fat Max % of VO<sub>2</sub> peak was significantly correlated to DM % of VO<sub>2</sub> peak ( $r = 0.534$ ,  $p = 0.04$ ) and MDM % of VO<sub>2</sub> peak ( $r = 0.622$ ,  $p = 0.013$ ). There were significant differences between the speed at Fat Max and LT ( $p = 0.011$ ) and Fat Max and LT % of VO<sub>2</sub> peak ( $p = 0.011$ ). Conclusion: In moderately trained endurance runners Fatmax is significantly correlated with the % of VO<sub>2</sub> peak at both DM and MDM, but not at LT. References Achten, J., and Jeukendrup, A.E., (2004). Relationship between plasma lactate concentration and fat oxidation rates over a wide range of exercise intensities, *Int J Spo Med*, 25: 32-37. van Loon, L.J., Greenhaff, P.L., Constantin-Teodosiu, D., Saris, W.H., and Wagenmakers, A.J., (2001). The effects of increasing exercise intensity on muscle fuel utilisation in humans, *J. Physiol*, 536: 295-304.

## 14:45 - 15:45

### Poster presentations

#### PP-PM76 Health & Fitness 2

##### COMPARISON OF TWO BALANCE TESTS TO PREDICT INJURY RISK IN A MILITARY SETTING

Wyss, T., Roos, L., Wunderlin, S., Mäder, U.

*Swiss Federal Institute of Sports Magglingen SFISM*

**Introduction** A negative association between balance ability and injury risk during physical training or sport has been shown in college students and athletes [1, 2]. The same association can be expected in a military setting, where a large number of physical activities on uneven surfaces and with heavy loads take place. Therefore, the aim of this study was to investigate the discriminative power of two different balance tests to predict injury risk during basic military training. **Methods** The study was conducted with 298 volunteering male recruits of an infantry training camp in Switzerland. Balance was assessed in the first week of basic military training using a one-leg standing (OLS) test [3] and the MFT S3 Check test [4]. In OLS participants had to close their eyes after 10s and lay their head back after 20s. The sum of time on each leg was valued. For the MFT S3 participants had to balance for 30s on a disc connected to a computer that calculated two indexes: sensorimotor function (S3 SMF) and symmetry (S3 SYM). Injury occurrences were recorded during 13 weeks of basic military training. Discriminative power of volunteer's balance ability for predicting risk of injuries were calculated using receiver operating characteristic curve (ROC) analysis. Results Correlation between OLS and MFT S3 performances were low but significant ( $r = .11$  for S3 SMF and  $-.27$  for S3 SYM,  $p = .05$  and  $.00$ ). Overall, 8.4 overuse injuries and 10.6 acute injuries per 100 recruits per month were registered. The area under the ROC curve to predict overuse injuries for OLS, S3 SMF and S3 SYM and to predict acute injuries for S3 SYM was small and not significant ( $p = .17 - .67$ ). However, to predict acute injuries by OLS and S3 SMF it was  $.57$  and  $.58$  ( $p = .06$  and  $.04$ ). A combination of both tests (OLS + 8\* S3 SMF) resulted in a ROC area of  $.61$  ( $p = .00$ ) to predict acute injuries. **Discussion** S3 SYM was not correlated to S3 SMF, negatively correlated to OLS and not related to injuries. This index does not appear to add any relevant information to a balance ability assessment in a military setting. OLS and S3 SMF are both related to acute injury incidences in infantry training, but correlate only to a small extent with each other. Therefore, we conclude, that a combination of the OLS and S3 SMF gives a more powerful index of balance ability to predict acute injuries in a military setting. **References** 1. Watson, A.W., Ankle sprains in players of the field-games Gaelic football and hurling. *J Sports Med Phys Fitness*, 1999. 39: p. 66-70. 2. Willems, T.M., et al., Intrinsic risk factors for inversion ankle sprains in male subjects: a prospective study. *Am J Sports Med*, 2005. 33: p. 415-23. 3. Wyss, T., et al., Assembling and Verification of a Fitness Test Battery for the Recruitment of the Swiss Army and Nation-wide Use. *Swiss J Sports Med Sports Traumatol*, 2007. 55: p. 126-131. 4. Raschner, C., et al., S3-Check-evaluation and generation of normal values of a test for balance ability and postural stability. *Sportverletz Sportschaden*, 2008. 22: p. 100-5.

##### DEVELOPMENT OF AN ENERGETIC DEMAND PROFILE IN FIGURE SKATING

Hermisdorf, M.1, Hartmann, U.1, Spiegel, S.2, Knoll, K.3, Ehrig, A.3

*University Leipzig*

**Introduction** Existing data for the metabolic background and the endurance skills in figure skating are very incomplete and primarily based on an 'old rating system' of the 70s and 80s. They show a high participation of anaerobic and low share aerobic energy for a free skating of four minutes [1, 2]. The aim of this study is the development of a complex sport-specific energetic demand profile for figure skating competition. **Methods** Eleven competitive figure skaters (five males, six females) with the following physical characteristics took part in the study: mean age  $16.4 \pm 2.5$  yrs, mean height  $164.5 \pm 6.9$  cm, mean body weight  $56.9 \pm 7.5$  kg. Ventilation, gas exchange and heart rate (HR) were measured during the free skating presentation for a minimum of four minutes with a portable spirometry system (MetaMax 3B, Cortex, Germany). Lactate concentration (LA) was assessed before and after the exercise (Biosen S\_line, EKF-diagnostic, Germany). Additionally, free skating presentation was recorded on video for quantitative analysis. Covered distance and velocity of the figure skater were measured with an local indoor position system (LPM, Inmotio, Netherland, frequency 1.000 Hz, measurement accuracy of 5 cm). Laboratory tests were carried out to determine maximum oxygen uptake (VO<sub>2</sub>max), HR and LA during a treadmill (Saturn, h-pocosmos, Germany) all-out-test with an increasing workload (start by 3.25 m/s, increase 0.25 m/s every 30 s, inclination 1 %) until exhaustion (vita-maxima-test). Results All athletes reached their individual maximum HR and VO<sub>2</sub>max during the four minutes free presentation on ice. In average VO<sub>2</sub>max ( $n=6$ ) was  $3.21 \pm 0.69$  l/min on ice and  $3.19 \pm 0.68$  l/min on treadmill, corresponding to  $59.0 \pm 7.4$  ml/kg/min and  $58.3 \pm 6.1$  ml/kg/min respectively. HR was  $194.0 \pm 7.7$  min<sup>-1</sup> on ice and  $198.0 \pm 4.1$  min<sup>-1</sup> on treadmill and LA  $9.7 \pm 2.5$  mmol/l and  $10.1 \pm 3.1$  mmol/l. The analyses of the gas exchange parameters indicate a distribution  $74.1 \pm 5.1$  % of aerobic,  $11.6 \pm 2.9$  % anaerobic

lactic and  $14.3 \pm 3.6$  % anaerobic alactic energy shares. Discussion The results point out to a very high aerobic metabolic rate in free skating for top competitors. All athletes showed very high physical strain during free skating. However, the data of the acyclic activity profile on ice implies that aerobic metabolism is the dominant source of energy. Compared to traditional perspectives, as mentioned in the introduction, the anaerobic shares take up a minor influencing factor. References (1) Dal Monte A. (1983): The functional values of sport. Florence: Sansoni (2) Shephard, R.J. (1990): Lactate levels in skaters. *Can J Sport Sci* 15(1) 4

### **HIGH INJURY PRONENESS IN PHYSICAL EDUCATION TEACHERS: A RATIONALE FOR INJURY PREVENTION**

Goossens, L., Cardon, G., De Clercq, D.

*Ghent University, Department for Movement- and Sports Sciences*

Teaching Physical Education is physically very demanding due to long-time standing, replacement and storage of materials, aid by and demonstrations of specific techniques and exercises (1). Sandmark (2) observed physical work load for PE teachers is considerable with high load on the lower extremities. In line with these results, Sandmark (3) found more injuries and osteoarthritis of the knees and a higher prevalence of low back pain in PE teachers between 53 and 65 years of age compared to referents. Updated information with reference to PE teachers of all ages in Flanders is needed for working towards sports injury prevention in this specific population. Study design 129 PE teachers (69 m, 60 f;  $42.95 \pm 10.25$ y) signed in to take part in this study. All teachers received a weekly email through which they reached the online registration. Time of exposure was questioned and whether or not an injury occurred during the last week. In case of injury, specifications were questioned. Results After 22 weeks of follow-up, injury prevalence was 51 injuries (28 in females, 23 in males) suffered from by 39 teachers. Injury incidence was 41 injuries in 32 teachers, incidence rate was 1.3 injuries/1000h of exposure. The absolute risk for having an injury was 31.7%. The injured teachers were  $41.18 \pm 9.95$ y of age. The majority of all injuries were acute (68.6%) and non-contact (76.5%). The amount of new and recurrent injuries was more or less the same (52.9% Vs 47.1%). Injuries happened during teaching activities in 43.2% of the cases whereas in 37.3% while practicing extracurricular sports. 71.5% of all injuries happened to the lower limbs with mostly affected body parts the lower leg and knee (13.7% each). Concerning the upper body, the lower back (7.8%) and shoulder (5.9%) were mostly affected regions. Mostly injured tissues were muscles (17.6%), followed by ligaments and joints (9.8% each). Discussion We observed that PE teachers are at considerable risk for having a sports injury and teaching activities are an important reason for this. As expected following the results by Sandmark (2), the majority of all injuries involved the lower limbs. Regarding the upper body, also in line with the results by Sandmark (3) we observed most injuries to the lower back. These epidemiological data will be used to refine a specific sports injury prevention program in PE teachers in Flanders. References (1) Lemoyne J, Laurencelle L, Lirette M, Trudeau F. Occupational health problems and injuries among Quebec's physical educators. *Applied Ergonomics*. Sep 2007; 38(5):625-634. (2) Sandmark H, Wiktorin C, Hogstedt C, Klenell-Hatschek E-K, Vingard E. Physical work load in physical education teachers. *Applied Ergonomics*. 1999; 30: 435-442 (3) Sandmark H. Musculoskeletal dysfunction in physical education teachers. *Occup Environ Med*. 2000; 57: 673-677

### **SAFETY IN SPORTS – DEVELOPMENT OF A METHODOLOGY FOR GUIDELINES ON INJURY PREVENTION AND SAFETY PROMOTION IN SPORTS**

Henke, T., Luig, P.

*Ruhr-University Bochum*

Introduction Sport is an important cultural element and one of the most widespread activities. There is a global consensus that health protection and health promotion are important potentials of sport. However, approximately 20% of all injuries result from sporting activities. In particular with regard to popular sports, the benefit for health can be increased by reducing the frequency of sports injuries. The general aim of the project, which receives funding from the European Commission, is to contribute to the reduction of sports injuries by elaborating general guidelines and recommendations for injury prevention and safety promotion in sports with absolute high numbers of participants and injuries. Methods Based on an up-to-date inventory, a consensus on best injury prevention measures and implementation strategies for handball and basketball was reached using a web-based evaluation tool in combination with multiple expert consultation meetings. Additionally, surveys among trainers measuring opinions, attitudes, needs and knowledge on prevention topics were carried out. Results Prevention toolkits were elaborated that consist of media and information to convey preventive contents to stakeholders and target groups in handball and basketball communities. In collaboration with the European Handball Federation and the FIBA Europe these toolkits have been pilot-tested in four national associations with special focus on acceptance and applicability. In the light of the test implementations, general guidelines on how to develop, implement and sustain injury prevention and safety promotion in a sports setting have been drawn up. Major task areas are: (1) Topic selection, (2) Resources, targets and realistic planning, (3) Methods for developing injury prevention measures and safety promotion strategies (4) Dissemination and sustainability (5) Evaluation, and (6) Updating and continuous improvement. For each area we developed a kind of checklist with instrumental advices for its successful realization but leaving enough space for individual adjustment to the specific demands and needs of the respective implementation setting. Conclusions The guidelines and recommendations are built on experiences from the pilot project "Safety in Sports" and may assist sports organisations during future safety approaches. To bridge the evidence-to-practice translation gap it is obligatory to involve the respective target communities from the very first process step and to acknowledge the specific demands, interests and settings of each sports community. Moreover, it is essential to analyse the sports communities' perception and knowledge of the injury problem itself as well as their perspectives of handling the problem within their own organisational structures and with regard to their capacities.

### **HEALTH REPORT BY STUDENTS FOR STUDENTS**

Simi, H., Grach, D., Neuhold, B., Wallner, D.

*FH JOANNEUM*

HEALTH REPORT BY STUDENTS FOR STUDENTS Simi, H.1, Grach, D.2, Neuhold, B. 3, Wallner, D.1 1:FH JOANNEUM Uni. App. Sci., Sport Science Laboratory (Bad Gleichenberg, Austria), 2:FH JOANNEUM Dietetics (Bad Gleichenberg, Austria), 3:FH JOANNEUM Health Management in Tourism (Bad Gleichenberg, Austria) Introduction Female students aged 15 to 17 years from four Austrian schools for food and agriculture worked on a health report by students for students. The goal was to gain data from and by female scholars to increase their interest in research in the disciplines of sport science, dietetics & social sciences. This article presents the results of the sport science component. The involvement of health oriented reports of citizen is recommended (Böhm, 2009). Methods 93 volunteer female students participated in this project. Workshops on the basics of the scientific method supported by experts like literature searching, quotation,

protocol implementation, exercise testing and interpretation, basic statistics were conducted. The students applied this knowledge by gathering data in a project week of four sport motor skill tests (Endurance: 2000m Walking Test, Coordination: Kasten-Bumerang-Lauf (KBL), Rapidity: 20m Sprint and Bounce: Standing Long Jump (SLJ)). To get valid data students collected data through a series of tasks including construction of the test, protocol implementation, explanation of the test & measurements. An additional workshop was held to interpret and analyze the results. Based on the results the students made recommendations for themselves and for their schools. Results 20m Sprint  $3.91\text{sec} \pm 0.33\text{sec}$  and SLJ  $1.58\text{m} \pm 0.23\text{m}$  was in average ( $3.75\text{sec}-4.15\text{sec}$  &  $1.58\text{m}-1.78\text{m}$ ), KBL  $20.73\text{sec} \pm 5.52\text{sec}$  was below average ( $>19.5\text{sec}$ ) in Austrian school students (bm:bwk, 2003). For the 2000m Walking Test  $18:52\text{min} \pm 09:30\text{min}$ , no reference data are available. Conclusion There should be more observance paid to the coordination exercises. This fact is also mentioned by the students in the recommendations on school level: More varied sport and hours in physical education and therefore an increased communication with their teacher should be given. Recommendations on personal level: Doing more sport, the sport needs to be enjoyed (e.g. with friends and pets) and better time management skills (e.g. using a bicycle instead of a bus). Experience The implementation of interactive workshops had a positive impact on the working behavior. The research process appeared complex for the students though the sport motor skill tests were handled well. References Bm:bm.k. (Hg). (2003). Klug & Fit. Sportmotorische Test, Schulärztliche Untersuchung des Bewegungsapparates, Muskelfunktionsprüfung. (S. 18-25). Download vom 16.09.2011 von <http://www.klugundfit.at/dokument/heft3.pdf> Böhm, A (2009). Bürgernahe Gesundheitsberichterstattung. In Kuhn, J. & Böcken, J. (Hg.). *Verwaltete Gesundheit. Konzepte der Gesundheitsberichterstattung in der Diskussion.* (S. 171-181). Frankfurt am Main: Mabuse Verlag.

## RELATIONSHIP BETWEEN LIFESPAN AND STRENGTH LEVELS FROM FORCE TESTS IN COLLEGE STUDENTS

Pessoa Filho, D., Bravo, V.A., Siqueira, L.O.C., Neiva, C.M., Verardi, C.E.L.

*São Paulo State University*

RELATIONSHIP BETWEEN LIFESPAN AND STRENGTH LEVELS FROM FORCE TESTS IN COLLEGE STUDENTS Bravo, V. A.1, Siqueira, L. O. C.1, Neiva, C. M.1, Verardi, C. E. L.1, Pessoa Filho, D. M.1. 1: UNESP (Bauru-SP, Brazil) Introduction The practice of physical activities from college students leading to damage level when not properly assisted, and worse it is when considering the practice of resistance exercise. To overcome this condition it is necessary to plan exercise programs taking into account anthropometric references, muscle level of fitness and lifespan information. The objective was to analyze the profile of college practitioners of resistive exercise from body composition, strength levels and lifespan. Methods 24 college students, 12 men ( $23.4 \pm 3.5$  years,  $75.2 \pm 6.5$  kg of body weight) and 12 women ( $21.2 \pm 3.2$  years,  $60.2 \pm 12.2$  kg of body weight) from UNESP at Bauru (SP) were subjected to body composition measurement from bio-impedance (Tanita, BC-553), that was classified following ACSM recommendation. The force was assessed from one repetition to maximum protocol (1RM) in bench press (BP), leg press (LP), arm curl (AC), lat pull down (PD), leg extension (LE) and leg curl (LC). The global index of force made possible a categorization of force into five levels ranging from poor to excellent for the performance in BP, LP, AC, PD, LE and LC. Lifespan information was analyzed from SF36 questionnaire, categorized into functional capacity (FC), physical constraints (FCo), pain (P), health status (HS), vitality (V), social features (SF), emotional features (EF), and mental health (MH). Results The body fat in men ( $14.96 \pm 3.29\%$ ) and women ( $21.95 \pm 6.99\%$ ) were considered below and at mean, respectively. The values of force from 1RM protocols for men (BP:  $0.89 \pm 0.20$  kg.kg<sup>-1</sup>; AC:  $0.51 \pm 0.14$  kg.kg<sup>-1</sup>; PD:  $0.85 \pm 0.24$  kg.kg<sup>-1</sup>; LP:  $1.38 \pm 0.28$  kg.kg<sup>-1</sup>; LE:  $1.32 \pm 0.34$  kg.kg<sup>-1</sup>; and LC:  $0.81 \pm 0.12$  kg.kg<sup>-1</sup>) and women (BP:  $0.44 \pm 0.12$  kg.kg<sup>-1</sup>; AC:  $0.29 \pm 0.08$  kg.kg<sup>-1</sup>; PD:  $0.51 \pm 0.06$  kg.kg<sup>-1</sup>; LP:  $1.16 \pm 0.30$  kg.kg<sup>-1</sup>; LE:  $0.93 \pm 0.17$  kg.kg<sup>-1</sup>; and LC:  $0.55 \pm 0.16$  kg.kg<sup>-1</sup>) were categorized into good after global force index analysis. From the percentage of each level of the categories, 64% of the men and 73% of the women were even at good level. However, the performance at BP, PD and AC was considered above the mean for men and women. But the general level of force was in concert to the eight categories of lifespan, in such all subjects were located at high percentiles: 89(+/-15) to FC; 94(+/-25) to FCo; 75(+/-21) to P; 77 9(+/-16) to HS; 66(+/-17) to V; 85(+/-18) to SF; 84(+/-26) to EF and 72(+/-37) to MH. Conclusion The analyzed college students show an adequate profile of body fat, strength level and lifespan when related to the health patterns. However, a deficit of force for upper limbs was observed, and must be considered when planning an exercise program with resistance exercise. References GRIFFIN, J. C. Client-centered exercise prescription, Ed.Human Kinetics, 2006. JOHNSON, B. L. Practical measurements for evaluation in physical education. Ed.Human Kinetics, 2006.

## EFFECT OF LOW-INTENSITY STRETCH EXERCISE ON RECTAL TEMPERATURE, STRESS, AND MOOD IN MIDDLE-AGED WOMEN IN JAPAN

Nagamatsu, T., Kitabatake, Y., Sensui, H.

*Meiji Yasuda Life Foundation of Health and Welfare*

Introduction Moderate exercise has been suggested to promote sleep onset and increase slow-wave sleep. We have also reported that low-intensity stretch training is effective in promoting greater improvement of sleep-related problems by shortening sleep onset latency. However, the mechanisms underlying such effects remain unclear. This study aimed to investigate the effects of low-intensity stretch exercise on physiological and psychological responses in relation to sleep. We examined changes in rectal temperature, stress, and mood states in response to acute exercise in middle-aged women. Methods Eight subjects (mean age,  $49.4 \pm 5.8$  years) who were not taking any medications affecting sleep volunteered to participate in this study. The exercise program required 10 min of stretching according to yoga techniques and poses. Exercise and control programs were randomly performed in a cross-over trial in each subject. Rectal temperature was measured before and after stretching. Cortisol in saliva was examined 5 min before and 5 min after each trial. Mood states (pleasantness, relaxation, anxiety) in response to stretching were also examined 30 min before and 5 min after each trial using a self-reported questionnaire. Results Significant interactions in the two factors (trial and time progress) were identified for rectal temperature, cortisol, and pleasantness score. A greater degree of change in rectal temperature was seen with the exercise program than with the control program. The rise in mean rectal temperature after stretching was approximately 0.1 deg C. Cortisol levels increased slightly in the control program and decreased in the exercise program. Pleasantness score increased over time in both programs, but the degree of change was greater in the exercise program than in the control program. Discussion Sleep onset is reportedly improved with peripheral heat dissipation at bedtime after a rise in core temperature of less than 0.5 deg C. This study found a suitable rise in core temperature was achieved after stretching. Stress response and pleasantness also improved with stretching. These changes after exercise may contribute to improved emotional condition at bedtime. In conclusion, performance of low-intensity stretch exercises immediately before bedtime may promote improvement in sleep-related problems by causing a suitable rise in core temperature, reduction of stress, and improved mood status in middle-aged women in Japan.

## SECULAR GROWTH CHANGES IN ATHLETIC BOYS - A PILOT STUDY

Farkas, A., Szmodis, M., Szots, G., Bosnyák, E.

*Semmelweis University, Faculty of Physical Education and Sport Sciences*

Introduction: Studies upon secular trend can show us the nature of changes in a population over time. We can get a common view into the essential effects of the socio-economical background – and also of the genetic components in different age groups and in active and non-active groups. The aim of this study was to analyze the trend and relationships, if any, between anthropometric characteristics over time in prepubertal and pubertal ball game players, so that to register any form of manifestation of the secular growth trend. Methods: The subjects were Hungarian basketball player boys living in Budapest, between 1993 and 2002, aged 9 to 16 (N=400). In taking all 24 anthropometric measurements the suggestions of the International Biological Program (Weiner and Lourie 1969) were considered. Body fat percentage was assessed by Pařízková's (1961) method, for body composition assessment the Drinkwater and Ross (1980) body fractionation method was used. We analysed the relationships of anthropometric variables and the changes of the trend over the time. Basic statistics, interrelationships and Student t-test were ( $p < 0,05$ ) used by Statistica Statsoft Version 9 computer programme. Differences of the respective subgroup means were tested by Tukey's post-hoc tests at the level of 5% random error. Results: There was an obvious constant age-dependent increase in the basic anthropometric measurements for the whole sample along the studied time period. When grouping the boys by age and by the studied years, we could only prove a definite, clear significant trend over time in some anthropometric measurements as most data followed oscillating manner of change. When considering the starting and the final time point of the 12 year old group they differed in their mesomorphy and in plastic index values, significantly. However there were interesting trend-like changes by age e.g. in the order of the magnitude in skinfolds by body regions. The relatively low subgroup numbers by age and by the subsequent years was a limitation factor in our present study. Discussion: When observing the growth trends we need really large sample of a population to check the consequent changes. Even when tendencies could be demonstrated no statistically proved results are existing. In the studied sample of basketball player boys the tendencies and trends of growth changes should be affected and modified by the factors of selection and their training history besides other socio-economical factors. We need to add further number of subjects to get more realistic picture on the quality of changes, if any, in respect of the secular growth trend.

**14:45 - 15:45**

## Poster presentations

### PP-PM77 Health & Fitness 3

#### CHEST AND ABDOMINAL CIRCUMFERENCE VARIATION ACCOMPANYING INCREASED VENTILATION IN INCREMENTAL-LOAD EXERCISE

KIMURA, M.1, YAMAMOTO, M.1, BAN, Y.2

*1:Tokyo Polytechnic University(Japan), 2:Musashino Junior College(Japan)*

Introduction The mode of diaphragm and respiratory-accessory muscle participation during high-intensity exercise has been reported to differ from the mode during rest or low-intensity exercise (Grimby et al.,1976; Johnson et al.,1993). The activated state of the respiratory muscles is manifested not only in increased ventilation, but also in accompanying variations in chest and abdominal movement (expansion and contraction). The present study therefore investigated the amplitude of cyclic variation in chest and abdominal circumference with rising ventilation during incremental-load exercise on a bicycle ergometer. Method Twelve healthy male subjects (age, 19-22 years) were participated in this study. With a pedaling speed of 50 rpm, the initial bicycle pedaling load of 50 W was increased by 10 W each minute until the subject exhibited total exhaustion. Mean values for minute ventilation (VE) and chest (chest-cir) and abdominal (abdominal-cir) circumferences during the 20 sec period from 40-60 sec at each load were obtained and the relationship between VE and chest-cir and abdominal-cir was analyzed. Results During the incremental-load exercise, the 12 subjects exhibited maximum VE of 89-143 L/min (mean, 113.9±17.6 L/min), maximum oxygen uptakes of 33.5-56.6 mL/kg/min (mean, 45.4±7.2 mL/kg/min), and peak heart rates of 179-207 beats/min (mean, 191.1±8.4 beats/min). All subjects exhibited the amplitude of cyclic variations in chest-cir, which increased linearly with the VE throughout the incremental-load exercise ( $r=0.818-0.974$ ). In contrast, the amplitude of cyclic variation in abdominal-cir increased with VE throughout the time to moderate exercise intensity (48-77% of maximum VE), but in some subjects declined relative to the VE with further increases in exercise intensity and in others continued to rise in positive linear correspondence with the VE in the same manner as chest-cir. Discussion These results indicate that during intense exercise, the respiratory and respiratory-accessory muscles in the chest work more strongly on the VE than do the muscles of the abdominal region. The decline in abdominal-cir variation relative to VE in high-intensity exercise that was found in several subjects may be attributed to fatigue of abdominal muscle (Bryan et al.,2006) and diaphragm (Johnson et al.,1993;Babcock et al.,1988). References ·Babcock M.A.,Pegelow D.F.,Taha B.H.,Dempsey J.A. (1997). *Med.Sci.Sports Exerc.*, 30,506-511 ·Bryan J.Taylor, Stephen C.How, Lee M.Romer (2006). *J.Appl Physiol.*,100,1554-1562 ·Grimby G., M.Goldman, J.Mead (1976). *J.Appl.Physiol.*,41,739-751 ·Johnson B.D., A.Babcock, O.E.Suman, J.A.Dempsey (1993). *J.Physiol.(Lond)*, 460,385-405

#### VALIDITY OF TRIAXIAL ACCELEROMETER FOR ASSESSMENT OF TOTAL ENERGY EXPENDITURE IN PRIMARY SCHOOL CHILDREN AGAINST DOUBLY LABELED WATER METHOD

Hikihara, Y., Midorikawa, T., Ohta, M., Tanaka, S.

*Chiba Institute of Technology*

Validity of Triaxial Accelerometer for Assessment of Total Energy Expenditure in Primary School Children against Doubly Labeled Water Method Hikihara Y. 1, 2, Midorikawa T. 3, Ohta M. 4, Tanaka S. 2 1:CIT (Chiba, Japan), 2:NIHN (Tokyo, Japan), 3:J.F.OU (Tokyo, Japan) 4:KSN (Ishikawa, Japan) Introduction Most of accelerometers underestimated total energy expenditure (TEE) compared with the value by doubly labeled water method (DLW). We speculate that it is because accelerometer cannot accurately evaluate nonlocomotive activities (Hikihara et al., 2012). Therefore we proposed algorithm and equations which differentiate locomotive activities from nonlocomotive using



triaxial accelerometer for children and adults (Oshima et al., 2010; Ohkawara et al., 2011; Hikiyama et al., under review). Moreover, we found that the equations for adults overestimate energy expenditure (EE) in children against EE evaluated by Douglas bag method. We examined the validity of triaxial accelerometer with algorithm and equations that we proposed for the assessment of TEE in children. Methods Twenty two primary school students (13boys, 9girls) participated in this examination. We measured TEE for 9 days using DLW method. We followed the standardized way of DLW in our previous study (Ishikawa-Takata et al., 2008). Simultaneously we asked them to wear triaxial accelerometer on left waist. This device memorized synthetic acceleration of a 10-s epoch length within a measurement range of  $\pm 6$  G and with a resolution of 3 mG. The synthetic acceleration was converted into metabolic equivalents through two equations of locomotive and nonlocomotive activities. Additionally, we asked subjects to record the time and duration when they detach the device from waist. Results Average TEE evaluated by DLW was  $2203 \pm 356$  kcal/day. Physical activity level (TEE/basal metabolic rate) was  $1.63 \pm 0.20$ . Meanwhile, TEE estimated from triaxial accelerometer was  $2223 \pm 311$  kcal/day. We did not find a significant difference between DLW method and triaxial accelerometer. Moreover, there is a significant relationship ( $r=0.83$ ,  $P<0.01$ ) between them. We also found a contribution of energy expenditure during nonlocomotive activities to TEE ( $r=0.67$ ,  $P<0.01$ ). Discussion Triaxial accelerometer that we proposed has better estimation accuracy than previous accelerometers. It might be because the equations in this accelerometer based on children's energy cost. Furthermore, we believe that we can evaluate nonlocomotive activities exactly as well as locomotive ones. We confirmed that it is important to focus on nonlocomotive activities because children have long time of such activities in their lifestyle. Conclusion Our results indicate that triaxial accelerometer with our unique algorithm can exactly estimate TEE in children.

### HOW IMPORTANT IS THE USE OF A LOGBOOK IN ADDITION TO ACCELEROMETER TO ASSESS THE PROPORTION OF INSUFFICIENTLY ACTIVE 13-YEAR-OLD GIRLS?

Titze, S.1, Stücker, M.1, Matouschek, S.1, Pedisić, Z.1,2

1 *Institute of Sport Science (Graz, Austria)*, 2 *Faculty of Kinesiology (Zagreb, Croatia)*

Introduction It is strongly recommended to use objective measurements for the assessment of physical activity among children and adolescents. However, as some activities such as bicycling/inline skating/scooter are incorrectly recorded by accelerometer, assisting methods are needed to obtain correct data. The aim of the study was to examine the proportion of insufficiently active girls based on data from accelerometer only compared to data from accelerometer combined with a logbook. Method In the city of Graz and in the rural surroundings 178 13-year-old girls filled in a logbook. Of those, 125 girls wore an accelerometer (GT3X+) for at least four days. In the logbook we particularly asked about the duration of cycling/inline skating/scooter for transport per day as this is recorded with the accelerometer as light-intensity physical activity. We calculated the average minutes of at least moderate-intensity physical activity (MVPA) per day as well as the average minutes of cycling/inline skating/scooter per day of each individual. Finally, we divided the girls into insufficiently (less than 60 min of MVPA per day) and sufficiently active groups. McNemar chi-squared test was applied. Results Cycling/inline skating/scooter for transport were performed at least once a week by 49% of the girls with a median duration of 36 min per day. Based on the accelerometer data 84% of the girls were insufficiently active. After adding the minutes of MVPA assessed by accelerometer and the minutes of cycling/inline skating/scooter derived from the logbook the proportion of insufficiently active girls was reduced statistically significantly to 53%. Discussion In our sample of young girls the prevalence of cycling/inline skating/scooter at least once a week was almost 50%. As long as accelerometers do not appropriately measure e.g. non weight bearing physical activities such as bicycling, it is strongly recommended to additionally apply methods to capture those activities. Without taking cycling/inline skating/scooter into account, the prevalence of insufficiently active girls would have been overestimated considerably in our study. Furthermore, correct information about such activities is important to assess relationships between MVPA and active transport or for tracking of cycling/inline skating/scooter over time (Carver et al., 2011). Literature Carver A, Timperio AF, Hesketh KD, Ridgers ND, Salmon JL, Crawford DA. (2011). *Int J Behav Nutr Phys Act*, 8, 126.

### HANDGRIP STRENGTH SEEMS TO BE AN IMPORTANT PREDICTOR OF PHYSICAL FITNESS REGARDLESS OF PUBERTAL STATUS

Matsudo, S.M.M.1, Rezende, L.F.M.1, Matsudo, V.K.R.1, Raso, V.2,3

1: *CELAFFICS (SP, Brazil)*; 2: *UNOESTE (SP, Brazil)*; 3: *UNIBAN (SP, Brazil)*

Introduction Numerous tests and measures have been used to physical fitness assessment. Handgrip (HG) dynamometry is one of the simplest to apply, and studies have showed that HG is associated with sports performance (FERRAGUT et al 2011). However, a few studies have showed the power of HG to predict other physical fitness variables. Purpose To examine the power of HG to predict physical fitness in boys and girls with different sexual maturation levels. Methods A cross-sectional study from the "Longitudinal Project of Growth, Development and Physical Fitness in Children from Ilhabela", Brazil. The sample consisted of 468 youth aged 10-15 living in a low socioeconomic status island in Brazil. We measured body composition (BMI), waist circumference and adiposity with mean of 7 skinfolds), physical fitness (lower limb strength: with vertical jump test, standing long jump; curl up, flexibility, agility and speed), energy expenditure (IPAQ), HG strength (mechanical dynamometer - Takey) and Pubertal status by Tanner self-evaluated. Multiple regression analysis investigated associations of physical fitness parameters with age, sexual maturation, energy expenditure and grip strength. Statistical significance was set at  $p<0.05$  Results The prediction power of HG in total sample was: 29% for vertical jump ( $R=.54$ ,  $R^2=.29$ ;  $P=.002$ ), 46% for standing long jump ( $R=.68$ ,  $R^2=.46$ ;  $P=.0005$ ), 24% for curl up ( $R=.49$ ,  $R^2=.24$ ;  $P=.010$ ), 4% for flexibility ( $R=.21$ ,  $R^2=.04$ ;  $P=.655$ ), 25% for agility ( $R=.50$ ,  $R^2=.25$ ;  $P=.0005$ ), 38% for speed at seconds ( $R=.61$ ,  $R^2=.38$ ;  $P=.0005$ ) and 47% for speed at meters per seconds ( $R=.69$ ,  $R^2=.47$ ;  $P=.0005$ ) to 47% (speed at meters per seconds:  $R=.69$ ,  $R^2=.47$ ;  $P=.0005$ ). Discussion Studies have showed the importance of hand-grip as a predictor of some anthropometric variables (SHYAMAL K et al. 2009). Our results support that hand-grip is consistently associated with several distinct parameters of physical fitness regardless of age, gender and sexual maturation, permitting to suggest that physical fitness could be independently predicted by hand grip strength with an elevated accuracy. References Ferragut C, Vila H, Abroades JA et al. (2011) *Journal of Sports Medicine and Physical Fitness*, 51, 26-32 Shyamal K, Pal SA. (2009) *Anthropologischer Anzeiger*, 67, 21-28 Wander P, Boyko EJ, Leonetti DL et al. (2011) *Diabetes Research and Clinical Practice*, 92, 261-264 #supported by FAPESP process number 2010/20749-8

### EFFECTS OF SUPINE POSITION IN WATER ON ARTERIAL STIFFNESS IN THE MIDDLE-AGED FEMALES

SAITO, T.1, TAKAHARA, T.2, TAKAGI, Y.1,3, HAYASHI, S.1, ARAKANE, K.1, SAITO, K.1,4, YAMADA, A.5, YOSHIOKA, A.6, ONODERA, S.2

1: GRADUATE SCHOOL, KUMMW, 2: KUMMW, 3: JSPS RESEARCH FELLOW, 4: THE SAKAKIBARA HEART INSTITUTE OF OKAYAMA, 5: MIYAKE MEDICAL INSTITUTE GROUP, GRACEFUL SPORTS CLUB SALAMANDER, 6: KAGAWA UNIV

Introduction: Heart rate, oxygen uptake and body temperature are influenced by the physical characteristics of water (water temperature, buoyancy, viscosity, etc). brachial-ankle pulse wave velocity (baPWV) is depended by Systolic blood pressure (SBP) and age. Previous studies demonstrated an increase of baPWV and SBP with aging. SBP was a different response to age in water. SBP of Younger decrease and the middle-aged increase. Therefore, we hypothesized that baPWV and SBP could change in water in the middle-aged. The purpose of this study was to clarify the effects of supine position in water on arterial stiffness in the middle-aged females. Methods: Six Japanese middle-aged females volunteered to participate in this study. We had informed consent prior to participate in this study. The age, body weight and body height of subjects were  $63.0 \pm 3.9$  years old,  $55.9 \pm 7.9$  kg and  $152.4 \pm 5.7$  cm respectively. This study consisted of two conditions. One was the land condition (room temperature:  $28.6 \pm 0.4$  °C), and the other was the water condition (water temperature: 30 °C). Subjects lay in supine position on the experimental steel board under the water. Whole body except for the face was submerged below the water surface. Measurement indexes were baPWV, heart rate, blood pressure and the scale of a subjective thermal sensation (STSS). Land condition was measured after supine position on land for 5 minutes. Water condition was measured after supine position in water for 5 minutes. Results: baPWV ( $1916 \pm 105$  cm/s), SBP ( $160 \pm 14$  mmHg) and STSS (2=Cool) at water condition was significantly higher than that at land condition (baPWV;  $1771 \pm 69$  cm/s, SBP;  $145 \pm 9$  mmHg, STSS; 0=Neutral,  $p < 0.05$  respectively). Discussion: STSS in water condition showed as 'cool'. SBP and age are potentially influential factors of the baPWV. SBP is determined by cardiac output and arterial elasticity. It was considered that the baPWV was influenced by SBP during supine position in water. Conclusion: Our conclusion is that supine position in water (water temperature: 30 °C) could be contributed to the constriction of a blood vessel of arterial stiffness in the middle-aged.

### EFFECTS OF A BEHAVIOR-ORIENTED EXERCISE INTERVENTION ON ACTIVITY-RELATED SELF-EFFICACY BY OBESE ADULTS

Eckert, K., Lange, M., Huber, G., Wagner, P.

University of Leipzig, University of Heidelberg

Eckert, K.1, Lange, M.1, Huber, G.2, Wagner, P.1 1: University of Leipzig, Institute of Exercise and Public Health (Germany) 2: University of Heidelberg, Institute of Exercise and Sport Science (Germany) Introduction There is enough evidence that physical activity (PA) plays an important part in regulating an un-healthy body weight, but the integration of PA in an individual's everyday life rarely succeeds. Ac-tivity related self-efficacy (SE) has determined to have a long-lasting effect on behavior change (Niermann, 2010). According to the literature SE typically differs in three SE phases: intention, recovery and planning SE (Schwarzer et al., 2008). The aim of our study was therefore to evaluate the effects of a behavior-oriented exercise program regarding the phase-specific self-efficacy by obese people. Method The study was designed as a multi-center, controlled intervention study (treatment group (IG): N=101, control group (CG): N=23) with pre-post testing (t1 and t2). The intervention took place for 10 weeks (1x/week á 90 min.) and combined functional training with elements of patient education and behavior-oriented techniques. Data of physical activity and phase-specific self-efficacy (SE) was assessed by questionnaires at first (t1) and last session (t2). Results The mean BMI of all participants was  $34,12$  kg/m<sup>2</sup> (s=4,52, Range 25,22 – 50,56) at time point t1. 84 complete datasets could be analyzed after intervention (t2). Only participants of the IG with a PA-level of 60-240 min./week at t1 showed significant improvements of their intentional SE at t2 (n=28;  $p < 0.01$ ,  $t = -2,657$ ;  $d = 0,67$ ). Furthermore participants of the IG with initially high levels of SE (in all three phases) at t1 increased their PA level significantly during the intervention (n=50;  $p < 0.001$ ,  $t = -4,145$ ;  $d = 0,67$ ). The CG showed no improvements neither to the intentional SE ( $p = 0,232$ ,  $t = 1,235$ ) nor the physical activity level (n=19;  $p = 0,461$ ,  $t = 0,798$ ). The measurements carried out did not reveal any significant changes in behavior change when comparing the groups (time:  $p = 0,167$ ,  $F = 1,950$ ; interaction time\*group:  $p = 0,182$ ,  $F = 1,851$ ). Discussion Our findings indicate that there is an interrelation between PA-level and phase-specific self-efficacy. Obviously, exercise interventions require a more behavior-oriented emphasis especially for unmotivated people. A replication of the intervention with a larger sample size and a longer, modified intervention-duration needs to be discussed. Literature Niermann C (2010). Vom Wollen und Handeln – Selbststeuerung, gesundheitsrelevantes Verhalten und sportliche Aktivität. Dissertation, Universität Kiel. Schwarzer R et al. (2008). Social-cognitive predictors of physical exercise adherence: Three longitudinal studies in rehabilitation. Health Psychology, 27 (1), 53-63.

### MENSTRUAL STATUS OF ATHLETES AND NON-ATHLETES

Atan, T., Cicek, G., İmamoglu, O.

Ondokuz Mayıs University

MENSTRUAL STATUS OF ATHLETES AND NON-ATHLETES Atan, T.1, Çiçek, G.2, İmamoglu, O.1 1 Ondokuz Mayıs University, Yaşar Doğu Physical Education and Sports High School (Turkey) 2 Hitit University, Physical Education and Sports High School (Turkey) Introduction The menstrual cycle is a complex physiological phenomenon and a major part of every woman's life (Fox et al., 1988). The aim of this study was to examine the menstrual status and feelings of athletes (in different sport branches) and non-athletes. Materials and methods A questionnaire consisting of 21 questions were prepared by researchers in order to obtain age, menarche age, menstrual status, menstrual cycle, menstrual pain, menstrual regularity and feelings throughout menstruation. Questionnaires were applied to participants by face-to-face method. Results In this study non-athletes' reached menarche age earlier than the whole athletes except wrestlers-judokas. Athletes' menstrual status was found more irregular than non-athletes. During the high intensive training, the percentage of regular menstrual cycle (29.7 %) was lower than the normal time (56.6 %). Menstrual cycle was found more irregular during high intensive training than in normal time. The prevalence of menstrual pain is higher in non-athletes. Throughout the menstruation, ratio of non-athletes to feel better about themselves were less than athletes. Discussion In the current study it has been seen that the mean menarche age for total athletes is  $13.78 \pm 1.31$  years. Athletes in certain endurance and aesthetic sports appear to be at an added risk of delayed menarche (Malina, 1979). The menarche age of non-athletes was found 13.04 years. When the status of the menstruation in normal time was examined, 56.6% of athletes and 59.1% of non-athletes had a regular menstrual cycle (once in 21-30days). This means that athletes' menstrual status is more irregular than non-athletes. As a result of a questionnaire 41.6% of athletes and 59.5% of non-athletes have pain all the time. Bayram (2007) have found frequency of dysmenorrhea 59% in athletes and 76% in sedentary women. Throughout the mens, ratio of non-athletes to feel better about themselves were less than athletes. Women who frequently exercised may be to some extent protected

from deterioration of mood before and during menstruation (Choi et al., 1995). References 1. Fox, L.E., Bowers, R.W., Foss, M.L. (1988). The Physiological Basis of Physical Education and Athletics, U.S.A., 379-386. 2. Malina RM, Bouchard C, Shoup RF, Demirjian A, Lariviere G. (1979). Age at menarche, family size, and birth order in athletes at the Montreal Olympic Games. *Med Sci Sports Exerc* 11: 354-358. 3. Bayram GO. (2007). Sporcuların Premenstrual Sendrom Yönünden Sedarer Bayanlarla Karşılaştırılması, *Bakırköy Tıp Dergisi*, 3:104-110 4. Choi, P.Y., Salmon, P. (1995). Symptom changes across the menstrual cycle in competitive sports women exercisers and sedantary women. *British Journal of Clinical Psychology*, 34(3), 447-60.

## WELLNESS EDUCATION IN JAPANESE UNIVERSITIES AND COLLEGES

Mizumura, S.

*Meiji University*

Introduction "Wellness is an active process of becoming aware of and making choices toward a more successful existence."(1) It is apparent that the concept of wellness is not widely spread throughout Japan. The author believes that university and college students should be familiar with the concept before they graduate. Therefore, it is very important to clarify the degree of wellness education at Japanese universities and colleges. To obtain basic data reflecting the spread of the wellness concept among Japanese institutions of higher education, the author investigated the number of Japanese universities and colleges providing courses which address the concept of wellness. Methods According to the previous study(2), the author investigated a total of 1335 websites from 771 universities (803 websites) and 532 junior colleges (532 websites) by using an internet search engine over a two month period. The word "wellness" and a Japanese word corresponding to wellness were selected as search terms. By using "site:" syntax all web pages that contained the search terms were retrieved from each official Japanese University or College website. Three investigators, including the author, separately inspected all web pages retrieved. The obtained data inspected by the three investigators were compiled into a single spreadsheet. Results The main findings of the present study were that only 10.3 and 2.4 percents of the websites from Japanese universities and junior colleges respectively, offered courses which included the word "wellness". The percentage of universities offering the subjects was significantly higher than that of junior colleges. A total of 177 courses contained the word "wellness" in its title or syllabus. Courses were classified into eight fields as follows: Health and physical education, 70.0%; Welfare and Nursing, 9.6%; Tourism, 5.6%; Nutrition, 4.5%; Human life, 4.5%; Psychology, 2.3% and Marketing, 1.1%. An analysis from each syllabus of the 177 courses revealed that 81 courses (45.8%) clearly describe the concept of wellness. Discussion The present study is the first to show how many Japanese universities and colleges provide courses that include the concept of wellness. The results revealed that Japanese universities and colleges offered small number of courses that included the concept of wellness, and the courses consist of many fields of study. These results indicate that the concept of wellness should be more spread in Japanese universities and colleges. The author also believes that Japanese wellness researchers and educators should expand their efforts to spread the knowledge of wellness for Japanese university and college students. References (1) <http://www.nationalwellness.org> (2) Mizumura, S. (2009). An investigative study of wellness education in Japanese universities and colleges. *Wellness Journal*, 5 (1), 38-45.

## INFLUENCE OF BODY MASS AND SKINFOLDS ON SKIN TEMPERATURE THROUGH INFRARED THERMOGRAPHY

Fernández-Cuevas, I.1, Marins, J.2, Ribot Serrano, J.1, Arnaiz Lastras, J.1, Butrageno, J.1, Sillero Quintana, M.1

*Technical University of Madrid (Universidad Politécnica de Madrid)*

Introduction For a correct application of Infrared Thermography (IR) on humans several influence factors should be controlled (Ring & Ammer, 2000). Subcutaneous fat is meant to be one of the most important factors on skin temperature, due to its isolation properties, between the body core and the skin. The aim of this study was to study the relation between body mass, skinfolds and skin temperature in different body areas. Methods A total of 33 male and female were divided according to their BMI classification: being normal weight NW (n=10: 24.9±3.9 yr, BMI 22.2±1.6), overweight OW (n=11: 41.6±7.0 yr, BMI 28.4±1.1) and obese OB (n=12: 37.8±8.5 yr, BMI 32.1±2.0). Skinfold thicknesses at 5 body sites -biceps (BI), triceps (TR), subscapular (SE), abdominal (AB) and thigh (T), all in mm- were measured following the ISAK guidelines with a skinfold caliper (Slim Guide, USA) in order to assess local fat distribution. Skin temperature from participants were recorded by Infrared Thermography (T335, FLYR Systems, Sweden) in a environment-controlled room (Temperature: 22.7±1.6°C; humidity: 44.0±3.2%), following the patterns set by Gomez-Carmona et al. (2010) patent pending protocol. Skin temperatures from 72 Regions of Interest (ROI) were obtained using Termotracker® software. ANOVA test were carried out for averaged temperatures by BMI group, and Pearson correlation test between skinfold thickness and averaged skin temperatures in each body area were calculated (alpha<0.05). Results Skinfolds temperatures for normal weight subjects were NW(TR)=29.3±0.8, NW(SE)=31.7±0.6, NW(T)=29.±1.0, NW(AB)=1.8±0.7; NW(BI)=31.8±0.6; for overweight were OW(TR)=30.1±1.1, OW(SE)=30.5±1.2, OW(T)=30.4±1.4, OW(AB)=30.8±1.5, OW(BI)=31.3±1.1; and for obese were OB(TR)=30.6±1.2, OB(SE)=31.2±1.2, OB(T)=30.2±1.3, OB(AB)=31.1±1.1, OB(BI)=31.7±0.9. ANOVA results show us only significant differences between BMI groups in Triceps (F=4.01; p<0.05) and Subscapular (F=3.42; p<0.05). However, Pearson test correlation results could not establish any significant relationship between local temperature and skinfold thickness. Discussion Some studies have considered that a greater subcutaneous abdominal adipose tissue provides a significant insulation and a cooler temperature (Savastano, 2009). Nevertheless, this BMI-based study could not get that relationship, probably due to the influence of other factors as the time of data collection or aging between BMI groups (Weinert, 2010). Based on our data, we conclude that the BMI classification NW, OW and OB is not related with the thermal response at skin level. Further investigations with a larger sample and more information about adipose tissue (i.e. DXA) are required (Glickman-Weiss, 1996). References Glickman-Weiss, E. L. et al (1996). *Wilderness & Environmental Medicine*, 7(1), 19-27 Gomez-Carmona, P. M.(2010). Spain Patent Pending No. P201031080 Savastano, D. M., (2009). *Am J Clin Nutr*, 90(5), 1124-1131 Weinert, D. (2010). *Ageing Research Reviews*, 9(1), 51-60.

## AN EXAMINATION OF SEDENTARY AND EATING ATTITUDES OF A SPANISH UNIVERSITY POPULATION: THE INFLUENCE OF STUDYING NURSERY ON ITS STUDENTS OWN BEHAVIOUR

Varela, V., Cancela, J.M., Ayán, C.

*Vigo University*

Introduction: Future education and health professionals will be responsible for encouraging physical activity and correct eating habits among the general population. However, it has been noted that the period of undergraduate study is often a phase of change in terms of practice of PA, often reduced<sup>1</sup>, and indeed dietary habits curb to less healthy options<sup>2</sup>, notably among females university students. The aim of this study was to discover the prevalence of physical activity and the existence of eating disorders among Nursing, Physiotherapy

and Education students. Materials and Methods: A transversal descriptive study through a combination of the International Physical Activity Questionnaire and the Eating Attitude Test 40 was directed to students that take part in the aforementioned degrees in the Pontevedra Campus at Vigo University. The data collection took place during a single day in the class with the most registered students for the selected course and academic year through an individual, anonymous and voluntary questionnaire on an "ad hoc" basis. Results: The data showed that 64% of Nursing students and 72% of Teaching students were qualified as sedentary individuals, while 19.5% and 15.3% of them respectively were likely to suffer from eating disorders. A significant association between physical activity performance and disturbed eating behaviours was observed among Education students. Discussion: The practice of PA has been identified as a risk factor linked with the existence of DEA13 among university students<sup>14</sup>, which coheres with the results of this particular study. However, this behaviour was only found to be significant among teaching students, albeit the results that showed that Nursery and Teaching students presented similar health patterns. As a result, it has been recognised that sedentary behaviour and poor dietary habits are linked to students within the vocations of health and education. References: 1. Keating XD, Guan J, Piñero JC, Bridges DM. A meta-analysis of college students' physical activity behaviors. *J Am Coll Health* 2005;54:116-25 2. Raich R, Mora M, Sánchez D, Torras J, Viladrich M, Zapater L, et al.. A cross-cultural study on eating attitudes and behaviours in two Spanish-speaking countries: Spain and Mexico. *Eur Eat Disorders Rev* 2001; 9, 53-63. 3. Jáuregui I, Tomillo S, Santiago M, Bolaños P. Body shape model, physical activity and eating behaviour. 4. Thome JL, Espelage DL. Obligatory exercise and eating pathology in college females: replication and development of a structural model. *Eat Behav* 2007;8:334-49.

**14:45 - 15:45**

## Poster presentations

### PP-PM78 Training & Testing 18

#### EFFECTS OF TRAINING ON 10MIN CYCLING TIME TRIAL PERFORMANCE AND PACING STRATEGY

Martin, D.T.1,2, Barnes, C.1, Bartram, J.1, West, N.1,3, Stephens, J.1, Michaels, S.1, Abbiss, C.2, Halson, S.L.4

1: AIS Physiology (Canberra, Australia), 2: Edith Cowan University (Perth, Australia), 3: Griffith University (Gold Coast, Australia), 4: AIS Performance Recovery (Canberra, Australia)

**Introduction** In sport, the distribution of work over a defined exercise period has been defined as a "pacing strategy." Both teleoanticipation and feedback mechanisms have been suggested to influence pacing (Abbiss and Laursen, 2008). The purpose of this study was to examine the influence of a 3-wk training camp on the pacing of cyclists that improved overall cycling time trial performance (i.e. responders) in order to gain insight into the role teleoanticipation and feedback mechanisms may play in pacing. **Methods** Male competitive cyclists (n=13; 19.9±1.3y, 71.8±5.7kg, maximal aerobic power; 370±36W) completed structured training for 5wks. Cyclists trained for 2-8 hours daily and the program included cycle ergometer sessions 3 d.wk<sup>-1</sup>. Each week participants performed a 10min cycling Time Trial (TT; Wattbike) at the end an interval session. Power was recorded at 1Hz and maximum mean power (MMP10min) was calculated. Responders were defined as cyclists that improved MMP10min 5-15% from baseline with baseline tests within 5%. The Typical Error (TE) was used to estimate reliability. A priori planned contrasts (paired t-tests) were used to compare MMP10min performance and pacing during baseline and best performances. Pacing was quantified by dividing the 10min time trial into 4, 150s segments. Results The TE for MMP10min was 1.4%. The best MMP10min produced in the camp was 8.4±2.9% (mean±90% CI) greater than baseline (362±41W vs 334±37W). The perception of effort and post TT heart rate were similar for baseline and best TT performances (~98%max and ~180-185bpm). On average, the distribution of work for each 150s of the TT10min at baseline and best performance was similar (25%, 25%, 24%, 26%). Following training, the increase in power for each of the four segments (150s) of the TT was 7±3%; 7±2%; 9±2% and 12±3%. **Discussion** Cyclists selected for this analysis produced a large and consistent increase in MMP10min (~8%) during a 3wk training study. The pacing during baseline testing and best 10min TT were similar. The dramatic increase in cycling power (~7%) during the first 150s of the 10min TT, following training supports the concept of teleoanticipation as feedback mechanisms are less likely to be involved. The improvement in power during the final 150s (~12%) with similar peak heart rates and perception of effort, indicates that peripheral feedback mechanisms may be involved in training improvements. Our data support the concept that both feed forward and feedback mechanisms contribute to training induced improvements in time trial performance. Reference Abbiss and Laursen (2008) *Sports Med.* 38(3):239-52.

#### EFFECT OF AEROBIC FITNESS LEVEL ON THE AMPLITUDE OF MODERATE, HEAVY AND SEVERE INTENSITY DOMAINS IN CYCLING

Greco, C.1, Caritá, R.A.C.1, Caputo, F.2, Denadai, B.S.1

1: Human Performance Laboratory - UNESP, 2: UDESC

**Introduction** Exercise intensity domains have been defined based upon their distinct metabolic profiles (Gaesser and Poole, 1996). The moderate domain consists of work rates at or below the lactate threshold (i.e., the first sudden and sustained increase in blood lactate above resting concentrations - LT). The heavy domain includes work rates above LT, but at or below critical power (i.e., the asymptote of the power-duration relationship - CP). The severe domain encompasses work rates above CP in which maximal oxygen uptake (VO<sub>2</sub>max) can be elicited. Endurance training enhances LT, maximal lactate steady state (MLSS) and critical power CP. However, VO<sub>2</sub>max has shown to be less sensible to aerobic training, particularly in well-trained subjects. Thus, the objective of this study was to analyze the amplitude of the exercise intensity domains in cyclists, runners and untrained subjects during cycling. **Methods** Twelve cyclists (EC) (25±5 yr., 67±8 kg, 65±7 ml/kg/min), eleven runners (ER) (27±9 yr., 65±6 kg, 55±6 ml/min/kg) and eight untrained subjects (UT) (24±3 yr., 72±11 kg, 42±4 ml/kg/min), performed the following protocols, in different days, in a cycle ergometer: 1) incremental test to determine the LT, VO<sub>2</sub>max and the intensity associated with the achievement of VO<sub>2</sub>max (IVO<sub>2</sub>max); and (2) constant work-rate running and cycling exercises to exhaustion at 95, 100 and 110% IVO<sub>2</sub>max in order to determine the CP and the highest intensity (IHIGH) at which VO<sub>2</sub>max is reached (Caputo and Denadai, 2008). The amplitude of the exercise intensity domains (i.e., moderate < LT; LT < heavy < CP; CP < severe < IHIGH) was expressed as percentage of the difference between the VO<sub>2</sub> at LT and estimated VO<sub>2</sub> at IHIGH (i.e., %Δ). Results The IHIGH was significantly higher in EC (448.9±34.4 W) than ER (318.7±50.7 W) and UT (257.3±58.9 W). The amplitude of moderate exercise domain

in EC ( $51.7 \pm 7.9\% \Delta$ ) was similar to ER ( $46.7 \pm 4.2\% \Delta$ ) and significantly higher than UT ( $41.2 \pm 6.8\% \Delta$ ). The heavy intensity domain was significantly narrower in EC ( $17.5 \pm 3.5\% \Delta$ ) than UT ( $27.1 \pm 5.6\% \Delta$ ) and ER ( $27.5 \pm 9.1\% \Delta$ ). The amplitude of the severe domain was similar among EC ( $30.9 \pm 6.5\% \Delta$ ), ER ( $26.2 \pm 5.2\% \Delta$ ) and UT ( $31.3 \pm 7.3\% \Delta$ ). Discussion The main finding of our study was that the magnitude of the exercise intensity domains may be influenced by the aerobic status training. Basically, the moderate exercise domain seems to be more sensitive to long-term endurance training in cycling. This can be explained, at least in part, by the greater sensitivity of blood lactate response (i.e., LT) to endurance training. References Caputo F, Denadai BS. (2008). *Eur J Appl Physiol* 103: 47-57. Gaesser GA, Poole DC. (1996). *Exerc Sports Rev* 24: 35-71.

### SPECIFIC PERFORMANCE DIAGNOSTIC IN LABORATORY AND FIELD OF BMX-RACING

Meurer, R., Schmidt, A., Meyer, H., Heine, O., Nüsser, S., Loetzerich, H.

*German Sports University Cologne*

Specific performance diagnostic in laboratory and field of BMX-Racing R.Meurer<sup>1</sup>, A.Schmidt<sup>1</sup>, H.Meyer<sup>1</sup>, H.Loetzerich<sup>1</sup>, O.Heine<sup>2</sup>, S.Nüsser<sup>3</sup> GSU1: (German Sport University, Cologne, Germany), OSP2: (Olympic Base Center Rheinland, Köln, Germany), SNDC3: (Stepahn Nuesser Diagnostic Center, Burscheid, Germany) Introduction: BMX Racing is an Olympic discipline and the BMX Sport is experiencing more attention. There is not much detailed information available about the sport specific requirements and the common performance tests are mostly transferred from road and track cycling. Method: Six high level BMX riders (mean  $\pm$  SD: 16,2 yrs  $\pm$  1,2, 65,2 kg  $\pm$  5,1, 178 cm  $\pm$  0,01cm) performed a performance test in the laboratory with the individual BMX bike position (standing up). Therefore the bicycle ergometer was adjusted to transfer the individual bike setup on to the ergometer. First step was a standardised warm up, with a step-wise increase of the resistance (watt), for 15 min. The test was performed until 200 watt was reached, mean lactate levels after the warm up were 1,92 mmol/l  $\pm$  0,25. Step two was a BMX start simulation, where the riders had to sprint for 5 sec., set up and resistance of the ergometer were similar to the start on a BMX bike. Peak Power Start (PPS) was 1311 w  $\pm$  154.17. Third step of the test protocol was a 15 sec. sprint test which is similar to the active exercise time on a BMX track. The test was accomplished in a isokinetic mode with a limit of rpm to determine Peak Power (PP). After the test, lactic acid was measured, regularly over 10 min to determine peak lactic values (PL). PP was 1283,75 w  $\pm$  135,44. PL was 7,43 mmol/l  $\pm$  1,59. To compare our data's from the laboratory we measured PP and PL on a BMX track with portable power meter system. After one lap under race conditions PP was 990 w  $\pm$  178,9. Mean power over the first 5 sec at the start (MPS) was 427,90 w  $\pm$  132,65. PL was 5,81 mmol/l  $\pm$  1,12. Results: The results of the BMX performance test show very assimilable results to the data we measured on the BMX track with mobile powermeter systems. PP, LP in the laboratory was for all riders higher than on the track. The order of the measured values in the comparison of laboratory to track was significant. The order of PPS, MPS, PP, PL were identical. The rider with the highest values in the laboratory also had the highest values on the track, same structure for all riders. Discussion: The purpose of this project was to develop a test protocol for a BMX specific performance diagnostic in the laboratory. In our BMX performance test protocol we are able to investigate the rider's individual performance and requirements of BMX racing performance under standardised conditions in the laboratory. The individual structure of the riders peak power, start power and lactic acid production are reflecting very closely the individual physiological performance on the track.

### THE ACUTE EFFECT OF WHOLE-BODY VIBRATION ON CYCLING PEAK POWER OUTPUT

Hill, C.

*University of Worcester*

Introduction The application of an acute bout of whole-body vibration (WBV), whereby athletes stand on a vibrating platform prior to exercise, has been shown to increase short-term anaerobic leg power (Cardinale & Lim, 2003; Cochrane & Stannard, 2005; Torvinen et al., 2002). The use of WBV has not, for the majority of cases, been applied to a sport specific event. The purpose of this study was to determine if WBV, included as part of a warm-up, will increase peak power output during standing sprint cycling. Methods Ten experienced cyclists performed two separate performance tests comprising of a ten second standing sprint on a cycle ergometer. Preceding both performances participants performed a ten minute cycling warm-up. In one of the two warm-ups participants were also exposed to a two minute bout of WBV after the cycle specific warm-up. Results No significant difference was found for peak power ( $p = 0.17$ ), time to peak power ( $p = 0.47$ ), peak cadence ( $p = 0.46$ ) and time to peak cadence ( $p = 0.18$ ) between trials. Discussion The main finding from this study is that the use of WBV prior to maximal sprint cycling does not increase peak power output. The repeated eccentric – concentric action that skeletal muscle undergoes during WBV may not be an appropriate intervention for the predominant concentric only activity of cycling (Cochrane et al., 2008). Previous successful intervention studies have utilised exercises that incorporate the stretch-shortening cycle during eccentric – concentric activity such as a countermovement jump (Cardinale and Lim, 2003; Cochrane and Stannard, 2005; Cormie et al., 2006; Torvinen et al., 2002). The results suggest that WBV does not affect the concentric only action of cycling. References Cardinale M, Lim J. (2003). The acute effects of two different whole body vibration frequencies on vertical jump performance. *Med Sport*, 56, 287-292 Cochrane DJ, Stannard SR. (2005). Acute whole body vibration training increases vertical jump and flexibility performance in elite female field hockey players. *Br J Sports Med*, 39(11), 860-865 Cochrane DJ, Stannard SR, Sargeant A, Rittweger J. (2008). The rate of muscle temperature increase during acute whole-body vibration exercise. *Europ J Appl Physiol*, 103(4), 441-448 Cormie P, Deane RS, Triplett T, McBride JM. (2006). Acute effects of whole-body vibration on muscle activity, strength and power. *J Strength Cond Res*, 20(2), 257 – 261 Torvinen S, Kannus P, Sievanen H, Jarvinen TAH, Pasanen M, Kontulainen S, Jarvinen TLN, Jarvinen M, Oja P, Vuori I. (2002). Effect of a vibration exposure on muscular performance and body balance. *Randomized cross-over study. Clin Physiol Funct Imaging*, 22(2), 145-152

### CHANGES IN ENDURANCE PERFORMANCE DUE TO AN ULTRA-NON-STOP CYCLING RACE – A SINGLE CASE STUDY

Wallner, D.1, Simi, H.1, Konrad, M.1, Hofmann, P.2

1: FH JOANNEUM Univ. Appl. Sci., 2: Karl-Franz.-Univ. and Med. Univ. Graz

Ultra-long distance exercises lead to changes in energy metabolism (Henrikson, 1991; Volk & Neumann, 2000) and hemodynamic variables which probably effect heart rate behavior (Pokan et al., 2011). These changes may influence endurance performance. Aim of this study was to analyze the effect of a 27 h non-stop cycling race on endurance performance. Method: One trained male cyclist ( $VO_{2max}$ : 59.1 ml/kg/min) performed an incremental exercise test before (T1) and after (T2) a 27:17 h (718 km, 8000 m difference in altitude) non-stop cycling race across Austria (Trans-Austria). During incremental test heart rate (HR) was measured continuously and blood lactate concentration (La) was measured at rest and after every load step (increments: 20 W every minute). Heart rate turn point (H RTP), first (LTP1) and

the second (LTP2) lactate turn point were defined as reported by Hofmann et al. (1997). Results: Average race speed was 26.3 km/h with an energy consumption of about 6300 kcal. Maximal power output (Pmax) was 400 W (T1) and 300 W (T2), respectively. La and HR at Pmax were 9.7 mmol/l (T1) and 2.9 mmol/l (T2), 199 min<sup>-1</sup> (T1) and 150 min<sup>-1</sup> (T2), respectively. No difference was found in the La performance curve till subjective exhaustion, whereas HF showed an increasing reduction with work load in T2. HRTP and LTP2 could not be defined in T2. Power output and La at LTP1 were unchanged (212 W (T1) and 210 W (T2), 0.7 mmol/l (T1) and 0.9 mmol/l (T2), respectively) whereas HF was reduced by 12.3% (155 min<sup>-1</sup> (T1) and 136 min<sup>-1</sup> (T2), respectively). Conclusion: Low pace aerobic endurance performance remains unchanged after ultra-non-stop cycling races whereas the corresponding HR markedly decreased. Therefore, exercise intensity regulation during ultra-long distance exercises should not be based on HR. References: Pokan et al. (2011) Heart rate behaviour and changes in hemodynamic variables during 24h continuous cycling ergometer exercise. *Med Sci Sports Exerc* 43 (5), 653-654 Henriksson (1991) Effect of exercise on amino acid concentrations in skeletal muscle and plasma. *J Exp Biol* 160, 149-165 Hofmann et al. (1997) Heart rate performance curve during incremental cycle ergometer exercise in healthy young male subjects. *Med Sci Sports Exerc* 29 (6), 762-768 Volk & Neumann (2000) Verhalten ausgewählter metabolischer und hormoneller Parameter während eines Dreifachlangtriatlons. *Österr J Sportmed* 4, 18-23

## THE EFFECT OF MAXIMAL AND SUB MAXIMAL STRENGTH TRAINING ON CYCLING ENDURANCE PERFORMANCE

Smit, A.1, Hameetman, C.W.1, Peters, T.1, Bastiaans, J.J.2

1: NOC\*NSF (Arnhem, the Netherlands), 2: KNWU (Nieuwegein, the Netherlands)

**INTRODUCTION** Cyclists feel reluctance to do maximal strength training (ST) because they fear for negative effects on cycling endurance performance. However, recent studies showed positive effects of maximal ST on endurance cycling performance. Therefore, the aim of the study was to compare the effects of a maximal and sub maximal ST program on cycling performance in elite cyclists. **METHODS** Seventeen highly trained cyclists (20.0±1.6 years old) were divided in two training groups. that performed a maximal or sub maximal ST program, twice a week for two blocks of four weeks concurrent to cycling endurance training. Changes in average power at 80% and 90% of the maximal heart rate (P80% and P90%) and total work (TW) and critical power (CP) were assessed in two consecutive tests. Between-group effects were determined with inferences based on a meaningful difference of 6% and 3% for P80% and P90% respectively and a smallest worthwhile change of 1% for time trial performance and standardized changes for road races for TW and CP. A Students T-test was used to establish within-group differences. **RESULTS** There were "likely positive" between-group differences for mean changes in the P90% (6.3%; 90% confidence limits, ±6.3) in favour of the sub maximal training group, with only a significant increase in P90% for the sub maximal group (p=0.011). Between-group differences for mean changes in P80%, W and CP were "unclear". T-tests revealed significant improvements in TW (p=0.019 and 0.030) and CP (p=0.022 and p=0.028) for the sub maximal and maximal group respectively from pre- to post-test. **DISCUSSION** The findings show that sub maximal ST, when performed concurrent to cycling endurance training, results in a greater improvement in sub maximal cycling performance than maximal ST. Earlier studies showed that replacing a portion of endurance training with sub maximal ST compared to only endurance training could maintain high intensity cycling performance (Bastiaans et al., 2001), while recent studies suggest that adding heavy-resistance ST improves endurance cycling performance (Aagaard et al., 2011; Rønnestad et al., 2010). Although concurrent strength and endurance training have a negative effect on each other (Rønnestad et al., 2011), the combination increases cycling performance more than one type of training alone. Our study suggests that cycling endurance training can best be combined with sub maximal ST instead of maximal ST to increase cycling performance. **REFERENCES** Aagaard P et al. (2011). *Scand J Med Sci Sports*. Dec;21(6):e298-307. Bastiaans JJ et al. (2001). *Eur J Appl Physiol*, 86, 79-84. Rønnestad BR et al. (2010). *Scand J Med Sci Sports*, 21(2), 250-259. Rønnestad BR et al. (2011). *Eur J Appl Physiol*, Online First, 11 Aug 2011.

## COMPARISON BETWEEN LOW VS HIGH CADENCE INTERVAL TRAINING SESSIONS

Bosio, A., Induni, M., Menaspà, P., Morelli, A., Tornaghi, M., Carlomagno, D., Rampinini, E.

*Mapei Sport Research Centre*

**COMPARISON BETWEEN LOW VS HIGH CADENCE INTERVAL TRAINING SESSIONS** Bosio A.1, Induni M.1, Menaspà P.1,3, Morelli A.1, Tornaghi M.1, Carlomagno D.1, Rampinini E.1,2 1MAPEI Sport Research Centre (Castellanza, Italy) 2Faculty of Exercise Sciences, Milan University (Milan, Italy) 3AIS, (Canberra, Australia) **Introduction** SFR (uphill pedaling at low rpm) is a type of interval training (IT). High cadence cycling achieves higher cardio-respiratory and metabolic responses than low cadence, but decreases neuromuscular properties to the same extent (Hirai et al. 2010; Lepers et al., 2001). Low compared to high cadence IT seems a better strategy to improve uphill and flat time trial performance. Aim of the study was to compare the acute effects of two IT sessions. **Methods** Low (35rpm, SFR) and high (115rpm, HC) cadence IT sessions (8x4min 2min rec) were carried out on 2 days. Workload was 64±2% of the aerobic peak power output. Heart rate (HR), oxygen uptake (VO<sub>2</sub>), blood lactate (La), and RPE were monitored. Quadriceps peak torque (PT), maximal rate of torque development and relaxation (MRTD, MRTR) were assessed by single (ST) and paired stimuli at 10 Hz (DB10) and 100 Hz (DB100). Maximal voluntary contraction (MVC) and activation (VA) were also noted. Measurements were performed at baseline (PRE), 5 and 20min after each session (POST5, POST20). Repeated measures ANOVA was used for analysis. **Results** SFR determined lower (p<0.05) HR (140±13 vs 149±7), VO<sub>2</sub> (2.664±0.297 vs 2.797±0.264), La (1.5±0.7 vs 2.4±1.1) than HC. RPE was similar (3.7±1.1 vs 3.7±1.2, p=0.734). MVC and VA decreased at POST5 (-9.5±6.7% and -3.9±5.0%; p<0.05) in SFR and HC, only VA recovered at POST20. PT ST decreased similarly at POST5 and recovered at POST20 only in HC (SFR: 49±8, 31±8, 41±8 Nm; HC: 48±7, 33±7, 46±8 Nm respectively at PRE, POST5, POST20; p=0.021). MRTD ST and DB10 (p<0.05) decreased similarly at POST5 but recovered at POST20 only in HC. MRTR DB100 decreased at POST5 and did not recover at POST20 just in SFR (1.14±0.31, 0.91±0.23, 1.03±0.19 and 1.19±0.31, 1.11±0.23, 1.19±0.24 N•m-1•ms-1 SFR, HC and PRE, POST5, POST20 respectively; p<0.05). **Discussion** The locus of exercise-induced fatigue is not central. The decreased MRTR DB100 and the non-recovery of PT and MRTD ST at POST20 support a more likely peripheral origin of fatigue during SFR, even with a lower physiological strain than HC. For each stroke, average torque is ~200% higher and applied for three times longer during SFR than HC. A greater blood flow restriction caused by a high level of muscle contraction (Lollgen et al., 1980) might be a reason for the greater peripheral fatigue induced by SFR. **References** Hirai, D. M., B. T. Roseguini, Diefenthaler, F., Carpes, F. P., Vaz, M. A., Ferlin, E. L., Ribeiro, J. P., Nakamura, F. Y. *Int J Sports Med* 31(8): 529-36. Lepers, R., G. Y. Millet, Maffiuletti, N. A. (2001). *Med Sci Sports Exerc* 33(11): 1882-8. Lollgen, H., T. Graham, Sjogaard, G. (1980). *Med Sci Sports Exerc* 12(5): 345-51.

## EFFECT OF MUSCLE SIZE ON CRANK FORCE GENERATION CAPACITY DURING CYCLING EXERCISE IN MALE.

Tanaka, S.1, Hiratsuka, K.1, Teshima, T.1, Kumagawa, D.2, Tsunoda, N.1

1: Kokushikan University. 2: Japan institute of Sports Science.

**Introduction** Anaerobic power generation capacity is important factor in athletic performance. Its power output capacity in cycling exercise affected by crank force was reported previously. Whereas, it was not cleared that the muscle thickness on lower limbs effect to the crank force during cycling exercise due to maximum efforts. Therefore, the purpose of this study was to investigate effect of muscle size on crank force generation capacity during cycling exercise in male. **Methods** The subjects were 37 varsity males. Muscle thickness in anterior, lateral and posterior of the thigh and that of anterior and posterior lower leg muscles were measured using the B-mode ultrasound method. The anaerobic power and crank force generation capacity were measured by a cycling ergometer with costume made measurement-analysis system. The all subjects performed the cycling exercise for ten seconds with maximal effort intermitted between three-step loads. The initial load was 6.0%kp, second load was 9.0%kp, third load was 12.0%kp to the body mass. **Results** Significant correlation was obtained between anaerobic power and crank force in all the cycling exercise. The ratios of anaerobic power to the crank force on initial and second loads were significantly higher than that of third load. The angular velocities of the crank were changed due to number of pedaling time in all the cycling exercise. However, changes of angular velocity due to number of pedaling time differed by the loads. The muscle thicknesses of the lower limb were closely related to the peak crank force in all the cycling exercise. In initial and second loads, muscle thickness were effect to the change ratio of crank force. **Discussion** In this study, it was cleared that characteristics of crank force generation capacity in cycling exercise. In addition, significant correlation was observed between muscle thickness and crank force. Moreover, muscle thickness was closely related to the change ratio of crank force from first pedaling to the seventh pedaling. From these results, it was suggested that muscle size of the lower limb was affect crank force generation capacity in cycling exercise. **References** Hintzy F, Belli A, Grappe F, Rouillon J. (1999). *Eur. J. Appl. Physiol.*, 79, 426-432 Martin J M, Wadner B M, Coyle E F. (1997). *Med. Sci. Sports Exerc.*, 29, 11, 1505-1512. Samozino P, Horvais N, Hintzy F. (2006). *Med. Sci. Sports Exerc.* 39, 4, 680-687.

## VO2 KINETICS DURING CYCLING AT CRITICAL POWER UNTIL EXHAUSTION BY TRAINED AND UNTRAINED SUBJECTS

Pessoa Filho, D., Caritá, R.A.C., Greco, C.C., Denadai, B.S.

São Paulo State University

**VO2 KINETICS DURING CYCLING AT CRITICAL POWER UNTIL EXHAUSTION BY TRAINED AND UNTRAINED SUBJECTS** Pessoa Filho, D.M. 2, Caritá, R. A. C. 1, Greco, C. C. 1, Denadai, B. S. 1 1: UNESP (Rio Claro-SP/Brazil), 2: UNESP (Bauru-SP/Brazil) **Introduction** The cycling intensity at critical power (PC) has been considered the upper boundary of the heavy exercise domain, which is characterized by the occurrence of an additional slow component of the VO<sub>2</sub> (CL) to the primary amplitude, without reaching its maximum rate (VO<sub>2</sub>max). Above PC (severe domain), time to exhaustion is shortening as soon as VO<sub>2</sub>max is reached by continuous increasing of the CL. Investigations outlined with untrained individuals exercising at heavy domain rarely was carried out until exhaustion takes place. Thus, the objective was to analyze the VO<sub>2</sub> kinetics in subjects with different aerobic training status, cycling at CP until volitional exhaustion. **Methods** Six trained cyclists (GT) and seven non-trained subjects (UNT) performed the following protocols in a cycle ergometer: (a) progressive test until voluntary exhaustion to determine VO<sub>2</sub>max and the intensity at VO<sub>2</sub>max (IVO<sub>2</sub>max); b) three constant workload tests until voluntary exhaustion at 95, 100 and 110% IVO<sub>2</sub>max to determine CP, and; (c) constant workload test at 100%CP until exhaustion takes place. The tests were performed in different days. The breath-by-breath VO<sub>2</sub> data was used to analyze the VO<sub>2</sub> responses to high-intensity exercise transition, which was fitted by a bi-exponential model. The initial cardiodynamic component will be ignored. Differences between groups means were analyzed by independent T-test, with significance level of 0,05. **Results** CP was significantly higher for GT (319.8+/-33.8W) than UNT (197.1+/-38.9W) when expressed as absolute value, but not when expressed as percentage of IVO<sub>2</sub>max (GT: 84.4+/-0.05%IVO<sub>2</sub>max and UNT: 83.2+/-0.03%IVO<sub>2</sub>max). The slow component VO<sub>2</sub> was significantly higher for GNT in absolute value (GT: 342.4+/-165.8ml.min<sup>-1</sup> and UNT: 571.3+/-170.1ml.min<sup>-1</sup>), as well as when expressed relatively to VO<sub>2</sub> increasing during the exercise (GT: 10.0+/-4.6% vs. UNT: 26.6+/-7.3%). The end VO<sub>2</sub> expressed as absolute value (GT: 3912.5+/-321.1ml.min<sup>-1</sup> vs. UNT: 2806.7+/-581.5ml.min<sup>-1</sup>) and relative value to VO<sub>2</sub>max (GT: 89.8+/-8.4% vs. UNT: 97.4+/-2.8%) were also significantly different between groups. **Discussion** For UNT, the end VO<sub>2</sub> was similar to VO<sub>2</sub>max, showing that the exercise for UNT group was severe, since it allowed subjects to attain VO<sub>2</sub>max. GT did not attained VO<sub>2</sub>max, but the time to exhaustion at CP was similar between groups (GT: 1177•402s vs. UNT 1400•506s). If CP had not be overestimated for UNT, it can be concluded that tolerance to exercise at CP is not modified by training status, but might determine different responses of VO<sub>2</sub>. **References** Jones AM, Grassi B, Christensen PM, Krstrup P, Bangsbo J, Poole DC. (2011). *Med Sci Sports Exercise*, 43 (11), 2046-2062. Jones AM, Vanhatalo A, Burnley M, Morton RH, Poole DC. (2010). *Med Sci Sports Exercise*, 42 (10), 1876-1890.

## NEURAL ADAPTATION TO PLYOMETRIC TRAINING

Behrens, M., Mau-Moeller, A., Pohlentz, B., Bruhn, S.

University of Rostock

**Introduction** Plyometric training (PT) is a popular form of physical conditioning of healthy individuals and patients, e.g. people suffering from osteoporosis. It has been shown that PT has the ability to increase maximum voluntary contraction (MVC) and rate of force development (RFD) (Markovic et al., 2010). Although numerous studies examined the effects of PT on MVC and RFD, only a few studies focused on the possible neuromuscular mechanisms. Therefore, we investigated the contribution of neuromuscular adaptations to strength changes after PT. **Methods** Twenty subjects, including 7 controls, volunteered for the study. Data were obtained before and after PT. The experimental group trained twice a week for 8 weeks. PT included countermovement jumps (CMJ), squat jumps (SJ) and drop jumps. We measured jump height in CMJ and SJ as well as isometric maximum voluntary torque (iMVT), normalized root mean square of the EMG signal during iMVT ( $\sum$ RMS-EMGiMVT/Mmax), voluntary activation (VA) and twitch contractions (TC) of the quadriceps muscle. Furthermore, we evaluated rate of torque development (RTD), impulse (IMP) and  $\sum$ RMS-EMG/Mmax in four 50 ms time windows (0-50 ms, 50-100 ms, 100-150 ms, 150-200 ms). The measurements were performed in two knee angles, i.e. 80° and 45° (0° = full extension). Transcutaneous femoral nerve stimulation (single and doublet stimulation) was used to produce TC. VA was assessed using the interpolated twitch technique. %VA was calculated with the formula:  $(1 - (\text{superimposed twitch} \times (\text{Tb}/\text{iMVT}) / \text{control twitch})) \times 100$ . Paired t-tests were used for statistical analyses ( $p \leq 0.05$ ). **Results** Jump height in SJ (+7.3%), iMVT (+8.9%),  $\sum$ RMS-EMGiMVT/Mmax (+26.1%), VA (+3.4%) and RTD, IMP as well as  $\sum$ RMS-EMG/Mmax in the four time windows were significantly increased after PT at the knee angle of 80°. Jump height in CMJ, TC at 80° of knee flexion and all parameters at 45° of knee flexion did not change significantly. No differences in any parameter could be observed in the control group. **Discussion** The increased iMVT, RTD and IMP, in the four respective time windows, at 80° of knee

flexion could be explained by an enhanced neural drive to the quadriceps muscle, as evidenced by increases in VA,  $\Sigma$ RMS-EMGiMVT/Mmax and  $\Sigma$ RMS-EMG/Mmax. This is in line with results of other studies that reported an increased MVC and RFD after PT (Saez-Saez de Villarreal et al., 2010). Data suggest that the neural adaptation was knee angle specific because parameters at 45° of knee flexion did not change. The strength gains probably contributed to the enhanced jump height in SJ. Adaptations at the muscle level seem unlikely because the parameters of TC did not change. References Markovic G, Mikulic P (2010). *Sports Med*, 40, 859-95. Saez-Saez de Villarreal E, Requena B, Newton RU (2010). *J Sci Med Sport*, 13, 513-22.

### RATE OF FORCE DEVELOPMENT DURING ISOMETRIC KNEE EXTENSION AT DIFFERENT KNEE JOINT ANGLES

Kobayashi, Y., Akagi, R., Hirayama, K., Hirano, Y.

*Japan Institute of Sports Sciences*

Introduction Measurement of the rate of force development (RFD) during maximal voluntary isometric knee extension has been performed at various knee joint angles, including 70° (Aagaard et al., 2002) and 90° (Blazevich et al., 2008) of knee flexion (full extension = 0°). However, the difference in RFD among various knee joint angles remains unclear. Therefore, the aim of the study was to determine the difference in RFD during maximal voluntary isometric knee extension between two knee joint angles. Methods Eighteen healthy adults participated in the study. Maximal voluntary isometric knee extensions of the right leg were performed at 70° or 90° knee flexion using an isokinetic dynamometer (Biodex System3, New York, NY, USA). Each subject performed three maximal isometric knee extensor contractions at each angle. Each contraction was sustained for approximately three seconds and the subjects were instructed to extend their knee "as fast and as hard as possible". For each trial, the dynamometer torque signal was sampled at 2000Hz. All torques were corrected for the effect of gravity on the lower leg. The participants were divided into a stronger (n = 9) or weaker (n = 9) group based on the mean value of the maximum torque at 70° and 90° knee flexion. Results In the stronger group, maximal torque and RFD were not significantly different between 70° and 90° knee flexion. However, in the weaker group, maximal torque and RFD at 70° were significantly greater compared with 90° knee flexion (P < 0.05). Discussion The results suggest that maximal, isometric knee extension strength and RFD at 70° are greater than at 90° knee flexion in relatively weaker individuals. Therefore, when evaluating maximum isometric strength and RFD, we should take into account differences in strength when selecting the knee joint angle that is going to be assessed. References Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P. (2002). *J Appl Physiol*, 93(4), 1318-1326. Blazevich AJ, Horne S, Cavanaugh D, Coleman DR, Aagaard P. (2008). *Muscle Nerve*, 38(3), 1133-1146.

**14:45 - 15:45**

## Poster presentations

### PP-PM79 Training & Testing 19

#### PERCEPTION OF EFFORT DURING LOCAL AND GENERAL EXERCISE IN JUDOKAS

Invernizzi, P.L., Michielon, G., Longo, S., Scurati, R.

*Università degli studi di Milano*

Introduction In judo combats, the physiological demand involve both the aerobic (to sustain effort for the duration of the combat) and the anaerobic systems (to provides the short, quick, all-out bursts of maximal power) (Franchini et al, 2003). The perceived exertion of the effort can be assessed, with respect to various features of effort (i.e. general, cardiopulmonary and of the lower limbs fatigue), through ratio-scales methods (Noble, 1996). This study in judokas aimed to analyze the perception of the effort during local and general exercise, at a high intensity. Methods Ten competitive judokas (19.9±4.7 years, 65.2±8.7 kg, 171.9±6.4 cm, 21.98±1.82 kg/m<sup>2</sup>) participated in the study. At a distance of 4 days, subjects performed following fatiguing tasks: i) push-up (PU), as exercise for upper limbs; ii) vertical jumps from deep squat (VJ), as exercise for lower limbs; iii) alternating push-up and vertical jump (PU-VJ) as global exercise. To ensure the raise of fatigue during the tasks, subjects performed five trials, in which the exercise stopped as the set pace was no longer held, one minute of recovery among trials. Perceived exertion of muscular and respiratory efforts were surveyed by CR10 scale and heart rate was also collected. Results Heart rate was significantly lower in PU than in VJ and PU-VJ (p<0.01, 156.4±4.7 vs. 172.0±3.0 and 179.7±1.8, respectively). VJ was lower than PU-VJ (p<0.05, 172±3.0 vs. 179.7±1.8). The perception of the muscular effort was lower in PU-VJ than in PU and VJ (p<0.05, 7.2±0.5 vs. 8.3±0.6 and 8.2±0.5, respectively) whereas no difference was found (p>0.05) between PU and VJ. The perception of the respiratory effort was lower in PU than in VJ and PU-VJ (p<0.01, 3.9±0.3 vs. 5.9±0.3 and 7.6±0.3, respectively). VJ was lower than PU-VJ (p<0.05, 5.9±0.3 vs. 7.6±0.3). Discussion The scale of the effort has been defined by heart rate variation. The heart rate during the tasks related to the volume of the muscular mass involved during each exercise, growing in this sequence: PU, VJ and PU-VJ. Muscular fatigue was highly perceived after local effort (arms or legs only) than after global exercise. This could be due to the wider recovery between the successive muscular contractions that in PU-VJ would be induced by the alternating actions of arms and legs, unlike in PU or VJ. On the contrary, the respiratory fatigue highly addressed to the volume of the muscular mass involved in the exercise, that is to the metabolic engagement. References Franchini E, Nunes AV, Moraes JM, Del Vecchio FB (2007). Physical fitness and anthropometrical profile of the Brazilian male judo team. *Journal of Physiological Anthropology*. 26 (2): 59-67. Noble BJ, Robertson RJ (1996). Perceived Exertion. Human Kinetics Publishers. Champaign (IL).

#### DIFFERENCES ANALYSIS IN SITUATIONAL EFFICIENCY OF WINNERS AND DEFEATED FIGHTERS AT THE INTERNATIONAL BOXING TOURNAMENT

Kapo, S., Fetahovic, Dz., Cutuk, H., Zoranic, J.

*Faculty of Sports and Physical Education, University of Sara*

Introduction Success in boxing is defined by the level and structure of a large number of abilities, knowledge, and characteristics which can be measured and analyzed, and then improved during the sports carrier with adequate means and methods (Kapo, 2005). Main goal is identification of parameters of situational efficiency of fighters based on the registration of events during a tournament, using a set



of technical and tactical elements applied by winners and defeated fighters at the boxing tournament "Zlaten Gong 2010" in Skopje. Methods The sample of analyzed fighters comprised of 56 representative competitors. The information was gathered based on video records of 28 fights / 18 semi-final and 10 final fights/. The collected data were processed using descriptive statistics. Results and discussion The basic descriptive parameters indicate that the total frequency of punches at this boxing tournament was 4,269, or 53.2%, for the winners, while for the defeated fighters it was 3,755, or 46.8%, of the total number of applied hand technical elements during fights. The winners were dominant in the application of direct punches to the head, with 2,682, or 63%, while the defeated fighters had only a somewhat higher frequency of applied uppercut punches to the head, namely 157, or 4%. The application of defensive techniques is on the side of defeated fighters, with a total frequency of 1,949, or 53%, while winners had a frequency of 1,665, or 47%. The winners applied a larger number of defense techniques against uppercut punches, 285 or 8%, than the defeated fighters, most probably due to the reason that the defeated fighters more frequently applied uppercut punches. The frequency of used offensive tactics and attacking techniques by the winners was 15, or 26.7%, which most probably contributed to their win, while the defeated fighters used defensive and combined tactics, which is confirmed by the fact that they applied defensive techniques more often than offensive techniques. A significant frequency of knock-downs was displayed by winners, namely 13, or 93%, while the defeated fighters only had one knock-down, or 7%, at the tournament. Conclusion The analysis of the differences in application of technical and tactical elements between the winners and defeated boxers, indicate that the winners used all hand techniques, and applied mostly offensive tactics, more than the defeated boxers. References Kapo, S., Kajmović, H., Čutuk, H., Beriša, S.: – Representation of Technical and Tactical Elements in Boxing Based on the Analysis of the "15th BiH Individual Boxing Championship" (Zastupljenost tehničko-taktičkih elemenata u boksu na osnovu analize "XV pojedinačnog prvenstva BiH u Boksu"), Homosporticus, 2008

### FEMALE OLYMPIC WRESTLING: PHYSICAL FITNESS MARKERS AND GENDER DIFFERENCES

Torres-Bonete, M.D., López-Gullón, J.M., De la Cruz-Sánchez, E., Izquierdo, M., Pallarés, J.G.

*University of Murcia*

Introduction Although female wrestling has received minor research attention, in male participants few studies examined differences in physical fitness and anthropometrical markers between successful and less successful wrestlers (García-Pallarés et al., 2010). These data have been of great importance for optimizing training programs, talent selection and weight cutting strategies for Greco-Roman and Freestyle male wrestlers (Horswill, 1992). Therefore, the first aim of this study was to investigate which anthropometric, physiological and neuromuscular factors are different between elite and amateur female wrestlers. Our second aim was to compare physical fitness markers between these elite female and those of a recent study conducted in our laboratory with elite male wrestlers. Methods Thirty five female wrestlers were assigned into 4 groups according to their body mass (light and middle weight) and their competitive level (elite and amateur): Light Weight (49-58 kg) in elite (LWE, n=6) and amateur (LWA, n=12) level; and Middle Weight (58-67 kg) in elite (MWE, n=7) and amateur (MWA, n=10) level. A binary logistic regression analysis was performed to identify which variables better predict female wrestling successes. Results Elite female wrestlers were older (8%-10%), had more training experience (27%-29%), fat free mass (FFM) (3%), maximum strength in absolute and allometrically scaled values (13%-33%), maximal muscle power (16%-34%), anaerobic capacity and power in absolute and allometrically scaled values (17%-23%) compared to amateur wrestlers ( $p < 0.05$ ). Discussion Based on the logistic regression analysis, FFM and 1RM strength were the most important factors of successful female wrestling performance. These results may suggest that the higher absolute and normalized maximum strength, muscle power and anaerobic metabolism, although explained in part by the differences in FFM, will give elite female wrestlers a clear advantage during Olympic wrestling compared to amateurs. When these results and those of a recent study performed in our laboratory with elite male wrestlers (García-Pallarés et al., 2010) were compared, elite females presented lower ( $p < 0.05$ ) physiological and neuromuscular values even when these data were normalized using allometric methods. In addition to differences in the FFM, other sex distinctions such as hormonal, enzymatic and/or neural activations patterns could be related to the physical fitness performance differences between genders (Weber et al., 2006). References García-Pallarés J, López-Gullón JM, Muriel X, Díaz A, Izquierdo M. (2011). *Eur J Appl Physiol*, 111, 1747-1758. Horswill CA. (1992). *Sports Med*, 14: 114-143. Weber CL, Chia M, Inbar O. (2006). *Med Sci Sports Exerc* 38, 129-137.

### ANALYSIS OF THE DIGIT RATIO ASSOCIATION WITH SUCCESS IN OLYMPIC WRESTLING

Torres-Bonete, M., Pallarés, J.G., López-Gullón, J.M., De la Cruz-Sánchez, E.

*University of Murcia*

Introduction The second-to-fourth digit ratio (2D:4D) has been reported to be negatively correlated with sport performance in male and female athletes across a variety of endurance and team sports (Manning and Taylor, 2001), even when physical factors and effort, cognitive, and personality variables are controlled (Testern and Campbella, 2001). Therefore, the aim of this study was to analyse the contribution of the 2D:4D to success in Olympic wrestling. Methods A total of 180 wrestlers that took part in the 2011 Spanish Wrestling Championship, in one of the three Olympic wrestling styles, participated in the study: Greco-Roman Male (GRM), n = 60; Freestyle Male (FSM), n = 72; and Freestyle Female (FSF), n = 48. According to the tournament results, two different competitive levels (i.e., successful and non-successful) were established in each wrestling style and weight category for subsequent comparisons. Successful groups of wrestlers were formed from the four medal winners (i.e., 1st, 2nd, and the two 3rd classified) in each of the 7 weight categories for both male styles (GRM and FSM) and the female style (FSF). Prior to competition, wrestlers were interviewed about their years of training experience and their hands were scanned. 2D:4D was calculated using computer-assisted image analysis (Allaway et al., 2009). A multinomial logistic regression coefficient to calculate odd ratios (OR's) and 95% confidence intervals (CI's) were established to determine the contribution of 2D:4D and training experience to success in Olympic wrestling. Results We found differences between genders and we could determine that 2D:4D was greater in men than women in both hands (right hand t-test  $p=0.009$ ,  $t=-2.63$ ; left hand t-test  $p=0.015$ ,  $t=-2.45$ ). There were no differences between successful and non-successful wrestlers in 2D:4D in any wrestling style (GRS, FSM and FSF) ( $p=0.87$  for right hand, and  $p=0.46$  for left hand), whereas having high training experience supposed an increase up to 4.38 (1.70 – 11.01) times more likely to be successful. Discussion As a possible marker of prenatal testosterone exposure (which could be a key factor in strength development), 2D:4D has been proposed as an indirect measure which can discriminate an exceptional and talented genotype for sport participation (Testern and Campbella, 2001). However, the main finding of the present study was that 2D:4D is not a valid assessment to discriminate successful and non-successful wrestlers, while training experience is a good predictor of competition prowess in that kind of highly trained athletes. References Manning JT, Taylor RP. (2001). *Evol Hum Behav*, 22, 61-69. Tester N, Campbell A. (2007). *J Pers*, 75, 663-677. Allaway HC, Bloski TG, Pierson RA, Lujan ME. (2009). *Am J Hum Biol*, 21, 365-370.

## MATCH ANALYSIS OF YOUTH TAEKWONDO COMBATS

Tornello, F.

*University of Rome*

Match analysis of youth taekwondo combats Tornello F. 1,3, Minganti C.2, Chiodo S.2,3, Tessitore A.1 1Department of Human Movement and Sport Sciences, University of Rome "Foro Italico", Italy. 2 Department of Experimental and Clinical Medicine, University "Magna Graecia" of Catanzaro, Italy. 3 Italian Taekwondo Federation, Rome, Italy. Introduction To deal a systematic coaching of taekwondo athletes based on scientific principles, a clear understanding of technical and tactical combat actions is needed. To this scope, providing a match analysis of actual combats can be an important factor in developing specific training programs (Pieter and Heijmans, 2000). However, at the contrary of elite athletes (Kazemi et al., 2010) there is a paucity of studies on youth competitions. Thus, the purpose of this study was to examine technical-tactical aspects during official youth taekwondo combats. Methods Altogether, thirty combats (semifinals: n=20; finals: n=10) of 10 male weight divisions were recorded and analyzed during the 2010 Italian Championship "Cadetti A" (age: 13-14 years). The recording of combats was authorized by the Italian Taekwondo Federation (FITA). All athletes were in the black belt rank (World Taekwondo Federation), had at least 4 years of previous training consisting of four 2 hr sessions week-1. The technical-tactical analysis was applied to investigate the following parameters: a) frequency of occurrence of offensive, defensive and block actions; b) efficacy of actions (i.e. actions resulted in points). An ANOVA for repeated measure was used to test for differences in type of actions (i.e. offensive, defensive and block) in relation to combat outcome (i.e., winner vs loser). A separate ANOVA was used to test differences between winner and non-winner efficacy. Results Differences ( $p < 0.001$ ) were found between all the action typologies (offensive:  $50.9 \pm 2.9$  %; defensive:  $28.4 \pm 1.8$ %; block:  $20.6 \pm 1.8$ %). Post-hoc showed that winner ( $p=0.004$ ) performed less offensive actions (winner:  $42.6 \pm 4.1$ %; loser:  $59.2 \pm 4.1$ %) and more ( $p=0.010$ ) defensive actions (winner:  $33.4 \pm 2.6$ ; loser:  $23.4 \pm 2.6$ ) with respect to loser. Furthermore winners were more efficacy ( $24.1 \pm 2.3$ %) than losers ( $8.9 \pm 2.3$ %), ( $p < 0.001$ ). Discussion The findings of this study showed as one action on two of Cadet competitions was generally performed as offensive. This trend can be argued by the fact that at this age the technical and tactical skills previously acquired, being still in developing phase, make easier to manage an offensive rather than defensive action. This hypothesis can be supported by the profile of winners, which performed less offensive and more defensive actions, compared to the losers. Furthermore, the winners showed a higher efficacy in terms of technical and tactical skills. References Pieter W, Heijmans J. (2000). Scientific Coaching for Olympic Taekwondo. Oxford, UK, Meyer & Meyer Sport. Kazemi M, Perri G, Soave D. (2010). J Can Chiropr Assoc., 54(4):243-9.

## EXPERT ANALYSIS K-1 GP FINAL JAPAN 1993

Kapo, S., Cikatic, B.

*Faculty of Sports and Physical Education, University of Sara*

Introduction Analysis of competitions of top K-1 fighters who were finalists of the K-1 Final, aims at determining the technical and tactical elements which are dominant in K-1 based on the situational efficiency of finalists of the K-1 WGP Final, Japan, 1993. Methods The sample of analyzed fighters comprised of eight top K-1 super heavyweight fighters, who are specialists for individual martial arts (boxing, kick boxing, karate, muay thai, etc.), and who competed under K-1 rules. The analysis reviewed the technical and tactical activities of the two finalists during the tournament. The total number of variables for this research was 38, in order to review the presence of technical and tactical elements during six top fights at the GP Final, Japan, 1993, in as much detail as possible (Cikatic, 2012). The information was gathered based on video records of seven fights which were used as a basis for the analysis of the K-1 tournament. The collected data were processed using descriptive statistics. Results and discussion Winner of the K-1 tournament did not apply hand technical elements as much as the defeated finalist, but had an advanced application of leg techniques (ushiro geri and ushiro mawashi) which confirms his abilities that proved efficient in the tactical application during the fight. A higher application of technical elements of the defeated finalist is reflected in the fact that he fought a higher number of rounds during the tournament when compared to the winner, while the tournament winner ended his fights before the end of regular time in all three fights. These indicators are best confirmed by the results of the expert analysis which point to the fact that the number of knock-downs and types of wins, as well as the application of offensive tactics by the tournament winner was more successful, which, in the end, resulted in him winning the tournament. Conclusion Based on the collected data, the realization efficiency of technical and tactical elements which are greatly linked with the condition training, and the mental attitude with regards to tactical actions which is linked with a good connection and communication between the coach and the contestant, can be observed. This connection is best described with the sentence spoken by the tournament winner, who said that he only heard the voice of his coach, Tom Harrinck, and his advice from the corner, although there were around 30.000 people present in the hall. "I believe that the synthesis between the coach and fighter is the most important thing for achieving success", are the words of the winner of the first, historical, K-1 WGP Final Tournament held in 1993. References Cikatic B., (2012). EXPERT ANALYSIS 1993 K-1 GP FINAL JAPAN, Master's Paper, Faculty of Sports and Physical Education, University of Sarajevo, BiH.

## EFFECT OF ELASTIC RESISTANCE TRAINING ON THE JAB PUNCH PERFORMANCE

Suzovic, D.1, Markovic, P.2, Planic, N.2, Jaric, S.3

*Faculty of Sport And Physical Education*

Suzovic, D.1, Markovic, P.2, Planic, N.2, Jaric, S.3 1Faculty of Sport and Physical Education, University of Belgrade, 2 Doctoral Program, Faculty of Sport and Physical Education, University of Belgrade, 3Department Kinesiology and Applied Physiology, University of Delaware, Newark, DE Introduction The elastic resistance training could be an efficient method that improves the speed performance in various movement tasks (Jakubiak, Sounders, 2008). However, very few studies have explored the effects of the elastic resistance training on the rapid arm movements. The aim of the present study was to explore the efficiency of the elastic resistance training through the performance of standard jab punch. Methods Twenty high school students (age:  $18.2 \pm 0.7$  yr, body mass:  $79.9 \pm 11.4$  kg, height:  $1.83 \pm 0.05$  m; mean  $\pm$  SD; all active in various sports through various school competition system) participated in the study. Experimental group (n=10) practiced jab with the applied elastic resistance over 6 weeks, whilst the control group (n=10) trained without the additional resistance. Both the punching peak speed and peak acceleration of selected body points were recorded by a 3D Qualisys system, while the markers placed laterally on the hand, elbow, shoulder and hip. All variables were individually tested by a mixed 2-way ANOVA with the main effects being group (elastic resistance vs. no resistance) and test (pre-test vs. post-test). Results The maximum speed of hand revealed the main effect of test ( $p < 0.01$ ), but not of group, and no interaction. Namely, the elastic resistance group was faster at the post-test, but the group x test interaction was somewhat below the significant level ( $p < 0.1$ ). However, the elastic resistance group revealed a higher gain in both the speed and acceleration of the hip and knee joint ( $p < 0.05$ ). Discussion Since the study was conducted on a relatively small sam-

ple of subjects, the observed effects suggest that the elastic training could be beneficial for improvement of rapid arm movements. Mechanisms of the improvement could be based on a higher involvement of the larger muscle groups acting in the leg and trunk joints, as we observed in the post-test of the elastic resistance group. Nevertheless, more research is needed to generalize the claims regarding the efficiency of the elastic resistance training (c.f., Jakubiak, Saunders, 2008; Stone et al. 2002) on the rapid arm movements, such as the tested jab punch. Acknowledgments The study was supported in part by a grant from Serbian Research Council (#145082) References Jakubiak, N., Saunders, H.D. (2008). The feasibility and efficacy of elastic resistance training for improving the velocity of the olympic taekwondo turning kick, *J Strength Cond Res* 22: 1194-1197, Stone, M., Plisk, S. and Collins, D. (2002). Training principles: evaluation of modes and methods of resistance training – a coaching perspective, *Sports Biomech* 1: 79-103

### MATCH ANALYSIS OF SPANISH FEMALE TAEKWONDO COMPETITORS

Menescardi, C., Bermejo J.L., Estevan, I., Falco, C.

*Catholic University of Valencia*

**MATCH ANALYSIS OF SPANISH FEMALE TAEKWONDO COMPETITORS** Menescardi, C.I, Bermejo J.L.I, Estevan, I.I, & Falco, C.I Catholic University of Valencia, Valencia, Spain Introduction The aim of this study was to analyze the performance of female taekwondo players in the semi-final and final contests using the eight weight divisions in the Spanish University Championship (2011), with emphasis on the type of action, type of kick and area of kick score. Methods Twenty-two female matches were analyzed. A total of eight kicking parameters were defined: total number of actions, type of action (attack or counterattack), type of kick (linear, circular or with previous spin), and the area of kick score (head or chest). Official videotapes were analyzed following standard procedures (Santos, Franchini, & Lima-Silva, 2011); a trained investigator analyzed all videos to determine the pre-defined parameters. Intraobserver measures were reliable with an ICC = .85 ( $p < 0.01$ ). Results Kruskal-Wallis test showed differences among weight divisions in total actions ( $\chi^2 = 22.74$ ,  $p = 0.01$ ), attacks ( $\chi^2 = 17.30$ ,  $p = 0.02$ ), actions to the chest ( $\chi^2 = 22.49$ ,  $p = 0.01$ ) and circular kicks ( $\chi^2 = 28.26$ ,  $p = 0.01$ ). Mann Whitney U test showed that flyweight and featherweight performed fewer total actions, attacks, circular kicks and kicks to the chest than the other weight divisions (flyweight, bantamweight, lightweight, middleweight and heavyweight). In contrast, middleweight and heavyweight performed more total actions, attacks, circular kicks and kicks to the chest than the other weight divisions (flyweight, bantamweight, featherweight and welterweight). Discussion and conclusion The results showed that attacks to the chest with circular kicks were the most commonly used actions regardless of weight division. In contrast with other studies (i.e., Santos et al., 2011), our results showed that women in higher weight divisions performed greater number of actions than lighters. This could be due to lower weight divisions perform other actions such as blocks or displacements, instead of perform attacks, while higher weight divisions do a less effective defense (Boguszewski, 2011) and therefore choose to initiate the attack. This information serves to focus taekwondo training in actions to void attacks to the chest with circular actions because it is the technical-tactical behavior undertaken by all taekwondo competitors. Moreover, in middleweight and heavyweight competitors that have had a higher frequency of actions, it could lead to a reorientation of physical training of these athletes in order to withstand in a better way the competition's demands. References Boguszewski, D. (2011). Defensive actions of world top judoists. *Journal of Human Kinetics*, 27, 111- 122. Santos, V., Franchini, E., & Lima-Silva, A. (2011). Relationship between attack and skipping in taekwondo contests. *Journal of Strength and Conditioning Research*, 25(6), 1743-1751.

### HAMSTRING INFLUENCE OF THREE POSITIONS ON FOOT IN YOYO LEG CURL

Nunez, F.J.1,2, Suárez-Arrones, L.I.2, Maldonado, R.I, Tous, J.3

*(1) VF Sport (Seville, Spain) (2) Universidad Pablo de Olavide (Seville, Spain). (3) Universidad de Barcelona (Barcelona, Spain).*

Introduction The hamstring is a muscle group that is in high risk of injury during sports activity, therefore, requires special attention in preventive training. The purpose of this study was to determine the influence of three different foot positions: neutral (PN), medial (PM) and lateral (PL) on the force (concentric-eccentric) and electromyography activity in the biceps femoris (BF) and semitendinosus (ST) in the action of leg curl when done in a iso-inertial machine. Methods 18 subjects performed in the exercise of leg curl doing 3 sets alternating different foot positions (PN, PM and PL) using the same amount of inertia, being executed at the maximum possible intensity of each subject, with a rest of 5' between series. Results Significant differences were found towards the concentric phase in the average force for each of the positions ( $p < 0.01$ ), and towards the eccentric phase regarding peak force with the exception of PN ( $p < 0.05$ ). Significant differences were observed in the ability to generate concentric strength between PN and PM ( $p < 0.05$ ) in comparing ST activation of PM-PL positions during both concentric ( $p < 0.05$ ) and eccentric ( $p < 0.01$ ) and PN-PL in both concentric phase ( $p < 0.05$ ) and eccentric ( $p < 0.05$ ). In the BF significant differences between PM-PL positions during both concentric ( $p < 0.05$ ) and eccentric ( $p < 0.01$ ), PN-PM in the eccentric phase ( $p < 0.01$ ) and PN-PL in the phase concentric ( $p < 0.05$ ). Discussion The machine iso-inertial YoYo™ Flywheel Ergometer, get great peaks of force in eccentric phases (Tous et al, 2006) and especially with the neutral foot position relative to the other two positions (medial and lateral). Given the stabilizing role that has semitendinosus and biceps femoris in the changes of direction drills (Houck, 2003), it is advisable to introduce foot rotations (internal to ST or external to BF) in the prevention or rehabilitation training programs. References Tous J, Maldonado RA, Quintana JM, Pozzo M, Tesch PA. The flywheel leg-curl machine: offering eccentric overload for hamstring development. *Int J Sports Physiol & Perfor*, 2006; 1(3): 293-298. Houck J. Muscle activation patterns of selected lower extremity muscles during stepping and cutting tasks. *Journal of Electromyography and Kinesiology*. 2003; 13:545-554.

### RELIABILITY OF PERFORMANCE IN 10 SEC ALL OUT SPRINTS ON A NON-MOTORIZED TREADMILL

Ribeiro, L.F.P.1,2, Sousa, F.A.B.3, dos Reis, I.G.M.3, Belli, T.2, Beck, W.R.3, Papoti, M.4, Cunha, S.A.3, Martins, L.E.B.3, Gobbato, C.A.5

*1: DCS/UESC (Ilhéus, Brasil), 2: IB/UNESP (Rio Claro, Brasil), 3: FEF/UNICAMP (Campinas, Brasil), 4: FCT/UNESP (Presidente Prudente, Brasil), 5: FCA/UNICAMP (Limeira, Brasil)*

Introduction Sprints on non-motorized treadmills (NMT) have been increasingly adopted in all-out laboratory running evaluation. Yet, limited information exists regarding the effects of familiarization and performance reliability in such tests (Lim & Chia, 2007; Hopker et al., 2009; Highton et al., 2012), particularly in fixed duration efforts. In this study we analyzed the familiarization effects as well as the reliability of performance parameters derived from 10 sec all out sprinting on a non-motorized treadmill. Methods Ten healthy active volunteers (7 men and 3 women) ( $24.7 \pm 2.4$  years,  $79.7 \pm 9.4$  Kg and  $175 \pm 6$  cm) without previous experience in NMT running underwent six sprints on an adapted treadmill (ATL, Inbrasport, Brasil). During the efforts subjects were attached by their waists to a force transducer fixed to a metal structure anchored to the wall, whereas treadmill's belt speed was accessed by means of a magnetic sensor in the front rolling

drum. Parameters retained for analysis were peak (VP) and mean (VM) velocities as well as peak (PP) and mean (PM) powers, with power measures derived from the product of horizontal force and velocity sampled at 1000 Hz. Results One way ANOVA for repeated measures showed no significant ( $P > 0.05$ ) differences between efforts for VP ( $5.4 \pm 0.7$  to  $5.5 \pm 0.8$  m/s), VM ( $4.3 \pm 0.6$  to  $4.5 \pm 0.7$  m/s) and PP ( $2347 \pm 590$  to  $2428 \pm 953$  W). On the other hand, PM increased throughout the trials ( $752 \pm 185$  to  $797 \pm 195$  W;  $P < 0.05$ ), with the highest value observed in the last effort. Coefficients of variation between consecutive trials were relatively stable and averaged 2, 3, 11 and 4.1 % for VP, VM, PP and PM, respectively. In addition, high intraclass correlation coefficients were found between trials for all studies variables (ICC = 0.98 to 0.99). Discussion The results of the present investigation suggest that familiarization has only minor effects on most performance parameters accessed in a 10 sec all out NMT sprint. In addition, in line with previous studies using fixed distance protocols (Hopker et al., 2009; Highton et al., 2012) our results indicate that reliable performance measures can also be obtained from a fixed duration sprint protocol. References Lim JM, Chia MY. (2007). *J Strength Cond Res*, 21, 993 – 996. Hopker GJ, Coleman DA, Wiles JD, Galbraith A. (2009). *J Sports Sci Med*, 8, 528 – 532. Highton JM, Lamb KL, Twist C, Nicholas C. (2012). *J Strength Cond Res*, 26, 458 - 465. This study was supported by FAPESP (2009 / 08535-5).

**14:45 - 15:45**

## Poster presentations

### PP-PM80 Physiology 21

#### PHYSIOLOGICAL AND HORMONAL RESPONSES TO SUCCESSIVE TAEKWONDO COMBATS

Bridge, C.A.1, McNaughton, L.R.1, Close, G.L.2, Drust, B.2

1 Edge Hill University; 2 Liverpool John Moores University

**Introduction** Recent research into the physiological demands of Taekwondo has resulted in significant advances in our understanding of the energetic requirements of a single Taekwondo combat (Bridge et al. 2009; Chiodo et al. 2011). During a championship event, however, competitors may be required to compete in several combats during a single day. The aim of this study was to examine the physiological and hormonal responses to successive Taekwondo combats using an ecologically valid time structure. **Methods** Ten male international Taekwondo competitors (mean  $\pm$  SD, age  $19 \pm 3$  years, body mass  $62.3 \pm 2.6$  kg, height  $1.72 \pm 0.04$  m, competition experience  $6 \pm 1$  years) took part in a simulated championship event. During the event, the competitors performed four combats that were interspersed with different recovery intervals ( $63 \pm 4$ ,  $31 \pm 3$  and  $156 \pm 5$  minutes respectively). Each combat comprised three two-minute rounds with one-minute rest separating each round. Heart rate (HR) was recorded at 5 s intervals during the combats. Venous blood samples were obtained immediately before and after each combat to determine plasma concentrations of lactate, glucose, glycerol, NEFA, epinephrine and norepinephrine. **Results** Significant reductions in plasma lactate ( $13.9 \pm 4.2$  vs.  $10.5 \pm 3.2$  mmol.l<sup>-1</sup>;  $P < .05$ ) and a trend for diminished norepinephrine ( $21.8 \pm 12.8$  vs.  $16.1 \pm 7.7$  nmol.l<sup>-1</sup>;  $P = .06$ ) were evident between combat 1 and 4. These responses did not appear to be influenced by the different recovery intervals. In contrast, greater ( $P < .05$ ) plasma glycerol ( $202 \pm 104$  vs.  $166 \pm 92$   $\mu$ mol.l<sup>-1</sup>), NEFA ( $0.92 \pm 0.24$  vs.  $0.78 \pm 0.33$  mmol.l<sup>-1</sup>) and reduced ( $P < .05$ ) epinephrine ( $10.1 \pm 5.5$  vs.  $12.1 \pm 6.3$  nmol.l<sup>-1</sup>) concentrations were identified in combat 3 following 31 minutes of recovery compared to combat 2, which was preceded by 63 minutes of recovery. Higher ( $P < .05$ ) mean HR was also identified both before and during combat 3. In the final combat, an extended recovery period of 156 minutes was sufficient to restore plasma NEFA, glycerol and epinephrine to similar concentrations as combats 1 and 2, but higher HR was maintained. **Discussion** The metabolic adjustments associated with performing repeated Taekwondo combats in this study are suggestive of an increased shift towards aerobic metabolism and diminished anaerobic energy yield. Interestingly, brief recovery intervals appeared to augment the aerobic requirements of the combat activity and accelerate lipolysis. These findings suggest that both the number of combats and different recovery intervals may play an integral role in regulating metabolic function in Taekwondo competition. References Bridge C.A. et al. (2009) *Int J Sports Physiol Perform*, 4, 485. Chiodo S. et al. (2011) *J Strength Cond Res*, 25, 334.

#### THE PHYSIOLOGICAL EFFECTS OF POWER ALTERNATION FREQUENCY DURING CYCLING ON SUBSEQUENT 5 KM RUNNING PERFORMANCE

Hill, C.

University of Worcester

**Introduction** Drafting behind another cyclist reduces energy expenditure and oxygen uptake compared to riding alone at the same speed (McCole et al., 1990). This leads to a significantly faster subsequent running performance in triathlon (Hausswirth et al., 2001). When cyclists alternate between a draft / non-draft position, power output also alternates, since drafting allows ~30% power reduction without a concomitant decrease in speed (Kyle, 1979). The aim of the present study was to determine if the frequency of power output alternation during cycling would affect subsequent running performance. **Methods** Eleven male triathletes completed a graded cycle test to determine power at 35% delta. Two performance tests were then conducted, each comprising of a thirty minute cycling protocol followed by a 5 km free pace run. Mean cycling power was equal for both trials; however the frequency of power alternations differed. In one trial cycling power output alternated every five minutes (CR5MIN), whereas in the other trial cycling power output alternated every one minute (CR1MIN). Power output was set to alternate 15% above and below the 35% delta value. **Results** A significant difference was observed for mean heart rate between cycle trials ( $p = 0.045$ ), however no significant difference was observed for mean oxygen uptake, minute ventilation, respiratory exchange ratio, blood lactate, rating of perceived exertion or pedal cadence ( $p > 0.05$ ). No significant difference was found between trials for the subsequent running performance time or mean heart rate ( $p > 0.05$ ). **Discussion** The present results show that when utilising a power alternation strategy in cycling, the frequency of power alternation (maximum five minutes, minimum one minute) does not significantly affect subsequent running performance. The results of this study agree with Brickley et al. (2007) who suggest that when the average PO between two protocols is similar, variations in exercise intensity do not significantly affect muscle metabolism, demonstrated by the similar overall oxygen uptake and blood lactate values for both cycle protocols. References Brickley G, Green S, Jenkins DG, McEinerly M, Wishart C, Doust JD, Williams CA. (2007). Muscle Metabolism during Constant and Alternating-Intensity Exercise around Critical Power. *Int J Sports Med* 28:300-305 Hausswirth C, Vallier J-M, Lehenaff D, Brisswalter J, Smith D, Millet G, Dreano, P. (2001). Effect of two drafting modalities in cycling on running performance. *Med Sci Sports Exerc* 33:485-492 Kyle CR. (1979). Reduction of

Wind Resistance and Power Output of Racing Cyclists and Runners Travelling in Groups. *Ergonomics* 22:387-397 McCole SD, Clancy K, Conte J-C, Anderson R, Hagberg, JM. (1990). Energy expenditure during bicycling. *J Appl Physiol* 68:748-753

### PHYSIOLOGICAL RESPONSES TO LOAD-INCREMENTAL AND FREQUENCY-INCREMENTAL EXERCISES DURING CYCLING

Migita, T.1, Tokui, M.2, Hirakoba, K.3

1:Kurume University, 2:Kyushu Kyoritsu University, 3:Kyushu Institute of Technology

**Introduction** Power output is recognized to generate from tension exerted by and contraction speed in exercising muscle. In cycling exercise, power output produced by exercising muscle is controlled by two factors, load added to pedal and pedal frequency. The calculation of total power output (TP) for cycling exercise is made based on external power (EP) and internal power (IP). EP is delivered to the pedal and IP is generated to overcome gravitational and inertial forces related to the movement of the exercising muscle. Then we measured physiological responses to load-incremental (LI) and frequency-incremental exercise (FI) during cycling, and re-verified the responses of the physiological variables to EP and to TP during the two modes of LI and FI. **Methods** Eight healthy male volunteers (mean  $\pm$  SD: age 20.5  $\pm$  0.5 yr, height 170.0  $\pm$  3.9 cm, body mass 64.8  $\pm$  5.7 kg) performed the two modes of cycling exercises (LI and FI). LI started 0.5 kp for 2 min, followed by an increase in 0.5 kp every 2 min until exhaustion point, at a constant pedal frequency of 60 rpm throughout LI. FI consisted of five levels of pedal frequencies of 40, 60, 80, 100 and 120 rpm and pedal frequency was increased by 20 rpm every 2 min (total exercise time = 10 min), at a constant load of 0.5 kp. TP was calculated as the sum of EP and IP. EP was obtained by multiplying by load added to pedal and pedal frequency. IP in this study was estimated according to Minetti et al. (2001). **Results** VO<sub>2</sub> at 120 rpm in FI was around 70 % of VO<sub>2</sub> peak at exhaustion in LI, whereas bold lactate accumulation in FI was only 30 % of that in LI. VO<sub>2</sub> rose linearly with increasing loads in LI and increased exponentially against increasing pedal frequencies in FI. Responses of VO<sub>2</sub>, VE, RR, RER, and HR to EP were different between LI and FI, and the changes of these variables at the same level of EP were greater in FI than in LI. On the other hand, VO<sub>2</sub> to TP revealed almost the same like other variables relationship regardless between LI and FI employed in this study. **Conclusion** These results suggested following two things: 1) an increased in pedal frequency without an increase in load to pedal could be a useful tool for adding metabolic stress to exercising muscle in unfit subjects such as older persons, 2) estimation of TP including IP is necessary to study energy demand during cycling exercise at higher pedal frequencies above 80 rpm. **Reference** Minetti AE, Pinkerton J, Zamparo P. (2001). *Proc R Soc Lond*, 268, 1351-1360.

### PEAK BODY CORE TEMPERATURE IN GRADED EXERCISE TESTING

Rakovac, M., Sentija, D., Babic, V., Marsic, T.

University of Zagreb, Faculty of Kinesiology

**Introduction** Severe increase in body core temperature (BCT) can limit duration and/or intensity of a physical activity. It is well documented that individuals with higher aerobic capacity already show thermoregulatory features that are otherwise characteristic for heat acclimatization (Gleeson, 1998; Nielsen, 1998). The aims of this study were twofold: a) to analyze peak BCT (BCT<sub>peak</sub>) during a graded treadmill exercise test; b) to determine the relationship between BCT<sub>peak</sub> and some indicators of aerobic capacity (maximal oxygen uptake (VO<sub>2</sub>max), maximum speed (v<sub>max</sub>), ventilatory anaerobic threshold (vAT), heart rate at vAT (HRAT)). **Methods** Thirty-two physically active males (age (mean $\pm$ SD) 26.5 $\pm$ 6.6 years; height 179.2 $\pm$ 5.0 cm; body mass 76.8 $\pm$ 8.1 kg) participated in the study. Graded treadmill exercise test with speed increments of 0.5 km/h each 30 seconds was performed until volitional exhaustion. The test was performed in controlled thermoneutral conditions. Ventilatory parameters, heart rate, and rectal temperature (at 8 cm from anal sphincter) were registered throughout the test. Pearson product-moment correlation coefficients were used to determine the relationship between BCT<sub>peak</sub> and indicators of aerobic capacity (VO<sub>2</sub>max, v<sub>max</sub>, vAT, HRAT). **Results** BCT<sub>peak</sub> measured during the test was (mean $\pm$ SD; range) 37.96 $\pm$ 0.37°C; 37.11–38.84°C, while the values for VO<sub>2</sub>max, v<sub>max</sub>, vAT, HRAT were, respectively, (mean $\pm$ SD) 60.4 $\pm$ 6.6 mlO<sub>2</sub>/kg/min, 17.8 $\pm$ 2.2 km/h, 13.1 $\pm$ 2.1 km/h, 170.1 $\pm$ 9.8 bpm. Moderate correlations were found between BCT<sub>peak</sub> and v<sub>max</sub> (r=0.36, p=0.043) and between BCT<sub>peak</sub> and HRAT (r=0.48, p=0.006). No significant correlation was found between BCT<sub>peak</sub> and VO<sub>2</sub>max (r=0.13, p=0.490) and between BCT<sub>peak</sub> and vAT (r=0.29, p=0.106). **Discussion** No participant reached BCT<sub>peak</sub> levels that would indicate hyperthermia, so increase in BCT was not a limiting factor in test performance. The positive correlations between BCT<sub>peak</sub> and parameters of aerobic capacity could be the combined result of: a) participants with higher aerobic capacity being able to accommodate more heat (Mora-Rodriguez et al., 2010), b) longer test duration in these participants. The relationship between the rate of temperature increase and indicators of aerobic capacity should be investigated. **References** Gleeson M (1998). *Int J Sports Med*;19:S96-9. Nielsen B (1998). *Int J Sports Med*;19:S154-6. Mora-Rodriguez R, Del Coso J, Hamouti N, Estevez E, Ortega JF (2010). *Eur J Appl Physiol*;109:973-81.

### POSSIBILITY OF INTRINSIC MUSCLE CONTRACTILE PROPERTIES AS AN INDEX OF MAXIMAL MUSCLE STRENGTH AND MUSCLE FATIGUE

Ohta, Y.1, Takahashi, K.2, Matsubayashi, T.2

1: Aichi Shukutoku University (Japan), 2: Japan Institute of Sports Sciences (Japan)

**Introduction** This study aimed to investigate whether the measurement of intrinsic muscle contractile properties is an index of maximal muscle strength and muscle contractile fatigue. **Methods** Seven subjects performed a fatiguing exercise involving 3 bouts of 120-s repeated right-ankle dorsiflexion at a frequency of 1 Hz with a 5-min rest period between bouts. Thirty percent of maximum voluntary dorsiflexion torque (MVC) measured at an ankle angle of 90° was used as the resistance load in the fatigue exercise. Intrinsic muscle contractile properties were defined as evoked peak torque (single stimulus, two-pulse trains, and three-pulse trains), post-activation potentiation (PAP), and ability of torque summation. The ability of torque summation was estimated by torque contribution of second stimuli of two-pulse trains (C2) and third contribution of three pulse trains (C3). The contribution of the response to the Nth stimulation was determined by subtracting the response to the N-1 stimulation from that to the N stimulation. Non-PAP-evoked torques, PAP-evoked torques, and MVC torques of dorsiflexion at isometric contractions were measured at an ankle angle of 90° in each rest period. The electrical stimulation was delivered from the common peroneal nerve near the fibular head. The responses to two-pulse trains and to three-pulse trains, which were delivered with a constant inter-pulse interval of 10 ms (100 Hz), were recorded. **Results and discussion** Regardless of with or without PAP, the peak torque evoked by a single stimulus, two-pulse trains, and three-pulse trains decreased with the increase in fatigue. Although C2 and C3 without PAP decreased with the increase in fatigue, the pattern of changes in C2 and C3 with PAP differed from that in other parameters. The percent fall was greater in the evoked torque parameters than in the MVC torque. These results suggest that the measurement of intrinsic muscle contractile properties overestimates the muscle fatigue during MVC of dorsiflex-

ion at isometric contraction. Moreover, the present study found that, with or without fatigue, the absolute value of evoked peak torque showed a significant positive correlation with MVC torque. In addition, significant relationships were found between MVC torque and magnitude of PAP and between MVC torque and magnitude of ability of torque summation by a second stimulus. Thus, the measurement of intrinsic muscle contractile properties can be used as an index of maximal muscle strength with or without fatigue.

### EVOLUTION OF HRR WITH TRAINING AND DETRAINING MEASURED WITH A NEW PROTOCOL.

Romagnoli, M.1, Alis, R.1, Basterra, J.1, Villar, J.1, Llana, S.2, Arduini, A.3

*Catholic University of Valencia*

Evolution of HRR with training and detraining measured with a new protocol. Romagnoli M.1, Alis, R.1; Basterra, J.1, Villar, J.1, Llana S.2, Arduini, A.3 1 Catholic University Valencia (Valencia, Spain). 2 University of Valencia (Valencia, Spain) 3 Harvard University (Boston, MA, USA) Introduction: The recovery of heart rate (HRR) after exercise responses to the training processes in health subjects [1]. Several test protocols and durations of the recovery period have been proposed to assess HRR. Our goal in this study is to check if a new protocol to assess HRR [2] responses to training and detraining periods. Methods: 20 healthy subjects (10 training, 10 controls) were involved in the study. The subjects on training group performed a 8 weeks aerobic training and a 8 weeks detraining periods. HRR test was performed at week 0, 4, 8 and 16 for training group and 0 and 8 for control group. Maximal tests to assess VO<sub>2</sub>max were performed at week 0 and 8 on both groups. HR recovery was assessed by 8 models, based on monoexponential kinetics or absolute recovery (recovered HR at fix time points). The protocol allows to determine HRR indexes for two submaximal exercise intensities (65% and 80% HR<sub>max</sub>) on cycle ergometer. Differences between variables were analyzed with multiple analyses of variance for related measures. Statistically significance was set at  $p < 0,05$ . All values as mean  $\pm$  sd. Results: We found no statistically differences on HRR measures between training and control subjects on Week 0 (W0) measure. VO<sub>2</sub>max was increased at week 8 (W8) (W0: 36,07  $\pm$  6,60 W8: 42,26  $\pm$  4,67 ml/min/kg,  $p < 0,05$ ) for training group. Absolute recovery of HR at fixed points were incremented significantly for both intensities and decreased to base line level after detraining except for indexes at 80% of HR<sub>max</sub>. T30 didn't decrease significantly with training but T30min did it (W0: 179,90  $\pm$  83,56 W8: 104,68  $\pm$  30,28  $p = 0,003$ ) at 65% HR<sub>max</sub>. HRR measures for control group at W8 weren't significantly different to W0 measures for the same group. Discussion Absolute indexes of HRR assessed using the proposed protocol reflects the effects of training period on the subjects. Monoexponential indexes of HRR weren't significantly improved, the effects of poor fitting data to the proposed function could explain this lack of response to the training effects. All indexes returns near to base line levels with detraining but this period seems not long enough. We conclude that HRR indexes measured with the proposed protocol are useful to determine the training status of the subjects. References 1. Sugawara, J., et al., Change in post-exercise vagal reactivation with exercise training and detraining in young men. *European journal of applied physiology*, 2001. 85(3): p. 259-263. 2. Arduini, A., M.-C. Gomez-Cabrera, and M. Romagnoli, Reliability of different models to assess heart rate recovery after submaximal bicycle exercise. *Journal of science and medicine in sport*, 2011. 14(4): p. 352-7.

### RELATIONSHIP BETWEEN OBESITY, HEART RATE VARIABILITY, AND SALIVARY ALPHA-AMYLASE IN CHILDREN

Santos-Magalhaes, A.1, Teixeira, A.M.2, Martins, C.3, Aires, L.3, Mota, J.3, Rama, L.2

1: *University Fernando Pessoa (Oporto)*, 2: *Research Centre for Sport and Physical Activity, FCDEF (Coimbra)*, 3: *Research Centre in Physical Education, Health and Leisure Time - CIAFEL, FADEUP(Oporto)*

Introduction: Obesity is characterized by changes in the activity of the autonomic nervous system (ANS), more specifically altered balance between the parasympathetic nervous system and sympathetic nervous system. Power spectral analysis of heart rate variability (HRV) allows for the characterization of sympathovagal balance. Salivary alpha-amylase (sAA) is an emerging biomarker for stress and there is evidence that might reflect changes in the ANS (Nater & Rohleder, 2009). The aim of the present study was to analyse the relationship between obesity, HRV and sAA in school children. Methods: A total of 30 school children (11 normal weight and 19 obese), 6-10 year-olds (8.33  $\pm$  1.14), of both genders (13 Males; 17 Females) were analyzed. Measurements included anthropometric variables (weight, height, waist circumference as well as BMI). Children were then categorized in obese/non-obese BMI groups (CDC Growth Charts). Maturation status was determined by Tanner's criteria. Autonomic function was evaluated by HRV short term evaluation (Task Force, 1996) and salivary alpha-amylase analysis (Salimetrics, UK). Descriptive statistics and partial correlations with gender, age and maturational stage adjustments were used to examine the relationship between the analyzed variables. Results: The HRV analysis showed that obese children presented significantly higher low frequency/high frequency ratio (LF/HF) than their normal weight counterparts. Additionally, positive correlations between obesity indicators (BMI and waist circumference) and LF/HF ( $p = .000$ ) were observed. No significant correlations were observed between sAA and obesity indicators. Conclusion: Our data support the evidence that obesity status is positively correlated with LF/HF in children, which can be an indicator of autonomic dysfunction. No other significant correlations were observed. Although we were not able to demonstrate an association between the sAA and obesity, more studies are needed to clarify this biomarker potential. References: Nater UM, Rohleder N (2009). Salivary alpha-amylase as a non-invasive biomarker for the sympathetic nervous system: current state of research. *Psychoneuroendocrinology*.34(4):486-96, May. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996). Heart rate variability: standards of measurement, physiological interpretation and clinical use. *Circulation*. 93(5):1043-65, Mar.

### COMPARISON OF ANAEROBIC THRESHOLD DURING GRADED EXERCISE BETWEEN IN THE MORNING AND IN THE AFTERNOON

NISHIMURA, K.

*Hiroshima Institute of Technology*

Comparison of anaerobic threshold during graded exercise between in the morning and in the afternoon Kazuki NISHIMURA1), Koji NAGASAKI1), Hidetaka YAMAGUCHI2), Akira YOSHIOKA3), Yuka NOSE4), Yutaro TAMARI5), Sho ONODERA6) Noboru TAKAMOTO1) 1) Hiroshima Institute of Technology, 2) Kibi International University, 3) Kagawa University, 4) Yasuda Women's University, 5) Graduate School of Hiroshima Institute of Technology, 6) Kawasaki University of Medical Welfare Purpose: The purpose of the present study was conducted to determine the relationships between the double product (DP) and cardiac parasympathetic nervous system (PNS) modulation during graded exercise in the morning and afternoon. Method: Volunteering to participate in this study were 10 healthy Japanese males, who gave their informed consent prior to participation. Each subjects performed graded exercise consisting of 90 seconds of exercise at pedaling rate of 60 rpm on an electrically braked cycle ergometer. The intensity of exercise was started at 10 watts and was increased 10

watts at every step of the graded exercise. The subjects were instructed to stop the exercise when the HR reached 160 bpm. Both experimental tests were performed in the morning (8-10 a.m.) and the afternoon (3-7 p.m.). Heart rate (HR), blood pressure (BP) and cardiac autonomic nervous system activity were measured at each exercise step. DP was calculated by multiplying systolic BP (SBP) and HR. A breaking point of DP (DPBP) was determined to be the point of rapid elevation of DP in relation to workload. An equation to define the relationship between each exercise workload and HF was obtained. The workload that yielded the highest absolute value for the slope was defined as the breaking point of HF, called the HFBP. The DPBP and HFBP were used as index of anaerobic threshold. Results and Discussion: At rest, HR, SBP and DP in the morning were significantly lower than in the afternoon ( $p < 0.05$ , respectively). The ln HF, index of cardiac PNS modulation, in the morning was significantly higher than in the afternoon ( $p < 0.05$ ). The DPBP and HFBP in the morning were significantly lower than in the afternoon ( $p < 0.05$ , respectively). These data suggested the possibility that an anaerobic threshold index showed a change in days. At intensity of DPBP, HR, SBP and DP in the morning were significantly lower than in the afternoon ( $p < 0.05$ , respectively). During graded exercise in the morning, the anaerobic metabolism was provided at HR, SBP and DP are low values. The maximum oxygen uptake of each subject in the morning was not observed comparison with the afternoon. This result suggests the possibility that DPBP in the morning was reached at a low at the relative intensity excise for maximum oxygen uptake. In conclusion, the anaerobic threshold in the morning was reached at a lower exercise intensity than exercise in the afternoon.

### SUITABILITY OF MODIFIED TANDEM-BICYCLE ERGOMETER

ONODERA, S.1, YOSHIOKA, A.2, YAMAGUCHI, H.3, MATUMOTO, N.4, NISHIMURA, K.5, SAITO, T.6, ARAKANE, K.6, HAYASHI, S.6, TAKAGI, Y.6, FURUMOTO, K.6, WOORAM, B.1, TAKAHARA, T.1 KATAYAMA, K.7, OGITA, F.8

1: KUMMW, 2: KAGAWA UNIV, 3: KIBI INTERNATIONAL UNIV, 4: SHUJITU JUNIOR COLLEGE, 5: HIT, 6: GRADUATE SCHOOL, KUMMW, 7: NAGOYA UNIV, 8: NATIONAL INSTITUTE OF FITNESS AND SPORTS IN KANOYA

Purpose: The tandem-bicycle ergometer we designed, has unique characteristics, which swing joint with one load and braking pist type. The aim of this study was to verify the validity of new tandem-bicycle ergometer. Methods: Fourteen Japanese healthy male volunteered to participate in this study after they signed the informed consent forms prior to participation in this study. The mean (SD) of their age, height, body weight and maximum oxygen uptake was 23 (4) years, 170 (6) cm, 69.0 (12.4) kg, and 45.4 (7.6) ml/kg/min, respectively. The experiments were performed in three different conditions: the single-bicycle ergometer (a), former saddle (b) and rear saddle (c) positions of the tandem-bicycle ergometer. The subjects were performed exercise for five minutes intervals at three loaded (1.5, 2.0 and 2.5kp). We measured heart rate, oxygen uptake and RPE. Results: Coefficient of variation (CV) of heart rate was  $6.4 \pm 3.9$ ; 1.5kp,  $4.7 \pm 4.4$ ; 2.0kp and  $4.1 \pm 3.7$ ; 2.5kp, respectively. CV of oxygen uptake was  $5.9 \pm 4.5$ ; 1.5kp,  $5.5 \pm 2.9$ ; 2.0kp and  $5.9 \pm 1.4$ ; 2.5kp, respectively. Also, CV of RPE was  $10.6 \pm 5.5$ ; 1.5kp,  $7.9 \pm 5.9$ ; 2.0kp and  $6.7 \pm 4.5$ ; 2.5kp, respectively. The correlation of heart rate among the each condition was  $r=0.848$ (a vs. b),  $r=0.929$ (a vs. c) and  $r=0.938$ (b vs. c). The correlation of oxygen uptake among the each condition was  $r=0.940$ (a vs. b),  $r=0.937$ (a vs. c) and  $r=0.948$ (b vs. c). The correlation of RPE among the each condition was  $r=0.795$ (a vs. b),  $r=0.734$ (a vs. c) and  $r=0.797$ (b vs. c). Thus high correlations among the each condition were observed. Discussion: It is known that CV of oxygen uptake whole circadian change is conceivable 3~10%, and CV whole changes of inter individual difference are conceivable about 5.5 %. Accordingly, the three conditions in our experiment did not affect the physiological parameters during the cycle exercise. Therefore, it might be that the suitability of a new tandem-bicycle ergometer was confirmed by CV.

## 14:45 - 15:45

### Poster presentations

#### PP-PM81 Physiology 22

#### INJURIES IN THE FIRST CROATIAN SOCCER DIVISION

Matkovic, B.R., Radman, I., Ruzic, L., Barisic, V.

*University of Zagreb, Faculty of Kinesiology*

Introduction Soccer players in most world leagues have very condensed schedule and these games are played at high intensity. Dupont with his coworkers (2010) showed that recovery time between two soccer matches appears to be sufficient for maintaining the level of physical performance but is not long enough to secure a low injury rate. The injuries in soccer appear to be more frequent and even more dangerous. The aim of this study was to identify the specific soccer circumstances and immediate technical and tactical causes of injuries in training process and competition of elite Croatian soccer players. Methods The study was conducted on the sample of 175 players from seven soccer clubs of the First Croatian Soccer Division at the beginning of the season 2010/2011 Croatian Championship. Soccer players were tested just before the start of regular practice through the written questionnaire. The questionnaire consisted of general questions about number of training sessions per week and their duration, number of games played in last two seasons and number and character of the injuries in the same period. Results and discussion The results show that 40% off all injuries occur during autumn competitive period. Significantly more injuries were sustained due to exposure to training load (60%). The highest percentage of injuries was recorded in the phase of defence set (26%). According to the ball possession, the highest injury risk was recorded during immediate contact with the ball or fight for her possession. In 70% of all injuries, recorded injuring mechanism was the physical contact with an opponent. The most vulnerable parts of the body were ankles and knees, and the ligaments and muscles were the most affected tissues. As prevention, implementation of training process should take place under conditions of controlled load in order to reduce the number of training caused injuries. The number of injuries caused by direct physical duel with an opponent is significantly higher than in Western European leagues, and indicates the need to raise the player body's hardiness and tactical maturity of team trainers. References Dupont G et al. (2010). *Am J Sports Med*, 38 (9), 1752-1758. Weiber NG, Roberts WO, Lunos S. (2011). *Br J Sports Med* doi:10.1136/bjism.2010.077198

## DOES RAMADAN FASTING INFLUENCE INJURY INCIDENCE AND INJURY PATTERN IN PROFESSIONAL MUSLIM FOOTBALL ATHLETES?

Farooq, A., Eirale, C.

*Aspetar-Qatar Orthopaedic and Sports Medicine Hospital*

**Introduction** Ramadan is the holy month of Islam, during which Muslims observe fasting (i.e. abstaining from eating and drinking) from sunrise to sunset. Among football players, Ramadan fasting is known to influence unhealthy dietary habits and disturbed circadian rhythms. Not being able to rehydrate during daytime in combination with lack of sleep may mediate increased susceptibility to injury during Ramadan. The aim of the present study was to investigate incidence and pattern of football injuries during Ramadan month among Muslim athletes practicing Ramadan fasting. **Methods** A total of 462 first division Muslim athletes from Qatar Stars league (QSL) were followed up for their total exposure to match as well as training sessions for three consecutive seasons that included the Ramadan month. All injuries were assessed for type, location, severity, mechanism and pattern by professional medical staff. Injury incidence was calculated as rate per 1000h of game exposure and data was compared between Ramadan and non Ramadan periods. **Results** During the three seasons, the football players sustained, on an average 5.0 injuries per 1000 hours of game (95% CI 4.6- 5.3). No differences were seen in injury incidence during Ramadan month (4.0/ 1000h) compared to non Ramadan period (4.9/ 1000h),  $p=0.266$ . Most common during Ramadan month were thigh injuries, with an injury rate of 1.4 per 1000 hours, and knee injuries, with a rate of 1.0 per 1000 hours. Muscular strains dominated in Ramadan month, with an injury rate of 1.5 per 1000 hours of activity. However, these patterns and injury severity were found to be similar with rest of the non Ramadan period. **Discussion** Ramadan fasting was not associated with increased risk of injury among Muslim athletes observing Ramadan fasting and moreover athletes presented with similar injury patterns as non Ramadan period. This study should be interpreted in light of the fact that at QSL, all training and competitions during Ramadan take place at least 4h after the break of fast. Further studies that also adjust for training intensity and sleep quality may provide better understanding of injury incidence during Ramadan.

## ACUTE AND PERSISTING FATIGUE EFFECTS IN BOW ARM MUSCULATURE IN COMPETITIVE RECURVED ARCHERY ATHLETES

Kolayis Eroglu, I., Knicker, A., Soyulu, R., Ertan, H.

*Sakarya University*

**Introduction** In an archery competition the archer is sustained to shoot in difficult conditions as stress, wind, etc. The pulling weight is approximately 20 kg. of a bow, and the archer 144 times pull his bow in a competition. If stress or weather conditions block shooting, the archer can hold down the bow but must pull again in order to shoot his arrow in a given period. When considering of the pulling weight of the bow, to shoot arrow will be difficult for the archer. Because of these conditions, the aim of this study was to analyse the effects of fatigue on bow arm muscular activity in archery. **Methods** 6 Female (Age: 16,66+3,44; Training age: 5,88+2,92) and 10 male (Age: 22,33+12,95; Training age: 4,11+2,80) subject were involved in the study. Each subject participated in double test session and each archer shot 12 arrows before and after fatigue protocol and bow arm Deltoid Posterior, Deltoid middle, Deltoid Front part, Trapezius Middle, Trapezius Upper, Triceps Brachii, Biceps Brachii, Forearm extensors and Forearm flexors EMG activities have been measured in each test. In the fatigue protocol, the subjects have repeated several sets of drawings. The subject was asked to rate his/her fatigue level according to the rating scheme of the Borg Scale. The subjects have repeated the drawing set till exhalation. The researchers has asked to archers who perform the drawing action to provide a score from 0 to 10. EMG recordings 1 s prior the fall of the clicker have been analysed and their Median Frequency values have been calculated in Matlab. Differences between two test session were analysed in paired samples t-tests. **Results** According to the results of the study, there were significant differences in DM and DF parts muscles ( $p<0,05$ ) on the basis of comparisons of the mean values of 12 arrows in test –retest condition. To estimate more acute fatigue effects only values of the first three arrows after fatigue protocol have been included into the statistical analysis. In this way there were significant differences between T.Brachii and D. middle test-retest results ( $p<0,05$ ). **Discussion** As a result, D. Middle muscle has an importance for stabilising the bow till the archer has pulled the string under his chin prior to the aiming phase and in the release phases to balance the weight of the bow. Insufficient release and instability of the bow can cause bad performance in a competition. In archery, an archer does not use his maximal strength for drawing the string. So recovery process starts after each arrow in the given time allowed. Long lasting fatigue effects were apparent for deltoid muscles and acute fatigue effects could be identified for triceps brachii muscles also. This indicates that resting periods between shots are long enough to recover from acute fatigue in some muscles but fatigue effects persist in other muscles. despite recovery periods. These results may help to design recovery strategies in archery shooting.

## THE INFLUENCE OF INJURY AND ILLNESS ON TOTAL HAEMOGLOBIN MASS

Gough, C.E.1,2, Sharpe, K.3, Garvican, L.A.1, Anson, J.4, Saunders, P.U.1,2, Gore, C.J.1,2,5

*Australian Institute of Sport*

The influence of injury and illness on total haemoglobin mass C. E. Gough<sup>1,2</sup>, K. Sharpe<sup>3</sup>, L. A. Garvican<sup>1</sup>, J. Anson<sup>4</sup>, P.U.Saunders<sup>1,2</sup>, C.J.Gore<sup>1,2,5</sup>. 1. Physiology, Australian Institute of Sport, Australia 2. Faculty of Health, University of Canberra, Australia 3. Department of Mathematics and Statistics, University of Melbourne, Melbourne, Australia 4. Faculty of Applied Science, University of Canberra, Australia 5. Exercise Physiology Laboratory, Flinders University, Adelaide, Australia Inclusion of total haemoglobin mass (Hbmass) in the Athlete Blood Passport would improve its sensitivity to acute autologous blood transfusion (1), a form of blood doping that is currently undetectable. The relative stability of Hbmass in non-doping athletes compared to doping athletes makes it potentially suitable for inclusion in the ABP (2) but reports of large (13-19%) Hbmass fluctuations in some injured athletes could compromise its reliability (3,4). This study quantified the effects of reduced training, surgery and changes in body mass on Hbmass in injured or ill athletes, and examined the dose-response effect of a decrease in training on Hbmass. Fifteen athletes (6 m, 9 f) were monitored for Hbmass a mean of 9 ( $\pm$  6; SD) times over 162 ( $\pm$  198) days, spanning a phase of their training involving a prolonged period of injury or illness. Additionally, body mass was recorded, as were details of recent altitude exposure, iron supplementation, blood donation or surgery. Details of the athletes' training (type, duration and intensity) were recorded and compared to pre-injury training load. Linear mixed models were fitted with  $\ln(\text{Hbmass})$  as response variable, Sex, Altitude, Surgery, Iron, Training and (log of) Body Mass as fixed effects and Athlete as a random effect. Detailed models of training intensity and volume, and combined models of training load were assessed for their effect on Hbmass. Using a simple dichotomous model of combined training load, a decrease from HIGH to LOW training led to a significant 2.3% (0.3 to 4.3, 95% confidence interval;  $p=0.02$ ) decrease in Hbmass. When training variables were examined in more detail, there was no significant association



for any other training model with Hbmass. Surgery was associated with a 2.7% (-5.4 to -0.1,  $p = 0.04$ ) decrease in Hbmass and a 10% decrease in body mass led to a 1.3% decrease in Hbmass. Reduced training, surgery and reduced body mass are each, separately, associated with significant Hbmass decreases in injured and ill athletes. These estimates could be used to differentiate the effects of injury-induced changes in Hbmass from doping if incorporated into the ABP. It was not possible with any real certainty to estimate the dose-response effect of training reductions on Hbmass using these data. 1. Morkeberg et al. *Scand J Med Sci Sports* 2011; 21: 235-243 2. Prommer et al. *Med Sci Sports Exerc* 2008; 40: 2112-2118 3. Garvican et al. *Eur J Appl Physiol* 2010; 109: 221-231 4. Schumacher et al. *Clin J Sport Med* 2008; 18: 172-173

### MORPHOLOGICAL CHANGES OF NEUROMUSCULAR JUNCTIONS DUE TO INACTIVITY IN RAT SKELETAL MUSCLE

Nishizawa, T.1, SUZUKI, H.2, YUKI, A.2, NORIKATU, K.2

1.sigakkan junior university, 2.aichi university education

**Introduction:** The purpose of this study is to clarify the form of degenerative changes in the neuromuscular junctions (NMJs) due to inactivity. Although skeletal muscles are significantly affected by inactivity, these changes are reversible and they recover functionally when the muscles are made to work again. Muscle activity also simultaneously restores the function of motor cells which govern skeletal muscle. This suggests that the contractive activities of muscles is not only output to the exterior from the nerves, but is also necessary to maintain neuromuscular function. **Materials and methods :** Cast immobilization was performed in order to observe adaptive changes occurring on inactivity. Male Fischer 344/Jcl rats (15 weeks old) were used. All procedures in the animal experiments were performed in accordance with the guidelines. The muscles studied were the plantaris muscle (PLA), extensor digitorum longus muscle (EDL), and soleus (SOL). In a deep relaxed state under anesthesia, using bandage type gypsum (Scott cast), the knee joint and ankle joint of the hind legs were fixed to cause inactivity. Cast immobilization was performed for 1week (G1W) and for 2weeks (G2W), and another group (R2W) was prepared which was fed as usual for 2weeks after cast immobilization for 2weeks. Single muscle fibers were dissected from the EDL. The morphological observation of NMJs by optical microscope used was used for the observation cholinesterase (ChE) and silver staining. **Results:** Regarding the skeletal muscle weight of G1W, G2W, and R2W, the value for group C decreased significantly. In G2W, it decreased to 60% for SOL and PLA, and muscular atrophy due to cast immobilization was observed. R2W showed a higher value than for Group G, which suggested increase of muscle weight after resumption of activity. When the skeletal myofiber and NMJs were observed by an optical microscope, small diameter muscle fibers were observed in G1W and G2W. This suggests that muscle atrophy takes place in 1week due to inactivity. On the other hand, in the NMJs of G1W, no anomaly was found in the axon terminal morphology. In G2W, an indicator of injured muscle fibers was observed, and there was a tendency to decreased area of the NMJs. In motor-endplate observation by acetylcholinesterase dyeing, no anomaly was observed in either G1W or G2W, suggesting that denervation does not occur due to cast immobilization. In R2W where there was resumption of activity, recovery of the diameter of muscle fibers was observed, and a nuclear matrix which is an indicator of regenerated muscle fiber was observed. This suggests the possibility that muscle damage had occurred when activity was resumed after cast immobilization.

### SERUM CONCENTRATION OF CARTILAGE OLIGOMERIC MATRIX PROTEIN IS DIMINISHED DURING 5 DAYS OF HDT BED REST

Liphardt, A.M., Mündermann, A., Andriacchi, T.A., Heer, M., Koo, S., Achtzehn, S., Mester, J.

German Sport University Cologne

Serum concentration of cartilage oligomeric matrix protein is diminished during 5 days of HDT bed rest Liphardt, A.M.1, Mündermann, A.2, Andriacchi, T.A.3, Heer, M.4,6, Koo, S.5, Achtzehn, S.1, Mester, J.1 1: DSHS-Institute of Training Science and Sport Informatics, Köln Germany, 2: Sport Science, University of Konstanz, Germany, 3: Mechanical Engineering, Stanford University, Stanford, CA, US, 4: DLR-Institute of Aerospace Medicine, Köln, Germany, 5: School of Mechanical Engineering, Chung-Ang University, Seoul, South Korea, 6: Profil Institute for Metabolic Research, Neuss, Germany **INTRODUCTION** Cartilage oligomeric matrix protein (COMP) is a structural protein found primarily in cartilage which has been associated with cartilage degradation (1). Serum COMP concentration is sensitive to physiological loading (2, 3). During spaceflight or immobilization the lower limb is unloaded for prolonged periods of time. Unless exposed to regular mechanical loading, cartilage atrophies (4, 5), and COMP is sensitive to 14 days of immobilization (6). The purpose of this study was to determine the effect of unloading on serum COMP concentration during 5-days of bed rest (BR) in combination with an exercise program using vertical jump and squats. **METHODS** Ten healthy male subjects (78.0±3.7 kg; 178.8±3.7 cm, 29.63±5.9 yrs) participated in a 5-day BR study after giving their informed consent. The study was divided into three periods: 5 days adaptation, 5 days HDT BR and 6 days recovery. Seven fasting blood samples were taken throughout the study in the morning before rising. Serum COMP concentration was analyzed using COMP@ELISA (AnaMar Medical AB, Uppsala, Sweden). Statistical analysis (IBM SPSS Statistics, 19.01) was performed using paired-samples T-Test ( $p < 0.05$ ). **RESULTS** Serum COMP decreased significantly after 24h of HDT by 17% (control: baseline = 7.6±1.5; HDT2 = 6.3±1.4,  $p = .000$ ), 12% (sham: baseline = 7.2±1.3; HDT2 = 6.4±1.2,  $p = .000$ ) and 9% (exercise: baseline = 7.7±1.6; HDT2 = 7.0±1.6,  $p = .013$ ) respectively. On the first day of recovery, COMP levels recovered to baseline values with all three interventions. **DISCUSSION** These results support earlier findings that HDT results in an immediate reduction in serum COMP concentration (8). COMP levels recover to baseline immediately after the end of the disuse period. The observed reduction in serum COMP concentration may be caused by decreased diffusion of molecules from cartilage into serum or by a change in cartilage metabolism both in response to the lack of mechanical stimulus during bed rest. **REFERENCES** 1)Neidhardt et al. (1997) *OA&C* 36, 1151-1160; 2)Neidhart et al. (2000) *Osteoarthritis Cartilage* 8, 222 - 229; 3) Mündermann et al. (2004) *Osteoarthritis Cartilage* 13, 34 - 38; 4) Hinterwimmer et al. (2004) *Arthritis Rheum* 50, 2616 - 20; 5) Vanwanseele et al. (2002) *Arthritis Rheum* 46, 2073 - 78; 6) Liphardt et al. (2009) *OA&C* 17 (12), 1598-603.

### CARDIORESPIRATORY FITNESS AFFECTS RELATIONSHIP BETWEEN GHRL LEU72MET POLYMORPHISM AND CARDIOVASCULAR DISEASE RISKS.

Shumpei, F.1, Motoyuki, I.1, Haruka, M.2, Kiyoshi, S.1, Hiroshi, K.3, Yuko, G.3, Ryoko, K.2, Motohiko, M.2

1: Ritsumeikan University, 2: National Institute of Health and Nutrition, 3: Waseda University

**BACKGROUND:** The Leu72Met (214C>A) polymorphism of ghrelin (GHRL) is associated with eating disorder, obesity and diabetes. Habitual exercise brings higher cardiorespiratory fitness and results in the improvement of risk of cardiovascular disease. However, combined effects of cardiorespiratory fitness and genetic variation on the ghrelin gene on cardiovascular disease risks remain unclear. **PURPOSE:** In the present study, a cross-sectional investigation of 763 Japanese men and women (18-70 years old) was performed to clarify the effects

of cardiorespiratory fitness and GHRL Leu72Met polymorphism on risks of cardiovascular disease. METHODS: Carotid beta-stiffness, measured by ultrasonography and tonometry, and brachial blood pressure, measured by oscillometry, were assessed as risks of atherosclerosis and arteriosclerosis. As an index of cardiorespiratory fitness, we measured peak oxygen uptake (VO<sub>2</sub>peak) during an incremental cycle ergometer exercise test, and then the study subjects were divided into high-cardiorespiratory fitness (High-Fit) and low-cardiorespiratory fitness (Low-Fit) groups based on the median value of VO<sub>2</sub>peak in each sex and decade. GHRL Leu72Met polymorphism was determined by real-time PCR with Taqman probe. RESULTS: In High-Fit subjects, VO<sub>2</sub>peak and serum HDL cholesterol level were significantly higher and serum LDL cholesterol and triglycerides levels were significantly lower than that in Low-Fit subjects. Additionally, total cholesterol, LDL cholesterol and triglyceride levels were significantly lower in the Met/Met genotype of GHRL Leu72Met polymorphism compared with the Leu/Leu and Leu/Met genotype individuals. Interestingly, in the High-Fit subjects, total and LDL cholesterol levels were significantly lower in Met/Met genotype individuals than that in Leu/Leu and Leu/Met genotypes, whereas there were no such differences in Low-Fit subjects. However, carotid beta-stiffness and blood pressure were not significantly affected by the GHRL genetic variant and fitness levels. The 72Met allelic frequency of in the GHRL genetic variant was 25.2% in the High-Fit group and 25.2% in the Low-Fit group. CONCLUSION: These results suggest combined effects of and genetic variation on the ghrelin gene on cardiovascular disease risks. Thus, GHRL Leu72Met variant may affect individual difference in the effect of habitual exercise on lipid profile. Grants Supported by KAKENHI of the Japan Ministry of Education, Culture, Sports, Science and Technology (MI, MM).

### ROLE OF THE ADRB2 GLN27GLU POLYMORPHISM ON THE EFFECT OF A WEIGHT LOSS PROGRAM

Szendrei, B.1, Cupeiro, R.1,2, Amigo, T.3, Morencos, E.1, Galindo, M.1, González-Lamuno, D.3

1:Facultad de Ciencias de la Actividad Física y del Deporte. Universidad Politécnica de Madrid, 2:Instituto de Ciencias del Deporte. Universidad Camilo José Cela, 3:IFIMAV-Universidad de Cantabria

Introduction The adrenergic system plays a role in the lipolysis, the lipid mobilization and the energy expenditure, so is associated with overweight and body composition (1). Therefore, its functionality could influence the response to an exercise-based weight loss program. Thus the aim of the present study is to analyse the effect of the Gln27Glu polymorphism of the ADRB2 gene on the response to a weight loss program for obese women. Methods 38 Caucasian obese women (39.2±7.8 yrs; 164.7±7.2 cm; 90.4±9.6 kg) followed a 24-week weight loss intervention. This consisted of a controlled training program (3 times/week, 38-60 min/session; strength, endurance and combined training) and a caloric restriction (30% of the daily energy expenditure). The Gln27Glu ADRB2 polymorphism was determined by PCR and restriction enzyme digestion. One-way ANOVA tests were used to determine differences among the genetic groups in body weight (BW) and fat percentage (F%) – initial data and the changes due to the intervention. The significant level was set at  $\alpha \leq 0.05$ . Results The Bonferroni post-hoc test showed differences between Glu/Glu and Gln/Glu for the initial BW ( $p=0.016$ ) and the initial F% ( $p=0.04$ ). Furthermore, we found significant differences between Glu/Glu and Gln/Gln for the initial BW ( $p=0.014$ ) and a borderline significant difference ( $p=0.086$ ) for the initial F%. However, we did not observe differences among groups in the BW and F% losses. Discussion Our results show that in Caucasian obese women, this polymorphism can have an influence on body weight and body composition, but not on weight or fat loss during the described intervention. The international studies have no consistent results about the exact role of this gene in obesity (2,3,4). Further studies are needed to investigate, not only isolated polymorphisms, but also haplotypes related with body composition, to show up stronger associations with the effects of weight loss programs. References 1. Lafontan, M., and M. Berlan J. *Lipid Res* (1993); 34:1057-1091. 2. Large V et al. *J Clin Invest* (1997); 100:3005–3013. 3. Gjesing AP et al. *PLoS ONE* (2009); 4(9): e7206 4. Masuo K et al. *Int J Hypertens* (2010); 21;2010:832821.

### DEPENDENCE OF CARDIO-RESPIRATORY SYSTEM ADAPTATION REACTIONS OF ATHLETES TO ENDURANCE TRAINING ON COMPLEX OF GENE POLYMORPHISMS.

Drozdovska, S.1, Lysenko, O.1, Dosenko, V.2, Ilyin, V.1

NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORT OF UKRAINE

Introduction The adaptation of an athlete to systematic physical exercise has been shown to depend on an individual's inherited properties (Bouchard et al., 1999). These properties are determined by a combination of great many genes polymorphisms (Bray et al., 2009; Timmons et al., 2010). The aim of our study was to investigate the dependence of the aerobic capacity parameters in sport on the gene polymorphisms. Methods Two hundred and ninety six athletes participated in the study of genotype features of the athletes including: 109 athletes specializing in the speed and strength sports, 103 athletes specializing in the endurance sports, and 93 volunteers which are not involved into sport. The T-786→C polymorphism of the promoter of eNOS gene as well as I/D polymorphism of ACE gene, Pro/Ala polymorphism of PPARG gene, G/C polymorphism of PPARA gene, Pro582Ser polymorphism of HIF1 $\alpha$  gene, and Ala203Pro polymorphism of PPARGC1B gene were identified using the method of PCR. Adaptation to exercise was assessed using the gas analysis which was carried out by an automatic gas analyzer of the Meta Max. Stress tests were conducted using the ergometer and treadmill. Results The impact of 6 polymorphisms on the aerobic performance level was analyzed. Cumulative impact of these polymorphisms in the combination with the individual parameters (gender; qualification; kind of sport) stipulates 71% of dispersion of VO<sub>2</sub>max value. The most stable parameters of the cardio-respiratory system reactions of the athletes in the repeated testing included: HRmax (V=1,5%), VCO<sub>2</sub>/VO<sub>2</sub> (V=5,5%), VO<sub>2</sub>max·kg<sup>-1</sup> (V=5,7%), VO<sub>2</sub>max (V=5,8%), HRTh (V=5,8%), Wmax and Wmax·kg<sup>-1</sup> (V=5,9%), VEmax and VEmax·kg<sup>-1</sup> (V=7,4%), EQO<sub>2</sub> (V=7,6%), fTmax (V=7,9%). ACE gene polymorphism has a definite effect on EQO<sub>2</sub> ( $p=0,020$ ), HRmax ( $p=0,029$ ). PPARA gene polymorphism has a definite effect both on WTh ( $p=0.04$ ) and WTh·kg<sup>-1</sup> ( $p=0,009$ ). eNOS gene polymorphism has an effect on EQO<sub>2</sub> ( $p=0,046$ ). Discussion The analysis of the obtained results has shown both single and combined effect of the gene polymorphisms on the aerobic capacity in the sports with the prevailing development of endurance. Though many studies demonstrated the exceptional significance of the maximal oxygen uptake to achieve the high sport results in the endurance sports, the necessity of VO<sub>2</sub>max high level is overestimated. Competitive activity has different requirements to the level and ratio of the factors in the functional fitness structure in the different sports. Each sport should have its own criteria of the aerobic capacity evaluation. It is necessary to focus on the sport-specific molecular-genetic markers. References Bouchard C., An P, Rice T, Skinner JS, Wilmore JH, Gagnon J, Perusse L, Leon AS & Rao DC (1999). *J Appl Physiol* 87, 1003-1008. Bray M.S., Hamberg J.M., Perrusse L., Raikinen T., Roth S. M., Wolfarth B., Bouchard C. (2009) *Medicine & Science in Sports & Exercise*, 41, N1, 35-73. Timmons J.A., Knudsen S., Rankinen T., Koch L.G., Sarzynski M. et al. (2010) *J. Appl. Physiol.* Jun; 108 (6): 1487-96

**A SYSTEMATIC REVIEW OF S100B METHODOLOGY AND ANALYSIS – WHAT DO WE KNOW?**

Schulte, S.1,2, Podlog, L.1, Hayes, B.1, Hamson-Utley, J.3, Toth, R.1, Petron, D.1

1: University of Utah (USA), 2: German Sport University Cologne (Germany), 3: Weber State University (USA)

Introduction S100B is an astroglial protein that is released after traumatic brain injury (TBI) and enters the peripheral bloodstream in higher amounts through a dysfunctional blood-brain barrier. Elevated levels of S100B in the peripheral blood stream have been shown to be predictive of mild TBI (mTBI). Furthermore, physical activity can affect S100B levels. However, S100B values of the same individual can differ by the methodological approach used to measure it, such as the type of sample assessed, the sample processing, storage time, or the type of assay. As a consequence, the discussion about appropriate reference values in the diagnosis of concussed athletes remains unclear. The purpose of this systematic review was to evaluate the methodology of S100B analytical measures. Methods Databases: PubMed, SciVerse Scopus, SPORTDiscus, CINAHL, The Cochrane. Keywords: S100B, S100 $\beta$ , S100beta, S-100B, S-100beta, S-100 $\beta$ , biomarker, assess\*, diagnos\*. Study selection: (i) exclusively research studies on humans in which (ii) physical activity was used as an intervention or (iii) physical active individuals/ athletes were test subjects and (iv) S100B was measured as a dependent variable. Results This review identified 23 articles that met the inclusion criteria. Four different types of S100B samples (serum, plasma, saliva, CSF) have been investigated and various procedures of sample processing (time, centrifugation, temperature) have been applied. None of the articles provided a precise statement about the storage time of the frozen sample. Six different types of immunoassay techniques (e.g. ELISA) were described. Additionally, we identified more than 8 different categories of physical activity (see ii/iii). Discussion Given the non-uniformity of analytical methods utilized, data samples collected, as well as diversity in the physical activities of individuals investigated, the similarity of S100B reference measures within the literature is currently unclear. Therefore, the appropriate evaluation and assessment of S100B levels remains unresolved at present. Thus, we recommend that the interpretation of S100B values be based on congruent study designs regarding the analytical method, the nature of intervention and other possible S100B level influencing factors to ensure the reliability and validity in the assessment of S100B measurements. References Cassidy et al (2004). J Rehabil Med. 43, 28-60.3 Pandor et al (2011). Health Technol Assess. 15(27), 1-202. Müller et al (2006). Clin Chem Lab Med. 44(9), 1111-1114. Petzold et al (2003). Brain research bulletin. 61(3), 281-285.

**EFFECTS OF ORAL APPLIANCE AND CPAP ASSOCIATED WITH PHYSICAL EXERCISE IN IMPROVING BODY COMPOSITION AND CARDIORESPIRATORY FITNESS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA.**

Ackel-D Elia, C.1,2, Pantiga Jr, G.1, Luz, G.C.P.1, Alves, E.S.1, Schütz, T.C.B.1, Cunha, T.C.A.1, Guimaraes, T.M.1, Mansur, M.1, Tufik, S.1, Bittencourt, L.R.A.1, Mello, M.T.1,2

Universidade Federal de São Paulo

1Departamento de Psicobiologia 2Departamento de Nutrição \*Universidade Federal de São Paulo – Escola Paulista de Medicina – UNIFESP-EPM Abstract Aim: The aim of this study was to compare the effects of Oral Appliance (OA) and Continuous Positive Airway Pressure (CPAP) associated with physical exercise in improving body composition and cardiorespiratory fitness after 2 months of aerobic+resistance training in patients with obstructive sleep apnea (OSA). Methods: A total of 19 male patients with OSA were randomized in three groups: OA (n=5), CPAP (n=7) and exercise (n=7). All patients completed 2 months of physical exercise (aerobic+resistance training) alone (exercise group) or associated with OA (OA group) or CPAP (CPAP group) during the study. Polysomnography (PSG), cardiopulmonary exercise test (CPET) and body composition (BODPOD) were evaluated before and after 2 months of physical training. Results: No differences were found among groups in the baseline condition for body mass (kg), BMI (kg/m<sup>2</sup>), body fat mass (%), body lean mass (%), sleep parameters (PSG) and CPET variables. VO<sub>2</sub>max (ml/kg/min) and maximal speed (km/h) increased significantly only for OA and exercise groups (VO<sub>2</sub>max=31.87±4.97 and 37.17±4.66\*; 32.70±5.38 and 36.72±5.47; 32.94±4.55 and 38.46±3.63\*; Maximal speed=10.80±0.84 and 12.40±0.89\*; 11.43±1.90 and 12.29±2.43; 10.86±2.34 and 12.14±1.86\* before and after physical training for OA, CPAP and exercise groups, respectively). Body lean mass (%) increased only in OA and exercise groups (64.64±5.14 and 68.12±4.00\*; 71.26±7.95 and 71.66±6.80; 75.11±9.06 and 78.56±9.41\* before and after physical training for OA, CPAP and exercise groups, respectively) while body fat mass (%) decreased only in exercise group (32.76±4.99 and 31.88±4.00; 28.74±7.95 and 28.63±6.19; 24.89±9.06 and 21.44±9.41\* before and after physical training for OA, CPAP and exercise groups, respectively). No differences were found after physical training for body mass (kg), BMI (kg/m<sup>2</sup>) and sleep parameters (PSG). Conclusion: OA associated with physical exercise is more effective than CPAP in improving body composition and cardiorespiratory fitness after 2 months of aerobic+resistance training in patients with obstructive sleep apnea (OSA). Financial support: AFIP, CAPES, CNPq, CEPE, CEMSA, UNIFESP-EPM, FAPESP (CEPID/Sono n° 1998/14302-3; 2009/01031-1)

**14:45 - 15:45****Poster presentations****PP-PM82 Physiology 23****HUMAN SKIN-GAS AMMONIA AFTER SPRINT CYCLE EXERCISE**

Itoh, H., Zhang, W., Inoko, N., Kimura, S., Ohkuwa, T., Yamazaki, Y., Tsuda, T.

Nagoya Institute of Technology

Introduction During short-term sprint exercise, the accumulation of ammonia in working skeletal muscles increases, and effluxes into the blood. Previously, we (Itoh & Ohkuwa 1991) have confirmed that the peak value of blood ammonia concentrations appears in sprints within 15-s. On the other hand, Nose et al. (2005) have found the existence of ammonia in human skin-gas in healthy persons and patients with hepatic disease. However, no one has confirmed changes in the skin-gas ammonia concentrations after exercise. Therefore, we examined changes in human skin-gas ammonia concentrations after the 10-s supramaximal cycle exercise. Methods Nine healthy male students (22.1 ± 1.0 years; mean ± SE) volunteered as the subjects. The subjects performed 10-s sprint cycle exercise as fast as they could. The skin-gas samples were obtained from the surface of forearm with a sampling probe which we developed. Both the skin-gas

and the blood samples were collected before exercise, after warm-up and 0, 3, 6, 9, 15 min after the 10-s sprint exercise. The skin-gas ammonia concentrations were measured by the ion chromatographic analysis. Blood ammonia concentrations were measured using the Ami-check (Arkray Co., Ltd., Japan). Results The peak power and the exercise load of the subjects were  $794.0 \pm 1.0$  watt and  $6.1 \pm 0.5$  kp, respectively. Both the skin-gas and the blood ammonia concentrations significantly increased after the exercise compared to pre-exercise values ( $p < 0.01$ ), and then returned to pre-exercise levels. The peak skin-gas concentrations of each subject appeared 3 or 6 min after the sprint exercise. Similar changes in the blood ammonia concentrations were observed, however, there was no significant relationship between the peak skin-gas and the peak blood ammonia concentrations. Discussion The ammonia that appears in the blood during short-term exercise originates from the deamination of adenosine 5'-monophosphate (AMP) to inosine 5'-monophosphate (IMP) in the muscle. This reaction occurs via the purine nucleotide cycle (PNC) and is catalyzed by AMP deaminase (Lowenstein 1972). Ammonia production via the PNC in contracting muscle depends on exercise intensity, and occurs predominantly in fast-twitch muscle fibers (Dudley et al. 1983). In this study, excessive energy demands during the sprint cycle exercise increased the blood ammonia concentrations, and these increased blood ammonia levels might reflect the ammonia concentrations in the skin-gas. Conclusions Skin-gas ammonia concentrations increased after 10-s sprint exercise, and reflected the blood ammonia concentrations. References Itoh H and Ohkuwa T (1991). *Eur J Appl Physiol*, 62, 23-25. Nose et al. (2005). *Anal Sci*, 21, 1471-1474. Lowenstein JM (1972). *Physiol Rev*, 52, 382-414. Dudley GA et al. (1983). *J Appl Physiol*, 54, 582-586.

## RELATIONSHIP OF ADIPONECTIN WITH SOME OF CARDIOVASCULAR RISK FACTORS, TESTOSTERONE, CORTISOL, AND VO<sub>2</sub>MAX IN SEDENTARY YOUNG MEN

Aminiaghdam, S., Moradi, F.

*Islamic Azad University, Saghez Branch*

**Introduction** Adiponectin is the one of adipocytokines secreted by adipose tissue that decreases with increased insulin resistance, dyslipidemia, and diabetes. The purpose of this study was to survey relationships between serum adiponectin levels and some of cardiovascular risk factors, testosterone, cortisol, and VO<sub>2</sub>max in sedentary young men. **Methods** This study conducted on 45 sedentary young men (BMI=26.3 kg/m<sup>2</sup>), between 20 and 30 years old who voluntarily participated in this study. Blood samples were collected to determine blood parameters after an overnight fasting. Also, general characteristics of subjects such as age, weight, body mass index, body fat percent, rest blood pressure, rest heart beat, and maximal oxygen uptake were measured. Pearson's correlation method was used to determine the relations of adiponectin with other variables in sedentary young men. **Results** Adiponectin levels were negatively correlated to insulin ( $r = -0.45$ ,  $p = 0.009$ ), glucose ( $r = -0.27$ ,  $p = 0.007$ ), HOMA index ( $r = -0.40$ ,  $p = 0.002$ ), LDL cholesterol ( $r = -0.25$ ,  $p = 0.008$ ), triglyceride ( $r = -0.30$ ,  $p = 0.003$ ), and testosterone ( $r = -0.41$ ,  $p = 0.002$ ), while positively correlated to HDL cholesterol ( $r = 0.26$ ,  $p = 0.005$ ) and maximal oxygen uptake ( $r = 0.31$ ,  $P = 0.09$ ). No significant correlations were observed between adiponectin levels with total cholesterol ( $r = -0.21$ ,  $p = 0.053$ ), resting blood pressure ( $r = -0.38$ ,  $p = 0.01$ ) and cortisol ( $r = 0.16$ ,  $p = 0.089$ ). Discussion The data suggest that sedentary young men with lower cardiorespiratory fitness and lower adiponectin levels may be associated with disorder in glycemic (Hansen et al, 2010) and lipid profile control (King GL, 2008) so that probability of diabetes type II and cardiovascular diseases increase in these subjects (Hamburg et al, 2007). Furthermore, serum concentrations of adiponectin are directly correlated with testosterone levels (Rolland et al, 2006); however, no correlations between adiponectin levels and cortisol concentrations and resting blood pressure were observed. In contrast, Venkatesh et al (2009) reported a significant relationship between plasma cortisol and adiponectin in critically ill patients. **References** Hansen D, Dendale P, Beelen M, Jonkers R, Mullens A, Corluy L, Meeusen R, Loon L. (2010). *Eur J Appl Physiol*, 109,397-404. King GL. (2008). *J Periodontol*, 79, 1527-34. Hamburg NM, McMackin CJ, Huang AL, Shenouda SM, Widlansky ME, Schulz E, Gokce N, Ruderman NB, Keaney JF, Vita JA. (2007). *Arterioscler Thromb Vasc Biol*, 27(12), 2650-6. Rolland y, Perry H, Patrick P, Banks W, Morley J. (2006). *Metabolism*, 55 (12),1630-6. Venkatesh B, Hickman I, Nisbet J, Cohen J, Prins J. (2009). *Critical Care*, 13: 105-110.

## EFFECTS OF EXERCISE TRAINING WITH WHEAT GLUTEN HYDROLYSATE SUPPLEMENTATION ON LEG FORCE GENERATING CAPACITY IN MIDDLE AGED AND ELDERLY INDIVIDUALS.

Shimmura, Y.1,2, Kobayashi, K.2, Aikawa, M.2, Nakamura, M.2, Kobayashi, M.2, Kanazawa, A.2, Fujikake, H.2, Asada, K.1, Yahata, N.1,2, Yamauchi, J.2,3

*1.Nisshin Pharma Inc. 2.Tokyo Metropolitan University 3. Future Institute for Sport Sciences*

**[Introduction]** Exercise training at home without using strength training equipment becomes increasing in demands of elderly individuals. We have shown that the exercise training with only using body weight for the 10-month period successfully increased in maximum force for average 15% and power output for 13% (Yamauchi et al. 2009). Aging-related muscle loss is also known as a cause of imbalance in protein turnover. It has been suggested that increase in protein intake enhances the synthesis rate of muscle proteins in older individuals. We have demonstrated that exercise with wheat gluten hydrolysate (WGH) supplementation has a beneficial effect on the muscle size (Shimmura et al. ECSS2012). However, there is currently little data available concerning the influence of exercise training with WGH supplementation in human. Therefore, the purpose of this study was to investigate the effects of bodyweight-based exercise training with WGH supplementation on leg muscle force generating capacity in middle aged and elderly individuals. **[Methods]** Twenty-five healthy middle-aged and elderly individuals between 35 and 75 years old completed the exercise training program for 3 months. They were randomly assigned to the exercise training with WGH supplementation group (WS, n=13; 61.6 ± 7.0 years; height, 160.1 ± 7.7 cm; body weight, 58.4 ± 9.8 kg) and the exercise training only group (EXE, n=12; 57.0 ± 13.5 years; height, 159.5 ± 7.5 cm; body weight, 57.7 ± 8.9 kg). The exercise program consisted mainly of exercises for large leg muscle groups without using external weight, performing 10-50 repetitions and 1-3 sets for each exercise. Before and after the training period, body composition, maximum isometric force of knee extension and knee-hip extension movements were measured with bioelectrical impedance analysis (Inbody), the knee extensor and leg press dynamometers, respectively. The EXE was administered total 1.5g containing sugar (77.3%) as a placebo, while WS was administered total 1.5g containing wheat gluten hydrolysate (66.1%), chondroitin sulfate (10.4%), and vitamin B (0.7%). **[Results and Discussion]** Both WS and EXE groups resulted in significant decreases in body weight and body fat, and increases in knee extension and leg extension force generating capacity. EXE group showed a decrease in muscle mass, but WS groups did not. This study showed the important findings with regard to the exercise training with WGH supplementation in middle aged and elderly individuals. Our results suggest that it is possible to gain muscle strength without muscle loss after 3 months of body weight based exercise training with WGH supplementation. **[Reference]** Yamauchi J. *Geriatrics & Gerontology International* 9: 262-269, 2009.

**EFFECT A BOUT ECCENTRIC EXERCISE ON HSP70 IN TRAINED RATS**

Isanezhad, A.

*tarbiat modares university*

Effect a bout eccentric exercise on HSP70 in rat muscles Isanezhad, A1., Saraf, Z H1. Mahdavi, M2. Gharakhanlo, R1. 1 Tarbiat modares university( Iran).2 Pastour institute (Iran) Introduction Myofibrillar disorganization and membrane disruption are hallmarks of exercise-induced muscle damage (Lieber et al 1999), and the functional outcome of such muscle damage is reduced force generating capacity. To counteract harmful events and agents, skeletal muscle cells provide protective mechanisms and produce stress proteins, such as heat shock protein 70. This heat shock protein affected the immune system (Fleshner et al 2003). Methods 24 male Wistar rats (body mass  $250 \pm 9$  g) were used in this study. Rats were maintained on a 12:12-h light-dark cycle and received food and water ad libitum. Rats were randomly assigned to one of four groups: control (Con; n= 6) and exercise group (n= 18). For eccentric exercise all animals ran individually on a  $16^\circ$  decline for 90 min (5-min bouts with 2 min of rest between successive bouts). Twenty four hour after a bout of eccentric we sacrificed animals. Twenty-four hours after the acute exercise bout, all animals were anaesthetized with an intraperitoneal injection of  $200 \mu\text{l}/100$  g body weight of a solution of 40 mg/ml ketamine and 5 mg/ml xilazine and the soleus muscle quickly dissected., rapidly frozen in liquid nitrogen, and stored at  $-70^\circ\text{C}$  until further analysis. After homogenate muscle, HSP70 measured in soleus muscle we used of ELISA kit for HSP70 (R&D system). A one-way repeated-measures ANOVA test used. Result Our result showed that HSP70 significantly increased after a bout of eccentric exercise ( $p \leq 0.05$ ). There is and significant difference between trained and untrained animals in muscular HSP70 ( $p \leq 0.05$ ). Dissuasion We indicated that muscular level of HSP70 rise in soleus muscle after a bout of eccentric exercise. Relatively new area of muscle damage research has focused on the role of heat shock proteins (HSPs) in protection against eccentric contraction-induced injury (Thompson, Clarkson, Scordilis, 2002). HSPs play an important role in cell survival following various stressors, most notably thermal stress (hence the name). hsp 70 is a danger signal for immune cells (Fleshner et al 2003) and may be has effects on inflammatory cells for muscle repair after eccentric in juries. Reference Lieber RL, Friden J. Mechanisms of muscle injury after eccentric contraction. *J Sci Med Sport* 2: 253–265, 1999 Thompson HS, Clarkson PM, Scordilis SP. The repeated bout effect and heat shock proteins: intramuscular HSP27 and HSP70 expression following two bouts of eccentric exercise in humans. *Acta Physiol Scand* 2002: 174(1): 47–56. - Pizza, F X., J. M. Peterson, B. Timothy J. K., 2005. Neutrophils contribution to muscle injury and impair its resolution after lengthening contraction in mice. *J Physiol* 562(pt 3): 899-913 Fleshner M, Campisi J, Johnson JD (2003) Can exercise stress facilitate innate immunity? A functional role for stress-induced extracellular Hsp72. *Exerc Immunol Rev* 9:6–24

**STRUCTURED PHYSICAL EXERCISE PREVENTS THERAPY RELATED LOSS OF PHYSICAL PERFORMANCE IN THE PEDIATRIC PBSCT – PRELIMINARY DATA FROM THE BISON-STUDY**

Arndt, S., Senn, A., Rosenhagen, A., Vogt, L., Siegler, K., Jung, M., Banzer, W., Bader, P.

*Medical Center of the Goethe University*

\* the authors are equal contributors Introduction The hematopoietic stem cell transplantation (PBSCT) is associated with a rapid decline of physical and psychological resources. Especially children and adolescents limit their activity level during and after cancer therapy. For adults evidence suggests, that additional physical activity minimizes or even prevents the loss of cardio-respiratory functioning and therapy-reduced muscle performance (Mello, 2003). The aim of this randomized controlled trial is to evaluate structured sports-interventions in the pediatric PBSCT with regard to the physical benefit of a supportive attendance. Methods Included participants are randomized into a sports or control group after informed consent. The main aspects in the sports group are resistance, endurance and flexibility training. The control group performs a mental training as well as relaxation exercises. The structured training lasts for 40-60 min daily for each group. 6-minute-walking-test, hand grip and knee extension strength are assessed before hospital admission and the day before hospital discharge. Results Six children (2 girls, 4 boys;  $10.7 \pm 3.5$ y) served as intervention group (IG), while eight children (4 girls, 4 boys;  $10.5 \pm 4.3$ y) were randomized into the control group (CG). At discharge from hospital, the relative pre-post hand grip strength (mean [SE]: IG:  $7.0 \pm 6.5\%$ ; CG:  $-10.8 \pm 4.4\%$ ), knee extension strength (mean [SE] IG:  $2.6 \pm 7.5\%$ ; CG:  $-10.9 \pm 8.1\%$ ) and 6-minute-walking-test (mean [SE]: IG:  $-0.9 \pm 4.5\%$ ; CG:  $-11.3 \pm 6.6\%$ ) differ between groups. A positive trend is shown for all physical parameters. But only the hand grip strength represents significant changes ( $p = 0.043$ ) until now. Discussion Following the corresponding pilot study (Rosenhagen et al., 2011) the preliminary data are promising and imply that structured sports intervention can reduce the loss of physical performance during a pediatric pbsct. Current studies with children undergoing cancer therapy support these findings (Wolin, 2010). These results and the fact that activity is an important component of child development confirm the need of interventions during cancer treatment. As next steps the secondary outcomes fatigue, health related quality of life and immunological reconstitution and body composition should be evaluated. The recruitment of the study BISON continues until June 2013. Further findings about the outpatient setting (day +100 & +200) are following. Reference Mello M, Tanaka C & Dullely FL (2003) Effects of an exercise program on muscle performance in patients undergoing allogeneic bone marrow transplantation. *Bone Marrow Transplantation* 32, 723–728. Rosenhagen et al. (2011). Implementation of Structured Physical Activity in the Pediatric Stem Cell Transplantation. *Klin Padiatr* 223:147–151. Wolin et al. (2010). Exercise in adult and pediatric hematological cancer survivors: an intervention review. *Leukemia* 24, 1113-1120.

**PHYSIOLOGICAL AND MECHANICAL RESPONSES AT AND ABOVE MAXIMAL LACTATE STEADY STATE IN SWIMMING**

Almeida, T., Espada, M., Reis, J., Vleck, V., Bruno, P., Alves, F.

*Faculty of Human Kinetics, Technical University of Lisbon*

Introduction In swimming, the velocity corresponding to the maximal lactate steady state (MLSSv), is the highest intensity that can be maintained over time without continuous blood lactate accumulation, defines the transition between heavy and severe domains of intensity, characterized by differences in  $\text{VO}_2$  kinetics (Reis et al., 2011) and stroke parameters (Dekerle et al., 2005). The purpose of this study was to analyze the physiological and mechanical responses at and above MLSSv in swimming. Methods Twelve competitive male swimmers completed an incremental test composed by  $5 \times 250$  and  $1 \times 200$  m front crawl for  $\text{VO}_2$ max determination. For MLSSv estimation, subjects performed, in random order and different days, 30-min at constant velocity at 87.5, 90 and 92.5% of  $\text{vVO}_2$ max. In a complementary day, two 6-min bouts were performed separated by one hour of passive rest between each repetition at 102.5% of MLSSv. Respiratory gases exchange was analyzed using a K4b2 unit with a "aquatrainer" swimming snorkel (Cosmed®). The parameters of the  $\text{VO}_2$  kinetics were modelled with two exponential functions. Best 400 and 800 m performances in a swimming competitive event were recorded (respectively, T400 and T800). Results MLSSv was achieved by all athletes at 90% of  $\text{vVO}_2$ max ( $1.30 \pm 0.04$  m.s<sup>-1</sup>). The athletes completed the two 6-min bouts at a mean swimming velocity of  $1.34 \pm 0.04$  m.s<sup>-1</sup> with seven swimmers exhibiting relevant slow compo-

ment (mean value  $41.4 \pm 21.4$  ml.min<sup>-1</sup>), 1.1% of VO<sub>2</sub>max ( $3767.67 \pm 483,86$  ml.min<sup>-1</sup>). Maximal lactate steady state ( $4.6 \pm 1.2$  mmol.L<sup>-1</sup>) was significantly lower ( $p < 0.01$ ) than at 102.5% MLSSv ( $7.4 \pm 1.4$  mmol.L<sup>-1</sup>), the same was also verified concerning the stroke rate ( $33.3 \pm 3.8$  vs  $37.8 \pm 4.1$  cycles.min<sup>-1</sup>) and rate of perceived exertion ( $5.8 \pm 0.6$  vs  $7.6 \pm 1.0$  in a 0-10 scale). Contrarily, stroke length significantly decreased above MLSSv ( $2.41 \pm 0.27$  vs  $2.17 \pm 0.20$  m.cycle<sup>-1</sup>). MLSSv was inversely correlated to VO<sub>2</sub> primary phase time constant ( $\tau_p$ ) ( $r = -0.59$ ;  $p < 0.04$ ). This last parameter was also correlated with T800 ( $r = 0.58$ ;  $p < 0.05$ ). Discussion Our results corroborate the assumption that MLSSv represents an exercise intensity above which swimmers have to adopt different strategies to deal with fatigue, decreasing stroke length and relying on higher stroke rate in order to maintain a constant velocity for a longer period of time. VO<sub>2</sub> kinetics time constant is related to exercise tolerance and performance, in line with previous results (Reis et al., 2011). References Dekerle, J., Pelayo, P., Clipet, B., Depretz, S., Lefevre, T., Sidney, M. (2005). *Int J Sports Med*; 26(1): 53-58. Reis, J.F., Alves, F.B., Bruno, P.M., Vleck, V., Millet, G.P. (2011). *J Sci Med Sport*; 15(1): 58-63.

### ROLE OF POSTURE IN EXERCISE INDUCED HYPERVOLEMIA

Perissiou, M., Xirouchaki, C., Armenis, E., Geladas, N., Baltopoulos, P.

*Faculty of physical education and sport science*

Introduction The supine posture has been shown to limit exercise-induced plasma volume expansion. Differences in hydrostatic pressure gradients between the standing and supine position. Exercise in water in both positions indicates that vertical posture during exercise might promote a greater plasma volume expansion than supine posture during exercise. Methods To test this hypothesis twenty subjects divided in two teams (swimmers and non swimmers) performed intermittent high intensity exercise (4 min at 85% VO<sub>2</sub>max, 5 min at 40% VO<sub>2</sub>max repeated 4 times) on separate days in the water in vertical and supine posture. Changes in plasma volume expansion were calculated from changes in hematocrit and hemoglobin. Plasma albumin content was also measured. Results Statistical analysis of the data indicated that all participants, both swimmers, as well as non swimmers, presented plasma volume expansion and an increase to plasma albumin content 24 hours after the completion of the vertical posture protocol respect to the values of the pre-exercise measurements. Special concern should be given on the supine posture protocol cause there was no plasma volume expansion or an increase in plasma albumin content 24 hours after the completion of the protocol in both groups due to the values of pre-exercise measurements. There were no significant statistical differences between the two different groups after the vertical exercise protocol in plasma volume expansion ( $p < 0.05$ ) Discussion The results confirm that exercise in water in both positions indicates that vertical posture during exercise promotes a greater plasma volume expansion than supine posture during exercise, though increased values in plasma albumin content after vertical exercise in water were slightly reduced in compare to vertical exercise in ground according to recent relevant articles. In conclusion the mechanism of the redistribution of albumin between extra and intra-vascular stores is altered by posture remains unknown but our speculations are that factors associated with postural changes (e.g. central venous pressure) modify the increase in plasma albumin content and the plasma volume expansion after exercise. References Convertino VA, Mack GW, and Nadel ER. Elevated central venous pressure: a consequence of exercise training-induced hypervolemia? *Am J Physiol* 260: R273- 277, 1991 Havas E, Lehtonen M, Vuorela J, Parviainen T, and Vihko V. Albumin clearance from human skeletal muscle during prolonged steady-state running. *Exp Physiol* 85: 863-868, 2000.

### SUBSTANCE USE IN SPORT COACHES

Nedic, A., Matkovic, A., Matkovic, B.R.

*Faculty of Kinesiology*

Introduction The risk factors influencing health in relation with the way of life are nutrition, physical inactivity, smoking, alcohol consumption and use of drugs (WHO, 2003). Smoking, as well as alcohol consumption start is associated with the influence of friends, parents or older brother and sisters (Epstein, 2000). Sport coaches are specific population who are in contact with children as well as adults. Dealing with children very often they become idols and children try to copy their behaviour. The aim of this study was to examine alcohol and smoking habits in sport coaches. Methods Respondents of this study were active sport coaches of both genders (57 females and 152 males) and from different sport disciplines. Alcohol Use Disorders Identification Test (AUDIT), developed by the World Health Organization (WHO) was used for screening alcohol consumption and for cigarette smoking habits FTND questionnaire (Haetherton et al, 1991). The questionnaires were completed anonymously. The obtained data were analyzed by standard statistical procedures, with statistical software package SPSS 13.0. Results and discussion According to the results it is obvious that wide adopted opinion about people involved in sport having good health habits is not so truth. The percentage of athletes consuming alcohol, mostly beer and wine, is great, even 87%. There is no statistically significant difference among the genders. According to AUDIT only 3 female coaches were above the limit values of AUDIT which indicates dangerous alcohol addiction, but among males 21% was above this limit values. The good observation is that most of the points were collected on questions dealing with alcohol risky behavior and very few of coaches get points on those questions indicating that harmful consequences were already experienced. Concerning the smoking habits it was found that 25% of the female coaches and 19.7% of the males are smokers. The majority of females stated that they are smoking between 5 and 10 cigarettes per day, while among the males dominate those who are smoking from 10 to 20 cigarettes per day. Although this study is showing somewhat lower values of smokers and coaches consuming alcohol than some previous studies conducted in Croatia it is still troubling number especially in the view that coaches are, through their education, well informed about the harmful effects of smoking and alcohol and that they are appearing as authoritative figures to those seeking guidance or information. References Matković B. et al. (2007). *HŠMV*, 22(2), 82-85. Mays D et al. (2010). *Addict Behav*, 35(3), 235-241.

### INFLUENCE OF TYPE OF CONTRACTION UPON TENDINOUS TISSUE DURING TRAINING: ANIMAL MODEL

Kaux, J.F., Drion, P., Croisier, J.L., Besancon, B., Libertiaux, V., Forthomme, B., Colige, A., Le Goff, C., Franzen, R., Defraigne, J.O., Cescotto, S., Rickert, M., Crielaard, J.M.

*University of Liège*

Introduction: The treatment of choice for tendinopathies is eccentric reeducation. Although the clinical results appear favourable, the biomechanical changes to the tissue are not yet clear. Materiel and methods: This study compared the effects of two methods of training (eccentric (E) training and concentric (C) training) with untrained (U) rats. The animals underwent training over a period of five weeks. The tricipital, patellar and Achilles tendons were subsequently removed to perform a traction test to the point of tendon rupture, and a histological analysis was performed. Results: There was a significant improvement in the rupture force of the patellar and tricipital tendons

between the U and E groups. The tricipital tendons in the control group presented a significantly smaller cross-section than the E- and C-trained groups. No significant difference was observed for the constraints between the three groups for all three tendons. However, a tendency towards improvement was observed between the trained and the U groups for the patellar tendon. Histological studies demonstrated the development of a greater number of blood vessels and a larger quantity of collagen in the eccentric group. Discussion and conclusion: The mechanical properties of tendons in rats improve after specific training, especially following eccentric training.

## 14:45 - 15:45

### Poster presentations

#### PP-BN14 Sport Biomechanics 8

##### REBOUND HEIGHT-DEPENDENT MODULATION OF LOWER LIMB JOINTS TORQUE IN DROP JUMP

Urata, T.1, Arai, A.2, Uematsu, A.1, Yamada, K.1, Akiyama, M.1, Ishikawa, M.1, Ito, A.1

1: Osaka University of Health and Sports Science (Osaka, Japan) 2: Mukogawa Women's University (Hyogo, Japan)

**Introduction** In the previous study, the peak torque in knee and ankle joints during countermovement jump was greater with increasing jump height [Vanrenterghem et al., 2004]. However, it is not clear how joint torque control when subject was performed the different rebound height from the same drop height. The purpose of this study was to investigate how angular impulse of torque in each joint control with increasing rebound height. **Methods** Seven male subjects were dropped from a 30 cm-height box and subsequently rebounded with different rebound efforts. Rebound efforts were determined by the maximal rebound efforts (RMAX), 50% rebound efforts (R50%) and no rebound efforts (RNO). The ground reaction force (GRF) and the kinematics of each joint angle were recorded to calculate GRF impulse and angular impulse of the net joint torques (TNET), the interaction torques (TINT), the muscle torques (TMUS), and the gravity torque (TGRA) in each joint during drop jump. In addition, the components of TINT were calculated separately for TINT from other joints (TINT-J) and TINT from GRF (TINT-G) during downward (toe contact-lowest COM position) and upward phase (lowest COM position-GRF below body weight). **Results/ Discussion** The rebound height in R50% ( $17.7 \pm 3.0$  cm) was smaller than that RMAX trial ( $27.0 \pm 3.6$  cm). The GRF impulses of down and upward phases were significantly greater when the rebound height was increased. With higher rebound height, angular impulse of extension TNET in hip and knee joints, extension TINT-J in knee and ankle joints, extension TMUS in knee joint and flexion TINT-G in knee joint were increased in downward phase. In upward phase, extension TNET in ankle joint, extension TINT-J in hip joint, and extension TMUS and flexion TINT-G in knee and ankle joints were increased with higher rebound height. These results suggest human mainly increase the knee joint stiffness to increase the rebound height in downward phase. Previous study reported that human stiffen the knee joint for achieving high frequent hopping [Hobara et al., 2010]. In this condition, rebound height must be lowered. Therefore, controlling the knee joint stiffness have different roll depending on performance requirements, that is to say, performing continuous or ballistic movement. In upward phase, by contrast, increasing angular impulse of extension TNET in ankle joint may be used to elastic energy stored in Achilles tendon. **References** Vanrenterghem J, Lees A, Lenoir M, Aerts P, Clercq DD. (2004). Human Movement Science, 22, 713-727. Hobara H, Inoue K, Muraoka T, Omuro K, Sakamoto M, Kanosue K. (2010). J Biomech, 43, 506-511.

##### COUNTER MOVEMENT JUMP AND DEPTH JUMP: POINTING TOES STRAIGHT FORWARD OR OUTWARD?

Nemtsev, O.

PTJI-ASU (Maikop, Russia)

**Introduction** Counter movement jump and depth jump from various heights are often used in sports training, as well as in fitness training. However, such an element of the technique of counter movement and depth jumping as feet position during contact phase has not been sufficiently researched. Therefore, the aim of this study was to compare the height of jump, peak and average force and ground contact time of counter movement jump and depth jump from 17 and 34 cm heights with toes pointed straight forward and outward. **Methods** From the force plate (VISTI) recordings, the following variables were calculated: flight time; contact time; peak and average vertical force developed during the jump. Six qualified male sprinters and jumpers took part in the investigation (age  $21.3 \pm 1.6$  years; body mass  $81.5 \pm 5.5$  kg; height  $1.81 \pm 0.06$  m). Each of them performed three attempts of counter movement jump (with bilateral arm-swing technique), depth jump from the heights of 17 cm and 34 cm with toes pointed outward, and three attempts of the same jumps with straight forward toes position. A Wilcoxon signed-rank test was used to examine statistical differences of data between both jumping techniques. **Results** Qualified athletes performed counter movement jump and depth jump from 17 and 34 cm heights without showing statistically significant differences in the height of jump in either position of the toes ( $p > 0.05$ ). However, the peak vertical force was significantly bigger during the depth jump from 17 cm height when the athletes performed it with their toes pointed straight forward ( $p < 0.05$ ). The contact time in the depth jump from 17 cm height with straight forward toes position was significantly less than when the athletes' toes were positioned outward ( $p < 0.05$ ). **Discussion** The absence of significant result differences between jumps with various toes positions make this element of technique meaningless for testing jumping abilities with the help of counter movement and depth jumps. The minimum differences of jump height, peak and average force of counter movement jump with various positions of feet allow to conclude that in power training this element of technique has no essential value. It doesn't confirm the existing recommendations about the necessity to use only straight forward toes position when performing this jump [Reid, 1989; Radcliffe & Farentinos, 1999]. Depth jump with straight forward toes position allows to reach a higher value of peak force during the exercise. It confirms the recommendation to use this variety of jumping technique in force training. **References** Radcliffe, JC, Farentinos RC (1999). High-powered plyometrics: 77 advanced exercises for explosive sports training. Champaign, IL: Human Kinetics. Reid, P (1989). Plyometrics and the High Jump. New Studies in Athletics, 4 (1), 67-74.

## COMPARISON OF THREE-DIMENSIONAL SCAPULAR MOTIONS DURING ACTIVE AND PASSIVE ARM ELEVATION

Kai, Y., Takei, K., Madokoro, K., Imura, T., Murata, S.

*Technical School of Medical and Welfare Ryokuseikan*

[Introduction] The normal motions of the scapula seen during arm elevation are produced by coordinated activities of the muscles around the shoulder joint. It was previously reported that abnormal muscular activities arising from shoulder muscle/tendon diseases (e.g., cuff tear and impingement syndrome) often result in abnormal scapular motions. The present study was undertaken to compare three-dimensional scapular motions between two types of arm elevation involving different muscular activities, i.e., between active and passive arm elevation. [Subjects and Methods] The dominant shoulders of 35 healthy subjects (35 male,  $21.2 \pm 1.8$  yrs) were examined. None of the subjects had any history of shoulder pain or injuries before participation to this study. Approval for this study was obtained from the institutional review board at Kurume University (#09078). The motion tested was scapular plane elevation. Active elevation (without a load and with a 3- and 5-kg external load) was compared with passive elevation (induced with an electrical motor-driven elevating device). Three-dimensional scapular motion was determined from electromagnetic tracking sensors (3SPACE-Liberty, Polhemus) attached to the scapular, humerus and thorax during active and passive arm elevation. For each 10-degree elevation of the arm, the angles of upward rotation, posterior tilt, and external rotation of the scapula were calculated. Muscle activity during each type of arm elevation was recorded from surface and intramuscular fine-wire electrodes on each of the supraspinous, upper and lower subscapularis, infraspinatus, middle deltoid, serratus anterior, upper and lower trapezius muscle. Two-way repeated measures analysis of variance was used as statistical analysis. Differences at  $p < 0.05$  considered significant. [Results] The angles of upward rotation and external rotation of the scapula during arm elevation by up to 90 degrees were significantly larger during active than during passive elevation ( $p < 0.01$ ). None of these angles differed significantly depending on the conditions of active elevation (no load, 3 kg, and 5 kg). The angle of posterior tilt of the scapula did not differ significantly between active and passive elevation. [Discussion] The results of this study indicate that scapular motions during arm elevation by up to 90 degrees show three-dimensional differences between active elevation and passive elevation which involve different muscular activities. The results additionally show that scapular motions are preserved even when muscular activity is increased by external loading.

## DIFFERENCES IN LOWER EXTREMITY JOINT KINEMATICS AND KINETICS DURING VERTICAL JUMPS WITH AND WITHOUT A LACROSSE STICK

Sanomura, M., Sakaguchi, M., Saho, Y., Fukubayashi, T.

*Waseda University*

Introduction Non-contact anterior cruciate ligament (ACL) injury has been reported to occur during the early stance phase of landing and/or cutting (Krosshaug et al., 2007). The incidence rate of ACL injury in women lacrosse athletes is higher than those in other competitive athletes. The purpose of this study was to compare lower extremity joint kinematics and kinetics during drop vertical jumps with and without a lacrosse stick. Methods Nine female collegiate lacrosse players participated in our study (mean age,  $20.0 \pm 1.3$  years; height,  $159.6 \pm 5.8$  cm; weight,  $55.1 \pm 6.3$  kg; lacrosse experience,  $24 \pm 3.4$  months). An 8-camera motion analysis system and a force plate were used to record three-dimensional marker positions and ground reaction forces, sampled at 240 Hz and 2400 Hz, respectively. The subjects were asked to perform the double-leg drop vertical jump from a 30-cm-high box (landing on a force plate with their right foot), and raising both arms above the head when vertical jumping, and were recorded for each of the 3 conditions; not holding a lacrosse stick (NH); holding a lacrosse stick in the right hand (RH); and holding a lacrosse stick in the right hand with a target ball (RHT). The values of knee abduction and hip adduction, knee and hip flexion angles at initial foot contact, and the peak values of knee abduction and hip adduction, knee and hip flexion angles, and peak knee abduction and hip adduction moments during the first 30% of the landing phase were compared among the 3 conditions. Results The peak knee flexion angle in the RHT trial was significantly smaller than that in the RH trial during the first 30% of the landing phase ( $109.7 \pm 10.4^\circ$  vs.  $113.5 \pm 9.8^\circ$ ,  $p < 0.05$ ). No significant differences in any other parameters were observed. Discussion The extended knee position during the landing from a jump has been reported may be a risk factor for ACL injury, as assessed by video analysis of actual injury and laboratory motion analysis (Renstrom et al., 2008). With respect to the relationship between the sagittal plane of the knee flexion angle and ACL strain, a cadaveric study showed that quadriceps muscle contraction at a smaller knee flexion angle produces an anterior shear force on the tibia relative to the femur (Li et al., 1999). The results of this study suggest that the RHT trial tended to have a smaller knee flexion angle during landing than the RH trial. Therefore, the drop jump task holding a lacrosse stick with a target (e.g., a lacrosse ball) may be useful as a screening test to prevent lower extremity injuries, such as ACL injury, in female lacrosse athletes. References Krosshaug T et al. (2007). *Am J Sports Med*, 35, 359-67. Renstrom P et al. (2008). *Br J Sports Med*, 42, 394-412. Li G et al. (1999). *J Biomech*, 32, 395-400.

## FORCE DEVELOPMENT OF A TRACK START MOTION ON THE STARTING BLOCK WITH A BACK PLATE IN COMPETITIVE SWIMMING

Takeda, T.1, Sakai, S.2, Ito, S.1, Okuno, K.1, Takagi, H.2, Tsubakimoto, S.2

*1:Waseda University, 2:University of Tsukuba*

Introduction Some studies about swimming start conducted force measurement acting on the starting block during a track start (Cavanagh et al. 1975; Benjanuvatra et al. 2004). However, no study measured the forces acting on the starting block by front leg, rear leg and hands during a track start. Information about force development during a track start was useful for understanding kinetic characteristics and a good example for a swim start instruction. The purpose of this study was to clarify an application of force by a front-leg, a rear-leg and both hands on the starting block. Methods Twelve male competitive swimmers participated in this study. They performed a track start from the starting block with a back plate. Two force plates (9258B11 Kistler Inc, TF-2050-W Tecgihan Inc.) were mounted in the starting block to measure force development by front and rear legs separately during a track start motion. The metallic cylinder bar with two built in two load cells (TL3B04 Tecgihan Inc.) was used to measure force development by both hands during the motion. Track start motions were filmed using four high speed cameras (100fps). We obtained three dimensional (3D) coordinates of swimmer's body parts using 3D DLT method and then extracted 2D coordinates for 2D analysis. 5 m and 10 m head passing time were measure by filming using two cameras placed on the underground pool side deck. Results Changing in horizontal reaction forces showed that peak values appeared in order of by the hands and by the rear-leg, and by the front leg. The amounts of peak horizontal forces by the hands were small. Changing in the vertical reaction forces showed that greater negative force by hands were shown as opposed to the forces by legs. Mean horizontal velocities generated by the front leg, the rear leg and the hands were  $0.35 \pm 0.14$  m/s,  $1.18 \pm 0.26$  m/s and  $2.89 \pm$



0.26 m/s, respectively. Mean vertical velocities generated by them were  $4.98 \pm 0.58$  m/s,  $3.14 \pm 0.28$  m/s and  $-1.58 \pm 0.52$  m/s, respectively. Discussion We have tried to measure force application on the starting block with a back plate during a track start motion. Horizontal reaction force by hands was not greater than a value we expected. The force applied by hands was almost vertical direction. Swimmers pulled the bar by the hands inward at the beginning of starting motion, and they did not push the bar backward to gain the horizontal velocity. The front leg force development dominated the generation of horizontal take-off velocity. On the other hand, the front leg force development dominated the generation of vertical take-off velocity. References Cavanagh P.R., Palmgren J.V. and Kerr B.A. (1975). A device to measure forces at the hands during the grab start. *Swimming II*, 43-50. University Park Press, Baltimore. Benjanuvatra N., Lytle A., Blanksby B., Laekin D. (2004). Force development profile of the lower limbs in the grab and track start in swimming. *Proceedings of XXII International Symposium of Biomechanics in Sports*: 399-401.

## ANALYSIS OF THE PLANTAR PRESSURE ON SOCCER PLAYERS AFTER THE USE OF CUSTOMIZED PLANTAR ORTHOSES

Leiras, J., Villas-Boas, J.P., Sousa, F.

*FADEUP*

ANALYSIS OF THE PLANTAR PRESSURE ON SOCCER PLAYERS AFTER THE USE OF CUSTOMIZED PLANTAR ORTHOSES. Leiras, J.I, Villas-Boas, J. P.1,2, Sousa, F.1,2 1 CIFI2D, Faculty of Sports, University of Porto, Porto, Portugal 2Porto Biomechanics Laboratory (LABIOMEPI), University of Porto, Porto, Portugal Although the use of plantar orthoses is performed in several applications, in recent years, they have led to greater attention particularly in sports. This has been done through the application of engineering expertise, technologies and materials applied. Orthoses are aimed to prevent and treat postural changes and promote a better distribution of body support and balance, which possibly is associated to a better organization of muscle tone and posture. According to Nigg (2003), specific and appropriate footwear for sports practice and the use of insoles or customized orthoses may reduce the frequency of movements that cause injuries, align the skeleton, provide better cushioning, improve comfort and correct the path of the centre of pressure. This study aimed to analyze the distribution of plantar pressure (PP) in soccer players of the Portuguese League, after the use of customized plantar orthoses. Fifteen male, aged between 18 and 35 years were submitted to a morphological and functional podiatric assessment, to better define the construction of the orthoses. Aspects like observation and palpation of the feet; classification of the foot, metatarsal and digital morphology; quantification range of motion of the feet joints; assessment of navicular drop and drift; position of the heel on load; classification of plantar support through the use of pedigráf, podoscopy and Foot Posture Index (FPI), were used. After the analysis of all the parameters, casts and the design of the insole inside the shoe of each individual were done. Orthoses were constructed respecting the anatomical structure of each foot. After testing the suitability of the individuals at the foot insoles and footwear, a comfort perception questionnaire was applied. Volunteers were instructed to wear the orthoses gradually for better adaptation. To analyze PP distribution a Footscan platform was used. Results showed a high incidence of digital and ungual changes, a predominance of hollow foot, heel varus, squared foot, with a high incidence of plantar support asymmetry. Before the use of the orthoses, the PP showed significant higher results on the left foot, and higher pressures on the forefoot area. After the customization of the orthoses, and their use for a period of two months, a redistribution of PP, by improving the bearing surface and distribution of the plantar support between the two feet was observed. Our results show that customized plantar orthoses on soccer players, improve the distribution of plantar loads, increasing the surface contact area and cushioning. It also improves comfort and adaptability of the shoe probably allowing the reduction of overload injuries. Nigg, B. et al (2003). *Medicine & Science in Sports & Exercise*, v.35, n.2, 314-319.

## THE EFFECTS OF SKI TYPE ON ACCELERATIONS AND FORCES DURING ALPINE SKIING

Seifert, J.G.1, Scheiber, P.2, Kipp, R.W.3, Müller, E.2

1: MSU (Bozeman, USA), 2: CDL - Biomechanics in Skiing (Salzburg, AUT), 3: USSA (Park City, USA)

Introduction The alpine ski industry is experiencing a shift towards wider recreational skis. There can be upwards of an additional 3cm width from the binding plate to the ski edge with a wide ski. Yet, little is known how this additional width affects acceleration and force patterns during skiing. The purpose of this study was to compare boot forces and accelerations between a narrow width ski (GS ski) and a wide width ski (powder ski). Methods Data collection began following approval from the IRB. Following a warmup run with each ski, 8 collegiate skiers (FIS GS pts: 71 (29) ) completed 1 run with a 65 mm mid-length width ski (GS; FIS GS) and 1 run with a 102 mm mid-length width ski (WIDE; K2 Coomback). The standardized run consisted of 10 gates that were set 20.5m downhill and 6m offset. The run was groomed nightly prior to data collection. Data from each of the 6 middle turns were averaged and used in analyses. Unidirectional force was measured with force insoles (100 Hz sampling frequency) and boot accelerations were measured with 3-D accelerometers (50 Hz sampling frequency). Data are listed as mean (+/-SD). Alpha level of significance was  $p < 0.05$ . Results No difference in completion time for the 6 measurement gates was observed between WIDE (8.20 (1.39) sec) and GS (8.16 (1.16) sec) skis. The relative total force (L + R legs) and relative force on the inner foot were greater for GS (1.32 (.24) N/kg BW; 0.41 (.11) N/kg BW) than WIDE (1.23 (.20) N/kg BW; 0.34 (.13) N/kg BW). No difference between skis was found for relative force for the outer foot. Co-loading for the inner foot was greater in GS (31.1 (7.8) %) than WIDE (26.7 (7.1) %). No differences between skis were observed for average acceleration in any of the 3 axes. The range in acceleration for the x and y axes were greater for WIDE (x: 64.7 (6.9); y: 66.6(12.7) m/s<sup>2</sup>) compared to GS skis (x: 55.9 (9.8); y: 54.9 (6.9) m/s<sup>2</sup>). Discussion Significant differences in forces and accelerations were found between the WIDE and GS skis. The greater load on the inner leg for the GS skis indicates an increased "two-legged skiing style", due to the self-steering mechanism of these skis. The greater range in accelerations was seen by significantly increased accelerations in the vertical and sagittal planes for WIDE. The significant differences between skis for the ranges and accelerations, within a turn, could indicate less stability for the skier using the WIDE ski on a groomed run. It may be assumed that for each change in acceleration, the body responds with some form of muscular contraction. Further research should evaluate i) force and acceleration data in a deep snow environment and ii) the physiologic effects using wider profile skis during on-piste and off-piste runs.

## HUMAN MOTOR NOISE AND VOLUNTARY MOVEMENT IMPLICATION

Miguel-Gallardo, C.

*Miguel Hernandez University*

Human motor noise and voluntary movement implication. Miguel-Gallardo, C., Barbado, D., Caballero, C, Urbán, T., Moreno, F.J. UMH (Elche, Spain) Introduction In biological systems noise is not completely random (white noise). Biological noises show deterministic patterns (Stergiou & Decker, 2011) and they come in different colours (for example, pink, brown, black) serving different functions (Davis et al,

2003). The aim of this study is to analyze how the structure of a signal changes according to the increased role of biological implication in movement control. To this purpose, we have computed and analyzed the complexity and the degree of autocorrelation of inert variability and movement variability under increased DoF implication. Methods Eight healthy young participants (30.6±8.28 yrs.) took part in the study. To measure inert variability, Polhemus Liberty sensor was placed on a stable surface (240 Hz). After that, the sensor was located on different places on the body according to increased DOF involved: a) on the hand placed on the stable surface (inert condition); b) on the hip, shoulder and on the hand, standing still; and c) on the hand during linear and circle movement. Each condition lasted 60 seconds with 1 minute rest between conditions. Time series data were analyzed through Fuzzy Entropy (FuzzyEn) and Detrended Fluctuation Analysis (DFA). Results The results showed significant higher FuzzyEn values for inert variability. Data from sensor on moving hand showed lower FuzzyEn values, mostly in the Z axis ( $F=89.205$ ,  $p<.001$ ). Results from DFA showed higher persistent correlation as movement implication increased, showing significant differences in every axis (X axis,  $F=138.614$ ,  $p<.001$ ; Y axis,  $F=215.726$   $p<.001$ ; Z axis,  $F=106.705$ ,  $p<.001$ ). Discussion Unlike inert condition which shows a random behavior (white noise), biological conditions show deterministic and random components (Riley & Turvey 2002). The degree of persistent autocorrelation change showing an inverse power-law ( $1/f$  - different colored noise) depending on the tasks (different movement implications). These results would indicate fractal process underlying in the biological behavior (Goldberger et al., 2002). References Davids, K, Shuttleworth, R, Button, C, Renshaw, I, Glazier, P. (2004). 'Essential noise'-enhancing variability of informational constraints benefits movement control: a comment on Waddington and Adams (2003). *Br J Sports Med*, 38(5) 601-605. Goldberger, AL, Peng, CK, Lipsitz, LA. (2002) What is physiologic complexity and how does it change with aging and disease? *Neurobiology of Aging*, 23, 23-26. Riley, MA y Turvey, M. (2002). Variability and determinism in motor behaviour. *Journal of Motor Behaviour*, 64, 99-125 Stergiou, N, Decker, LM. (2011). Human movement variability, nonlinear dynamics, and pathology: Is there a connection? *Human Movement Science*, 30, 869-888.

### THE EFFECT OF SWIMSUIT ELASTICITY TO MASCLE OUTPUT -PILOT WORK FOR NEW SWIMSWIT PRODUCTION-

Gonjo, T.1,3, Tsuboi, J.2, Todoko, F.2, Tsubakimoto, S.3, Takagi, H.3

1: Centre for Aquatics Research and Education, The University of Edinburgh (Edinburgh, UK), 2: Descente LTD. (Tokyo, JAPAN), 3: Institute of Sports Science, University of Tsukuba (Ibaraki, Japan)

Introduction Nowadays, many swimsuits are composed of materials that have strong elasticity. It is advertised that this kind of swimsuit reduces drag, or enables an increase of power during swimming. Reduction of drag may be due to the elasticity of the swimsuit (Oliveira, 2009). However there are few studies that clarify the relationship between elasticity of the swimsuit and the swimmer's power output. Thus, the purpose of this study was to clarify the effect of swimsuit elasticity on muscle power output of swimmers. Methods Fourteen male swimmers participated in this study. The swimsuits used in this study were swimsuit A that has middle-strength elastic material on the back half side, swimsuit B whose back side has strong elastic material, swimsuit C, the back part of which is made by weak elastic material. In the experiment, three concentric hip extension-flexion tests at 60, 120, and 180 deg/sec respectively were performed by subjects wearing each of the three types of swimsuit. An isokinetic dynamometer (Biodex Medical System, Inc.) was used to measure isokinetic power output. Only the right hip extension-flexion was tested, and their upper body and left hip were fixed. Results There were no statistically significant correlations between elasticity of the swimsuit and isokinetic power output. However, when subjects wore swimsuit B, 11, 8, and 10 subjects showed larger isokinetic power output in 60, 120, and 180 deg/sec respectively. The mean values (mean±SD N/m) were as follows; 60deg/sec (swimsuit A: 212.0±32.4, swimsuit B: 220.4±31.4, swimsuit C: 193.9±32.8), 120deg/sec (swimsuit A: 196.9±20.5, swimsuit B: 208.9±28.9, swimsuit C: 189.1±27.3), 180deg/sec (swimsuit A: 184.01±17.86, swimsuit B: 198.60±24.35, swimsuit C: 185.08±29.84). Discussion Although there were no statistical differences, many subjects showed larger muscle output when wearing swimwear B in all three isokinetic angular velocity conditions. In a previous study (Doan et al., 2003) for compression garments, there was evidence that strong material elasticity may assist the athletes' hamstrings so that the height of vertical jumps increased. It is possible that swimsuit B also assists the hamstring power output. References Oliveira, S. (2009). Measurement of compression in different last generation swimsuits using three dimensional-body scanner. Undergraduate thesis submitted to the Faculty of Sport, University of Porto. Doan, B.K., Kwon, Y., Newton, R.U., Shim, J., Popper, E.M., Rogers, R.A., Bolt, L.R., Robertson, M., and Kraemer, W.J. (2003). Evaluation of a lower-body compression garment. *Journal of Sports Sciences*, 21, 601-610.

### RUBBER FULL-BODY SWIMSUIT: PASSIVE DRAG AND BODY POSITION OF GLIDE SWIMMING

Fantozzi, S., Cortesi, M., Di Michele, R., Zamparo, P., Gatta, G.

University of Bologna

RUBBER FULL-BODY SWIMSUIT: PASSIVE DRAG AND BODY POSITION OF GLIDE SWIMMING Fantozzi, S.1, Cortesi, M.2, Di Michele, R.2, Zamparo, P.3, Gatta G.2 1: DEIS (Bologna, Italy), 2: DIEBA (Bologna, Italy), 3: DNNMM (Verona, Italy) Introduction The swimmer's drag is due to the shape of the body and for a lower proportion to friction drag and to wave formation. Full-body swimsuits, initially manufactured using a textile material, reduce considerably the passive drag (Dp, Benjanuvatra et al., 2002). The introduction of rubber suits abruptly improved the swimming performances (O'Connor and Vozenilek J, 2012). The aim of this study was to analyze how the trunk and lower limbs hydrodynamic position, induced by wearing a rubber swimsuit, affects the Dp in glide swimming. Methods 14 male high-level swimmers performed six 20-m trials of passive swimming. From Dp glide position they were towed at the surface by means of an electromechanical motor (Ben-Hur, ApLap Roma) that measures the force needed to tow a swimmer (Dp) at increasing velocities (1.0, 1.2, 1.4, 1.6, 1.8 and 2.0 m/s). The whole protocol was repeated wearing a brief-traditional suit (S, Sali, Arena, Italy) and a full-body (shoulder to ankle) synthetic rubber swimsuit (Rs, X-glide Power-skin, Arena, Italy). The swimmers were filmed with an underwater camera placed perpendicular to the sagittal plane TI angle, between the horizontal and the trunk segment (anatomical landmarks of angle of scapula - greater trochanter) and LI angle, between the horizontal and the lower limbs segment (greater Trochanter - head of the Fibula) were computed. The automatic tracking was performed by an ad-hoc software. Paired Student's t-tests were used to assess the differences between TI, LI and Dp in the two considered swimsuit conditions. Significance was set at  $\alpha = 0.05$ . Results No significant differences were found for TI between S and RS, with the exception of the 1.6 m/s velocity (mean values: 174.0±3.6° vs. 171.8±4.3°, respectively). Conversely, the mean LI angle was significantly larger when the swimmers wore the rubber swimsuit at all the velocities (mean values for six velocities were 188.4±3.9° for Rs compared to 185.5±3.7° for S). The Dp values at the highest velocities (1.6 to 2.0 m/s) were significantly lower in RS. (Dp values at the six velocities were 29.3±4.7, 42.2±9.5, 56.7±6.4, 71.8±10.0, 90.0±11.6, 120.3±15.1 N (for S), and 28.8±4.9, 41.4±6.8, 54.0±9.5, 65.8±9.2, 77.9±9.6, 102.7±13.8 N (for RS). Discussion The present data showed that the RS induces an increase of legs inclination with a raising effect similar to that involved by a pull-buoy. As the drag is reduced by changing the body position during gliding [14], a modified position of the lower limbs may be a further factor contributing to the Dp reduction observed when using a full-

body swimsuit. References Benjanuvattra N, Dawson G, Blanksby BA, Elliott BC. (2002). *J Sci Med Sport*, 5(2), 115-23. O'Connor L, Vozenilek J. *J Strength Cond Res* (2012, in press).

### DO LATERALITY AND STRENGTH ASYMMETRY RELATE TO PREFERRED SIDE IN THE CROSS-COUNTRY SKIING G2 SKATE TECHNIQUE?

Thorrud, S.

*North-Troendelag University College, Levanger, Norway*

DO LATERALITY AND STRENGTH ASYMMETRY RELATE TO PREFERRED SIDE IN THE CROSS-COUNTRY SKIING G2 SKATE TECHNIQUE? Thorrud, S.1, Welde, B.1, Sandbakk, Ø.2 1 North-Troendelag University College, Levanger, Norway; 2 Norwegian University of Science and Technology, Trondheim, Norway. Introduction Laterality, or limb dominance, is well known feature in both humans and animals. In the cross-country skiing G2 skating technique, skiers use an asymmetrical loaded double pole push synchronous with one leg push (strong side), but without poling on the other leg push (weak side). Anecdotal evidence indicates that most elite skiers manage to use both sides without difficulties at low and medium exercise intensities. However, when the intensity increases, skiers show a greater bias towards one side. Therefore, the aim of this study was to examine whether this bias is found in elite skiers, if it is related to exercise intensity and the association with laterality, muscle strength and power asymmetry. Methods Fifteen male cross-country skiers were tested for upper and lower body maximal strength and power on the dominant and non-dominant side in five exercises. General laterality was assessed via the Edinburgh Handedness Inventory and the Waterloo Footedness Questionnaire- Revised. Lateral preferences in the G2 technique at five different intensities, ranging from low to maximal sprinting, were assessed by a five-point scale from always left to always right. Additionally, the subjects rated how well they coped with the G2 on the preferred and non-preferred strong side on a 10-point scale at the five different intensities. Results The degree of coping was significantly different ( $p < 0.05$ ) between the preferred and non-preferred strong side for all intensities. Lateral preference in the G2 was not related to either handedness ( $r = 0.218$ ) or footedness ( $r = 0.282$ ). Strength and power variables were not significantly different ( $p > 0.05$ ) between the preferred strong side and weak side. Coping of the non-preferred side decreased as intensity increased with significant differences ( $p < 0.05$ ) between all intensities, except for the two lowest. Discussion The current study demonstrates a greater bias towards preferring one side in G2 skating among cross-country skiers, and that this bias increase as intensity increases. The athletes' coping of the preferred strong side remains stable across all intensities, whereas coping of the non-preferred strong side decrease. There were no clear patterns of laterality, strength or power related to the preferences in G2 skating. Thus, lateral preference in the G2 is task specific and is not related to laterality in general or the athletes' strength asymmetry.

### RELIABILITY OF AN ISOKINETIC TEST TO ASSESS TRUNK MUSCULAR STRENGTH AND ENDURANCE

García-Vaquero, M.P., Barbado, D., Juan-Recio, C., Vera-García, F.J.

*Miguel Hernandez University of Elche*

Introduction Isokinetic tests are commonly used in laboratory settings to measure trunk muscular strength and endurance, as they are considered important for both athletic performance and health care (Ho et al., 2005; Mayer et al., 1995). The aim of this study was to analyze the reliability of a new flexion-extension isokinetic trunk test to measure trunk muscular strength and endurance, and to examine the effect of repetition on the measurements. Methods Forty physically active volunteers (28 men and 12 women) participated in this study. The isokinetic test (Biodex\*) consisted in performing 4 trials of 15 maximal flexion-extension exertions at 120°/s (range of motion = 50°). In order to assess the repetition effect on the measurements, the test was performed 4 times, with 7 days between sessions. Peak torque (PT) and total work (TW), and their decrease over trials, were used to assess trunk muscular strength and endurance, respectively. Results Extension and flexion PT and TW showed high ICC and low SEM values between trials (PT:  $0.87 \leq \text{ICC} \leq 0.96$ ,  $4\% \leq \text{SEM} \leq 8\%$ ; TW:  $0.73 \leq \text{ICC} \leq 0.98$ ,  $4\% \leq \text{SEM} \leq 16\%$ ) and sessions (PT:  $0.81 \leq \text{ICC} \leq 0.96$ ,  $5\% \leq \text{SEM} \leq 11\%$ ; TW:  $0.81 \leq \text{ICC} \leq 0.95$ ,  $7\% \leq \text{SEM} \leq 16\%$ ). ANOVA for extension PT didn't show significant differences between trials. On the other hand, the maximal extension TW was found in the first or second trial in all sessions. After the second trial, the extension TW decreased due to fatigue, although differences between the third and fourth trials were not statistically significant for session 1 and 4. Overall, the maximal flexion TW and PT were found in the first trial. Afterward, Flexion TW and PT decreased progressively from trial 1 to 4. ANOVA for extension and flexion PT and TW didn't show significant differences between sessions, with the exception of the comparison between sessions 1 and 2 for the first two trials of flexion TW. Discussion These results showed good absolute (SEM) and relative (ICC) isokinetic test reliability. In addition, there was no repetition effect due to learning, training and/or fatigue across sessions for most measures. Therefore, one recording session could be enough to evaluate trunk muscular strength and endurance. In order to achieve the maximal PT and TW, at least 2 trials of the isokinetic test are required. The decreases of PT and TW seem useful parameters to analyze trunk flexion endurance. However, only the decrease of TW seems suitable to assess trunk extension endurance. In general, 3 trials of the isokinetic test are needed to obtain reliable measures of trunk endurance. References Ho CW, Chen LC, Hsu HH, Chiang SL, Li MH, Jiang SH, Tsai KC. (2005). *Spine*, 30(18), E528-533. Mayer T, Gatchel R, Betancur J, Bovasso E. (1995). *Spine*, 20, 920-927.

14:45 - 15:45

## Poster presentations

## PP-PM83 Nutrition 5

**DIFFERENT EFFECTS OF SHORT-TERM PREDNISONE TREATMENT ON BODY COMPOSITION AND ON ADIPOKINES IN HEALTHY, PHYSICALLY FIT WOMEN**

Rieth, N., Jollin, L., Thomasson, R., Amiot, V., Lasne, F., Collomp, K.

*UFR STAPS ORLEANS*

DIFFERENT EFFECTS OF SHORT-TERM PREDNISONE TREATMENT ON BODY COMPOSITION AND ON ADIPOKINES IN HEALTHY, PHYSICALLY FIT WOMEN Rieth, N.1, Jollin, L.1, Thomasson, R.1, Amiot, V.2, Lasne, F.3, Collomp, K. 1,3 1: CIAMS (Université Paris XI-Orléans, France), 2 : Service Médecine du Sport, CHR Orléans, 3: Département des Analyses, AFLD (France) Introduction Long-term glucocorticoid treatment has many known side effects, including weight gain and increased fat mass with skeletal muscle atrophy (Schakman et al., 2008) but deleterious effects of short-term (<2 weeks) systemic administration are still questioning. Methods This randomized, double-blind, cross-over study assessed the food intake of 17 female recreational athletes with and without prednisone ingestion (50 mg/day for 1 week). Body weight, body composition, leptin, adiponectin, insulin and blood glucose levels were determined before and at the end of each treatment. Results One week prednisone intake did not induce significant change in body weight, body composition or food intake. Insulin and blood glucose were not significantly altered by prednisone compared with placebo, but leptin and adiponectin concentrations were significantly increased after prednisone treatment (respectively  $P<0.01$  and  $P<0.05$ ). Discussion This study rules out any side effect of 1 week systemic administration of glucocorticoid on body composition and dietary intake in healthy, physically fit women. These results appear partly in contradiction with some studies (Udden et al., 2003) but in accordance with other works (Beard et al., 1984; Rieth et al., 2009). It can be suggested that the daily exercise habits of our subjects may have counteracted the increased dietary intake and/or the fat mass gain. Further studies are needed to understand the mechanisms behind the prednisone-induced increase in adipokines. References Beard J, Halter J, Best J, Pfeifer M, Porte D (1984). *Am J Physiol*, 247: E592-596. Rieth N, Jollin L, Le Panse B, Lecoq A, Arlettaz A, De Ceourriz J, Collomp K (2009). *Eur J Appl Physiol*, 105:309-313. Schakman O, Gilson H, Thissen JP (2008). *J Endocrinol*, 197: 1-10. Udden J, Björntorp P, Arner P, Barkeling B, Meurling L, Rössner S (2003). *J Intern Med*, 253:225-231.

**THE MINERAL STATUS OF YOUNG ATHLETES**

Rilova, N.1,2, Troyegubova, N.2

*1. Volga Region State Academy of Physical Culture, Sport and Tourism (Kazan, Russia) 2. Kazan State Medical University, Department of pediatrics (Kazan, Russia).*

Introduction From a physiological point of view, many minerals are of major importance for the high intensity physical activity given their role in the maintenance of muscle contraction, nerve impulse, transport of oxygen, activation of enzymes, immune function, antioxidant activity, bone health, and acid-base balance of blood (Dressendorfer et al., 2002). The aim of the study is assessment of mineral status in the hair of young athletes. Methods The content of magnesium, zinc and calcium in the hair samples of 15 young athletes (figure skaters) and 28 healthy children aged 12-16 years was investigated. We used a method of mass spectrometry with inductively coupled plasma mass spectrometer «Elan-9000», the optical emission spectrometry with inductively coupled plasma optical emission spectrometer for «Optima 2000DV». Results It was revealed that the level of magnesium, calcium and zinc was significantly lower in the hair of young athletes than in the hair of the control group: magnesium  $84,3\pm 4,8$  vs.  $171,6\pm 3,9$  ( $p<0.05$ ); zinc  $158,5\pm 7,2$  vs.  $204,5\pm 6,4$  ( $p<0.05$ ) (Micheletti, 2001); copper  $11,4\pm 0,8$  vs.  $15,4\pm 0,4$  ( $p<0.05$ ). Following the mineral screening, the athletes were given individual advice on the basis of gender, age, micronutrient deficiencies, and physical activity. Repeated hair samples were taken one month after the correction. It was shown that the correction of nutrient intake with mineral supplements led to an significant increase in the mineral content of hair samples. Conclusions Identified deficit of the minerals in the hair of athletes is probably due to two reasons: the loss of macro- and micronutrients with sweating (Maughan, 2000) and their movement into the intracellular region (in the active muscle cells). Correction changes can lead to better tolerance of stress among athletes who require special endurance (Lukaski, 2001). References Dressendorfer R. et al. Mineral metabolism in male cyclists during high-intensity endurance training. *Int J Sport Nutr Exerc Metab.* 2002;12(1):63-72. Lukaski H. Magnesium, zinc, and chromium nutrition and athletic performance. *Canadian J Appl Physiol* 2001, 26:13-22. Maughan R. Nutrition and the young athlete. // *Sports Medicine* 2000, 4:51-58. Micheletti A. Zinc status in athletes: Relation to diet and exercise. *Sports Medicine* 2001, 31:577-582.

**EFFECT OF HYDRATION STATUS ON THE DEVELOPMENT OF ACUTE MOUNTAIN SICKNESS**

Gatterer, H.1, Wille, M.1, Lukaski, H.2, Angelini, F.3, Faulhaber, M.1, Burtcher, M.1

*University Innsbruck*

EFFECT OF HYDRATION STATUS ON THE DEVELOPMENT OF ACUTE MOUNTAIN SICKNESS Gatterer, H.1, Wille, M.1, Lukaski, H.2, Angelini, F.3, Faulhaber, M.1, Burtcher, M.1 1:Sport Science, University Innsbruck (Austria), 2:Physical Education, Exercise Science and Wellness, University of North Dakota (USA), 3:Italian Society of Sport Nutrition and Wellness, University of Pavia (Italy) Introduction Low fluid intake and inadequate diuresis are risk factors for the development of acute mountain sickness (AMS) (Mairer et al., 2009). Therefore, the assessment of fluid balance before and during ascent to high altitude could be helpful to avoid excess dehydration and to provide recommendations on fluid intake. A noninvasive method to monitor body fluid variation is the RXc graph method (BIVA) (Piccoli et al., 1996). However, so far the accuracy of BIVA to identify fluid shifts and the impact of these shifts on the development of AMS were not investigated. Method 59 healthy participants (32 males and 27 females, age:  $26\pm 5$  years, height:  $173\pm 8$  cm, weight:  $68\pm 11$  kg) were exposed to a simulated altitude of 4500 m ( $F_{iO_2}=12.6\%$ ) for 12 h. During the 12 h period food and drinks were provided ad libitum. The Lake Louise Score was used to assess the severity of AMS. Before and after the 12 h exposure body weight measurements and bioimpedance analysis (BIA-101, Akern) were performed. BIA analyses were done according to the RXc graph method. The length of each vector was calculated as the hypotenuses of individual impedance values. Plasma osmolality (Posm) was measured by freezing point depression method

(Fiske Osmometer). Urinary volume and fluid intake were collected during the 12 h exposure. Results 43 participants spent the whole 12 h in the hypoxic chamber, 16 had to abort because of severe AMS symptoms. The mean AMS score when leaving the chamber was  $3.5 \pm 2.7$ . Participants drank  $309 \pm 125$  and urinated  $225 \pm 116$  ml/h. Body weight increased ( $68.0 \pm 11.0$  to  $68.4 \pm 11.1$  kg,  $p=0.001$ ) and Posm and the vector length decreased ( $297 \pm 4$  to  $293 \pm 7$  mOsm/kg and  $315 \pm 64$  to  $306 \pm 65$  ( $p<0.001$ )) from pre to post exposure. The ratio between fluid intake and water loss per h and the changes in Posm correlated with the AMS score ( $r=0.289$ ,  $p=0.027$ ;  $r=-0.336$ ,  $p=0.009$ ). Vector length changes correlated with weight changes, with the ratio between fluid intake and water loss and with the fluid intake per h ( $r=-0.587$ ,  $p<0.001$ ;  $r=-0.371$ ,  $p=0.004$ ;  $r=-0.442$ ,  $p<0.001$ ). Discussion The increases in body weight, the reduction in Posm, the shortening of the vector length and the lesser urine volume compared to fluid intake indicate fluid gain. AMS symptoms were more severe for participants whose plasma osmolality dropped the most and for whom the fluid intake was much in excess to the fluid loss. The correlations found for the RXc graph method indicate that vector length changes reflect fluid shifts. References Mairer K, et al. (2009). *High Alt Med Biol*, 10, 239-245. Piccoli A, et al. (1996). *Med Sci Sports Exerc*, 28, 1517-1522.

### EFFECT OF CARBOHYDRATE SUPPLEMENTATION ON HORMONAL AND IMMUNE RESPONSES OF YOUNG TENNIS PLAYERS

Capitani, C.D.1, Gomes, R.V.2, Coutts, A.J.3, Moreira, A.2, Aoki, M.S.2

1 - University of Campinas, Campinas, Brazil; 2 - University of São Paulo, Sao Paulo, Brazil; 3 - University of Technology, Sydney, Australia.

Introduction: The aim of the present investigation was to assess the effect of CHO supplementation on hormonal and immune responses during prolonged tennis match play with well-trained young players ( $n=12$ ; top 50 in Brazil ranking) in an ecological setting. It was hypothesized that CHO supplementation would attenuate the physiological responses related to a match play. Methods: The study was conducted following a randomized, double-blind, placebo-controlled design in order to determine the influence of a carbohydrate versus placebo beverage ingestion on hormonal and immune responses to 3 h of tennis match. Cortisol, testosterone and immunoglobulin A (IgA) concentrations were assessed from saliva samples collected four times on each testing day (7:00, 9:00 (pre-match), 12:00 (post-match), 17:00 and on the following morning 7:00). Salivary steroid hormones and IgA concentration were determined by ELISA kits. Results: Accordingly, to the initial hypothesis, carbohydrate ingestion was associated with lower post-match salivary cortisol ( $p<0.05$ ). No influence of carbohydrate supplementation on salivary testosterone was observed ( $p>0.05$ ). IgA response was not affected during both experimental conditions ( $p>0.05$ ). Conclusion: These data indicate that carbohydrate ingestion during 3 h of competitive tennis match play attenuates salivary cortisol increase as compared to placebo feeding. Previous studies have shown that CHO ingestion during prolonged, high-intensity, intermittent exercise can protect against a decrease in plasma glucose levels that reduces the activation of the hypothalamic-pituitary-adrenal (HPA) axis and blunts cortisol release. On the basis the current findings, it is recommend that players consume CHO to assist in blood glucose regulation and minimize the stress hormones release during extended tennis match play.

### ETHNICITY AND SWEAT SODIUM IN MALE ATHLETES

McLean, D.W., Black, K., Brown, R.

University of Otago

Introduction Inappropriate replacement strategies can impair performance and health. Experts recommend customised fluid and electrolyte replacement strategies during recovery (Sawka et al., 2007). Individualisation is not always practical in a team sport setting. Therefore, identifying groups prone to large sodium losses is important for sports nutritionists. Sweat sodium loss may be influenced by ethnicity. Small field studies in the USA suggest that 'White' male athletes have higher sweat sodium losses than their 'Black' counterparts (Godek et al., 2010). The purpose of this study was to investigate sweat sodium concentrations of male team sport athletes of New Zealand European (EUR) or New Zealand Maori/Pacific Island (MPI) ethnicity. Methods A total of 23 elite rugby players ( $n=9$  EUR,  $n=14$  MPI) volunteered. Body mass was measured before and after a 60 minute pre-season spin (RPM) training session to estimate sweat rate. Sweat patches were placed on the athletes back to estimate sweat sodium concentration. Blood samples were collected and analysed pre- and post-exercise for blood sodium concentration. Results Pre-exercise body mass was not significantly different between EUR ( $100.2 \pm 9.9$ kg) and MPI ( $101.0 \pm 12.5$  kg) ( $p=0.872$ ). Sweat sodium concentration was significantly different (EUR= $42 \pm 13$ , MPI= $66 \pm 9$  mmol/L) ( $p=0.045$ ). However, there was no significant difference in sweat rate between the two groups (EUR= $0.96 \pm 0.53$  vs MPI= $1.01 \pm 0.39$  L/h) ( $p=0.789$ ), nor for post exercise blood sodium concentration (EUR = $137.7 \pm 2.2$  vs. MPI= $139.2 \pm 2.0$  mmol/L), ( $p=0.122$ ). Interestingly two of the participants recorded a blood sodium concentration below 135 mmol/L. Discussion This study indicates that ethnicity may influence sweat sodium losses. This may be due to dietary or genetic differences between the two groups (Eichner, 2008). The findings may allow for a more targeted approach to fluid and electrolyte replacement strategies amongst teams. The finding of two players with a blood sodium concentration below 135 mmol/L suggests that even when exercise duration is short inappropriate fluid intakes can lead to blood sodium dilution. References Eichner, E. R. (2008). Genetic and other Determinants of Sweat Sodium. *Current Sports Medicine Reports*, 7(4), S36-S40. Godek, S. F., Peduzzi, C., Burkholder, R., Condon, S., Dorshimer, G., & Bartolozzi, A. R. (2010). Sweat rates, sweat sodium concentrations, and sodium losses in 3 groups of professional football players. [Comparative Study]. *Journal of athletic training*, 45(4), 364-371. Sawka, M. N., Burke, L. M., Eichner, E. R., Maughan, R. J., Montain, S. J., & Stachenfeld, N. S. (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. *Med Sci Sports Exerc*, 39(2), 377-390.

### EFFECTS OF LEUCINE SUPPLEMENTATION IN THE PROTEIN SYNTHESIS SIGNALLING PATHWAYS OF SOLEUS AND EDL MUSCLES IN YOUNG AND OLD RATS

Chaves, D., Nicastro, H., Lorenzetti, F.M., Dantas, W.S., Campos, P., Luz, C.R., Lancha Jr, A.H.

Universidade de São Paulo

Introduction Supplementation with leucine (Leu) has been used as a strategy to increase muscle protein synthesis and attenuate muscle loss in various situations. However, in old muscles, higher doses are necessary in order to achieve the same response observed in young muscles. The objective of this study was to evaluate the phosphorylation response of proteins involved in the protein synthesis translation initiation in soleus and EDL muscles of young and old rats given either low or high dose of leucine. Methodology Histological analyses were performed in order to confirm morphological differences between the young and old animals. Phosphorylation of eIF4E, 4EBP1, p70S6K was determined using a commercial Enzyme-Linked Immunoabsorbent Assay and oxidative stress was measured using the FOX-1 assay. Results In the young group, the low and high doses of Leu supplementation did not enhance eIF4E phosphorylation neither in soleus nor in EDL muscles. On the other hand, in the old group, eIF4E phosphorylation was enhanced in the high dose of Leu

only in soleus muscles when compared with the low dose. In the young group, the high dose of Leu supplementation enhanced eIF4E phosphorylation when compared to the control group. In the old group, 4EBP1 phosphorylation was not enhanced with either dose of Leu. In the young group, there was no difference in p70S6K with either dose of Leu in both muscles. However, in the old group, p70S6K phosphorylation was enhanced with the high dose of Leu when compared to the control in soleus muscles. Leu supplementation did not alter the levels of plasma hydroperoxide (determined by the FOX-1 assay) in the young group but, in the old group, Leu supplementation was able to reduce FOX-1 in a dose dependent manner. Discussion Here, we showed that the phosphorylation response of young and old animals was different, furthermore, we showed, to our knowledge for the first time that leucine may have an antioxidant/dose dependent effect. This research was supported by FAPESP, grants 2010/10852-6 and the scholarships 2009/52022-2, 2010/08329-3.

### DIETARY PRACTICES AND ANTHROPOMETRIC PROFILE OF PROFESSIONAL MALE SURFERS

Lima Ribeiro, S., Freitas, A.M.P., Pereira, B., Vilalva, R., Krinski, K., Souza-Junior, T.P.

*University of São Paulo, Federal University of Paraná*

**Introduction:** There is a lack of information concerning nutritional status of surfers. This study has the aim to identify dietary practices together with anthropometric variables of a group of professional surfers. **Methods:** The volunteers were recruited at a National Surf Championship in Brazil, and were evaluated for anthropometric measures, indexes and calculations (body mass, height, arm span, body circumferences and nine skinfold thicknesses, arm span/height ratio, waist-to-hip-ratio, conicity index and % body fat). They answered a 24h food-recall, calculated by daily intake of energy, macro-nutrients, some micro-nutrients and food groups were analyzed. The values were compared with some references and position statements and with the Brazilian Food Guide. The daily basal energy expenditure, daily total energy expenditure and energy balance were predicted by specific equations. **Results:** - The intake of carbohydrate is below the position statements, at least considering the day before competition. However, possibly the intake of supplements such as maltodextrin fulfilled the requirements of some, but not all, the athletes; - The intake of BCAA showed to be high; - The low intake of vegetables possibly contributes to the low intake of micronutrients such as folic acid; - The high intake of fried food overlapped healthy habits such as nuts consumption; - The percentage of body fat seems to be similar to swimmers (around 12% of body weight). **Discussion:** This study certainly will contribute to the understanding of body composition and feeding practices of professional surfers. Further investigation, with more sophisticated methods of evaluation, could improve our findings.

### COMPARISON OF PSYCHOLOGICAL STATUS FOR PROPER DIET AND NUTRITIONAL STATUS BETWEEN ADOLESCENT FOOTBALL PLAYERS IN DIFFERENT TEAM

SAKAI, K.1, HOSOYA, M.1, WATANABE, H.1, SUZUKI, I.2, OHTA, A.1

*1: Josai International University (Japan), 2: Utsunomiya Bunsei Junior College (Japan)*

**Introduction** It is well known that prudent nutrient intake and certain dietary constituents improve physical performance and/or maintain physical condition in youth football players. In Japan, all of adolescent football players registered into Japan Football Association belong to only one team under three different organizations: Nippon Junior High School Physical Culture Association (school-based team), Japan club youth football federation (town-based club team), and J. league (academy team). Therefore, the aim of this study is to compare the psychological status for proper diet and nutritional status in adolescent football players belonging to three different teams. **Methods** The cross-sectional study used a questionnaire consisting of decisional balance, self-efficacy, behavioral skills, social support, perceived environment and food accessibility for proper diet (Sakai et al., 2009). Twenty two U-15 footballers in school-based team (ST), fifty seven in town-based club team (TT) and thirty seven in J. league academy team (JT) completed the questionnaire and 2-day food records. **Results** Positive perception (pros) and self-efficacy in TT were higher than in ST. Perceived environment and food accessibility in ST was lower than in both groups. Most nutrient intakes including major nutrients, vitamins and minerals in JT were higher than in both groups, but there were no significant difference in nutrient densities except for vitamin A among all groups. **Discussion** Scores of psychological and social factors for proper diet in TT and JT tended to be higher than in ST. These results suggest that the players belonging to club team have higher consciousness to become good footballer. They joined club team although they were also able to join their school-based team. By the way, nutritional status, including intakes energy and most nutrients in JT was higher compare to other groups. There was not significant relationship between psychological and social factors for proper diet and nutritional status. The environment of each team may influence these results. The coach and trainer only in JT have received the education about sports nutrition to obtain the national license of coach. **Limitation** The population size in each group was small. Moreover, training intensity, duration and frequency was not investigated. It will be need for further study to elucidate the relationship between psychological factors for proper diet and nutritional intakes in adolescence football players belonging to different organizations. Reference Sakai K, Ohta A, Sugiura K, Akamatsu R. (2009). JSHEP, 17(4), 248-256 (in Japanese)

**14:45 - 15:45**

## Poster presentations

### PP-SH16 Sport Psychology: Team sports

#### DIFFERENTIAL CONTRIBUTION OF EACH ONE OF THE THREE BASIC PSYCHOLOGICAL NEEDS ON INDICATORS OF WELL-BEING IN YOUNG FOOTBALLERS

González, L., Fabra, P., Mercé, J., Rodenas, L., Castillo, I., Balaguer, I.

*Universitat de Valencia*

**Introduction** Self-Determination Theory (SDT; Deci & Ryan, 2000) postulates that there are three basic psychological needs –competence, autonomy, and relatedness– that when satisfied yield well-being and optimal functioning (Ryan & Deci, 2000). The purpose of the present study was to analyze whether, according to SDT, footballers' satisfaction of the three basic psychological needs for autonomy, competence and relatedness, predicts indices of well-being (self-esteem, subjective vitality, and satisfaction with life), and in addition, to exam-

ine the specific contribution of each one of the basic psychological needs on the three different indicators of well-being. Methods 597 male footballers from the Valencian Community Football Federation (Spain) aged between 11 and 14 years old ( $M = 12.91 \pm 0.68$  years) completed a questionnaire package tapping the variables of interest. Three multiple regression analysis were performed using self-esteem, subjective vitality and life satisfaction as dependent variables and the three basic needs as independent predictor variables in each analysis. Subsequently, semi-partial correlation analyses (Cooley & Lohnes, 1976) were performed to examine the specific contribution of each one of the three basic psychological needs on the variance of the different indicators of well-being. Results Satisfaction of the three basic psychological needs predicted each indicator of well-being in the expected direction. Competence explained most unique variance in self-esteem ( $r = .27$ ), followed by the need of relatedness ( $r = .15$ ) and need of autonomy ( $r = .11$ ). Satisfaction of the need of autonomy ( $r = .22$ ) explained most unique variance in subjective vitality, followed by the need of relatedness ( $r = .15$ ) and need of competence ( $r = .12$ ). Finally, the contribution of each one of the basic psychological needs to the variance of satisfaction with life was very similar ( $r = .15$ ). Discussion Results confirmed predictions of the SDT, showing the basic psychological needs as positive predictors of the three indicators of well-being in young footballers. The contribution of each one of the basic psychological needs was not consistent in the case of each well-being indicator examined. This Research was funded by Ministerio de Ciencia e Innovación (DEP2009-12748), Spain. References Cooley, W.W. & Lohnes, P.R. (1976). Evaluation research in education. New York: Irvington Publishers. Deci, E.L. & Ryan, R.M. (2000). The 'what' and 'why' of goal pursuits: Human needs and the self-determination of behaviour. *Psychological Inquiry*, 11, 227-268. Ryan, R.M. & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68-78.

## RED SHIRT COLOUR AND THE HOME ADVANTAGE IN ENGLISH PREMIER LEAGUE FOOTBALL

Allen, M.

*London South Bank University*

Introduction The home advantage, which refers to a greater success rate in home versus away competitions, is a robust phenomenon that has been consistently demonstrated in various sports (Jamieson, 2010) There is also a growing body of research evidence that the colour red is associated with a greater incidence of victory in physical contests (Hill & Barton, 2005). Shirt colour represent one potential contributing factor to the home advantage in sport since home teams designate their shirt colour (away teams must wear a contrasting colour) and red shirts have been associated with a greater winning percentage in team sport competitions. This study explored the relationship between teams' home shirt colour and the magnitude of the home advantage. Method Data from 7340 matches played over the first 19 seasons of the English Premier League were obtained from the official website of the English Premier League. Data on home team shirt colour over the 19 seasons were obtained from official club websites and cross-checked with online encyclopaedias. The home advantage was calculated as the total points gained in home fixtures as a percentage of the total points gained in the season. The shirt colours explored were red, blue, white, and a fourth grouping of other colours. Results The data show that teams wearing red are more successful than teams wearing blue, white or other colours,  $F(3, 382) = 18.81, p < .001, \eta^2 = .13$ , and that teams are more successful in home games than in away games (home advantage index = .609) ( $t(385) = 29.52, p < .001, d = 1.34$ ). After controlling for team ability, it was found that teams opting for red shirts in their home games did not show a greater home advantage than teams opting for blue, white or other colour shirts,  $F(3, 381) = 1.73, ns, \eta^2 = .01$ . Discussion Although a "red win" effect and a home advantage effect were both observed, the main hypothesis that teams contesting their home games in red would show a greater home advantage was not supported. This finding has two possible explanations: 1) the red win shirt effect represents a type 2 error (in this sample successful teams just happen to play in red) or 2) the benefits of playing in red extend to away competitions even though teams are not playing these competitions in red shirts. It is recommended that researchers continue to explore the effect of shirt colour on athlete and team behaviour. References Hill, R. A., & Barton, R. A. (2005). Red enhances human performance in contests. *Nature*, 435, 293. Jamieson, J. P. (2010). The home field advantage in athletics: A meta-analysis. *Journal of Applied Social Psychology*, 40, 1819-1848.

## PASSION FOR OFFICIATING FOOTBALL AMONG TOP-CLASS REFEREES

Johansen, B.T.1, Bjørnstad, J.O.1, Giske, R.1,2

*University of Agder 1 & University of Stavanger 2*

Introduction Do top-class football referees see officiating as a passionate activity and thereby get highly motivated and involved despite experiencing extensive pressure and negative emotions? Vallerand and his colleagues (Vallerand et al., 2003) have defined passion as a strong inclination or desire toward an activity that one likes (or even loves), that one finds important (high valuation), and in which one invests time and energy. The aim of this study is to investigate the role of passion for officiating football among Norwegian top-class referees. Methods This cross-sectional study was conducted as a part of the "Norwegian Elite Referees in football"-study. A total of 83 from 98 (84.7 %) top-ranked referees (73 males and 10 females) from age 20 to 46 (mean age 33.3 years) completed a questionnaire using SurveyXact, a web based program for electronic questionnaires. In one of the questions the referees were asked to report randomly three main reasons or motives for officiating football. The data were analyzed using a well specified phenomenological procedure for qualitative research (Marton, 1995). Results were obtained by bracketing, intuiting, and describing the different motives reported and organized into categories of description. The different categories of description that emerged were studied and regrouped by two colleagues. Results 236 different motives for being a referee reported were bracket and grouped, and three main categories emerged; passion motives, 61 % (e.g., simply love football, enjoyment, mental fulfillment, coping of stress), social motives, 26 % (e.g., meeting with people, staying in football, competition situation, member of the team), fitness motives, 13 % (e.g., physical activity, being in good shape, body appearance). A second analysis of the category passion motives revealed two main categories of passion; activity related passion (e.g., enjoyable, leadership, incredible fun), and performance related passion (e.g., handling stressful situations, feeling of success, leadership fulfillment). Discussion Norwegian top-class referees are passionate in their refereeing and are truly motivated by just being part of the football family and playing a vital part of the game, and based on research in this field, there is little or no reason for suggesting that this is not the case for football referees in other parts of the world. One could say that Norwegian top-class referees' officiating is more or less based on the enjoyment in refereeing in itself, and their desire for an errorless performance. To handle the implementation of the laws throughout a football games gives them great satisfaction and fulfillment, and they are passionate about it! References Vallerand RJ et al. (2003). *J Pers & Soc Psy*, 85, 756-767. Marton F. (1995). *Nord Ped*, 15, 165-180.

**POMS DIFFERENCES BETWEEN SOCCER PLAYERS UNDER SIMILAR CIRCUMSTANCES.**

Pastor, D.1, Bonete, E.1, Sarabia, J.M.1, Aracil, A.1, Moya, M.1

*1: Research Group on Healthy Physical Conditioning, Centro de Investigación del Deporte, UMH (Elche, Spain).*

**Introduction** It is well known that self-perception of mood correlates with performance in several sports. Mood can be influenced by multiple types of social and psychobiological stimuli. In order to understand the role that perception of competitive status can have in collective sports, such as soccer, two soccer teams that were initially in the process to losing their competitive status were studied. **Methods** Two competitive non-professional soccer teams that were in the process of descending to a lower competitive status during the last three weeks of the tournament were included. Whilst one of them (team A) maintained its category, the other (team B) lost it. During the three weeks, players of each team completed weekly the POMS questionnaire after a training session (Filaire et al, 2001). Data were aggregated depending on the minutes played by each player during the three weeks, and compared between the two teams. Results When compared among teams, there was a tendency to reduce the POMS score over the period ( $p=0.05$ ), with the players feeling less tension ( $p=0.05$ ), depression ( $p=0.01$ ) and anger ( $p=0.05$ ) in the team A. In the team B increasing values in POMS score ( $p=0.05$ ) and especially anger ( $p=0.05$ ), were found in the players that didn't play in the last three matches ( $n=3$ ), in comparison with their colleagues that played more than 150 min ( $n=9$ ). After losing category, team B' players that played more than 150 min showed more depression ( $p=0.05$ ) and confusion ( $p=0.03$ ) than their colleagues. **Discussion** Our data suggest that game results and circumstances in soccer psychologically affect the players differentially. This should be taking into account when planning psychological interventions at high competitive situations like the one described in this report. **References** Filaire E, Bernain X, Sagnol M, Lac G. Eur J Appl Physiol. 2001 Dec;86(2):179-84.

**COPING MECHANISMS OF JAPANESE TEAM SPORT ATHLETES IN RESPONSE TO INJURY**

Geisler, G.1, Razavi, S.2, Kerr, G.2

*1: University of Edinburgh, 2: University of Toronto*

**Introduction** Injury in competitive sport can jeopardize an athlete's confidence, self-esteem, and sense of identity (Brown, 2005). Research into corresponding coping mechanisms has centered largely on problem-focused and emotion-focused strategies, but the integrated model of Wiese-Bjornstal, Smith, Shaffer, and Morrey (1998) also lists ethnicity and various social influences as factors in the psychological response to injury and rehabilitation. Therefore, the aim of this study was to examine the coping mechanisms of non-Western (Japanese) team sport athletes after debilitating sports injuries. **Methods** The participants were 12 Japanese intercollegiate athletes who competed in soccer, rugby, baseball, and American football. Each had sustained a serious injury and was currently involved in a physical rehabilitation program. Data were collected through semi-structured interviews and responses were transcribed verbatim. They were then analyzed via content analysis, which identified various meaning units that were categorized into higher order themes. Results All of the athletes used a near-equal share of problem-focused and emotion-focused coping strategies. The most common methods involved physical interventions and distractions, such as swinging a bat while sitting, picking up balls for the pitcher, and participating as much as possible in team warm-up and cool-down activities. To maintain spirits and a sense of accomplishment, players also tried to stay active by doing core conditioning and training uninjured parts of the body. Lastly, many players reported a total reliance on their trainers as a coping resource. **Discussion** A number of culturally-derived cognitions could be gleaned from the research data. To illustrate, beliefs that 'getting injured prevented me from contributing to the team,' 'the trainers' devotion to my recovery kept me from giving up,' and "the trainer has been working to treat me so I have to make progress" reflect the collectivistic nature of Japanese society and the hierarchical power dynamics within groups (Markus & Kitayama, 1991), including those of sports teams. Accordingly, the findings are compared and contrasted with the extant literature for Western athletes, and implications for future research and practice are addressed. **References** Brown, C. (2005). Injuries: The psychology of recovery and rehab. In S. Murphy (Ed.), *The sport psych handbook* (pp. 215-236). Champaign, IL: Human Kinetics. Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, 98, 224-253. Wiese-Bjornstal, D. M., Smith, A. M., Shaffer, S. M., & Morrey, M. A. (1998). An integrated model of response to sport injury: Psychological and sociological dynamics. *Journal of Applied Sport Psychology*, 10, 46-70.

**PRE COMPETITIVE ANXIETY AND ROLE OF ACHIEVEMENT MOTIVATION ON PLAYING PERFORMANCE**

Antony, V.C., Tomar, R.

*King Fahd University of Petroleum and Minerals//PHYSICAL EDUCATION DEPARTMENT*

**PRE COMPETITIVE ANXIETY AND ROLE OF ACHIEVEMENT MOTIVATION ON PLAYING PERFORMANCE** Antony, Varghese C.1, Tomar, Rakesh.2  
1: KFUPM (Dhahran, Saudi Arabia), 2: KFUPM (Dhahran, Saudi Arabia) **Introduction** Anxiety and Motivation are important psychological variables in sports and it is needed to achieve high level of competition. Taylor (1994) treated motivation as the base of a pyramid towards success in sports. The elements of anxiety have a major influence in the athlete's performance in any sport. Authors examined relationship of sports pre-competition trait anxiety & achievement motivation on football performance. **Methods** Sixty football players (M age = 22.6 years) were selected as subjects, who played divisional football tournament at Jabalpur, India. Sports Competition Anxiety Test (Martens 1977) & Sports Achievement Motivation Test (Kamlesh 1990) were administered few hours and one day prior to the tournament respectively to collect data. As per SCAT scores, players were divided into moderate level and high level anxiety groups. Football playing performance was assessed by using a subjective evaluation chart prepared by soccer experts. Results Pearson Product Moment Correlation found significant relationship between achievement motivation & football playing performance ( $r=0.367$ ,  $p<.05$ ). A positive relationship was established between pre-competitive moderate anxiety level players & playing performance ( $r=0.348$ ,  $p<.05$ ); and negatively related with pre-competitive high anxiety level players & football playing performance ( $r=-0.139$ ,  $p<.05$ ). **Discussion** Football players showed significantly high level of achievement motivation towards playing performance ( $r=0.367$ ,  $p<.05$ ) which is supported by (Dureha et al., 2010; Unierzyski, 2003; Butt&Cox, 1992) who had noticed achievement motivation is one of the attributes of higher performance. Moderate anxiety level players shown positive relationship towards performance ( $r=0.348$ ,  $p<.05$ ) which endorses findings of (Bawa, 2001) that higher level performance group has moderate level of anxiety than the low level performance group. High anxiety level players had negative relationship with performance ( $r=-0.139$ ,  $p<.05$ ). If anxiety is not handled well or misinterpreted, athlete will lose control and their performance will decrease (Martens et al. 1990; Gualberto & Wiggins, 2008). **References** Bawa K (2001). *Journal of Sports Science*, Vol24, (3): 42-48 Butt DS, Cox DN (1992). *Int. J. Sport Psychol.*, 23: 1-13. Dureha DK, SinghM, Yaduvanshi S, Mishra P. (2010). *Brit.J.Sports Med.*, 44, 58-58. Gualberto CJ, Wiggins MS (2008). [www.athleticinsight.com/Vol10Iss2/TraitAnxiety.htm](http://www.athleticinsight.com/Vol10Iss2/TraitAnxiety.htm) Kamlesh ML (1990). *NIS Scientific Journal*, 13; 28-39. Martens R (1977). *Sports Competitive Anxiety Test* Champaign, IL: Human Kinetics. Martens R, Vealey RS, Burton D.



(1990). Competitive Anxiety in Sport. Champaign, IL: Human Kinetics Taylor J (1994). Pre-match routines. International Tennis Federation Coaches Review, 4, 11. Unierzyski P (2003). JSSM, 2, 184-186

### LONGITUDINAL STUDY OF COACH BEHAVIORS, BASIC PSYCHOLOGICAL NEEDS AND WELL-ILL/BEING IN YOUNG FOOTBALLERS: A TEST INVARIANCE OF TWO CONSECUTIVE SEASONS

González, L., Fabra, P., Castillo, I., Tomás, I., Balaguer, I.

*Universitat de València*

**Introduction** Self-determination theory holds that autonomy supportive coaching style will promote well-being, whereas controlling coaching style will favor ill-being (Ryan & Deci, 2000). It has been also suggested that when the psychological needs are satisfied, well-being will be improved and when those needs are thwarted, well-being will be diminished and ill-being likely to result. The purpose of this study was to examine the relationship between changes in perceptions of the coach style (Autonomy supportive and Controlling) to changes in footballers' need satisfaction/need thwarting and indices of self-esteem/burnout over a two consecutive football season (four points in time) and to test season invariance. **Methods** 360 male footballers from the Valencian Community Football Federation, aged between 11 and 13 years old at Time 1 ( $M = 12.6 \pm 0.53$  years) completed a questionnaire package tapping the variables of interest. Data were gathered at two points in time during two consecutive seasons. The experience in competitive football at Time 1 was 3.59 years. **Results** Structural Equation Models were performed using LISREL 8.80 (Jöreskog and Sörbom, 2006). Results revealed that in Time 2 controlling Time 1 (first season), and in Time 4 controlling Time 3 (second season), changes in autonomy support to be a positive and significant predictor of changes in need satisfaction. Moreover, changes in coaching style (autonomy supportive and controlling) predicted (negatively and positively, respectively) changes in need thwarting. In turn, changes in need satisfaction emerged as a positive and significant predictor of changes in self-esteem. Finally, changes in need thwarting positively and significantly predicted changes in burnout and negatively predicted change in players' self-esteem levels. Only in the first season, changes in need satisfaction emerged as a negative and significant predictor of changes in burnout. **Results of the Multisample Invariance Models** also supported the invariance of the relationship across seasons. **Discussion** The relationship model was invariant across two seasons, which indicates the strong importance of promoting autonomy supportive atmospheres with young footballers and avoiding controlling styles to facilitate young athletes' well-being and to prevent ill-being. This Research was funded by Ministerio de Ciencia e Innovación (DEP2009-12748) Spain.

### ANXIETY IN OFFICIATING FOOTBALL AMONG NORWEGIAN TOP-CLASS REFEREES

Bjørnstad, J.O.1, Johansen, B.T.1, Giske, R.1,2

*1University of Agder, Norway and 2University of Stavanger, Norway*

**Introduction** According to Helsen & Bultynck (2004) the most important aspect of football refereeing is the decision-making process. Officiating can also be emotionally pressured, and referees need great communication skills and a calm attitude when explaining their decisions to players. Referees who have a high trait anxiety view more situations as more threatening than those with lower trait anxiety and so respond with a higher state anxiety. This is known as competitive trait anxiety (Spielberger 1983). The aim of this study is to measure Norwegian top-class referees' anxiety in officiating before and during a football match. **Methods** This cross-sectional study was conducted as a part of the "Norwegian Elite Referees in football"-study. A total of 83 from 98 (84.7 %) top-ranked referees (73 males and 10 females) from age 20 to 46 (mean age 33.3 years) completed a questionnaire using, SurveyXact, a web based program for electronic questionnaires. The questionnaire required referees to provide demographic information (age, gender, civil status) and details relating football playing experience, refereeing experience, and current referee status. The questionnaire also consists one of the most long-standing and frequently used measure of anxiety, State-Trait Anxiety Inventory STAI (Form Y) (Spielberger 1983). Cronbach's alpha in this study was 0.84. **Results** All the referees were former football players. Refereeing experience varied from 4 years to 33 years. The referees were also asked whether they played football in their spare time, and 81.7% said they rarely or never played football. Anxiety level among top-class referees show that all values are within 20 and 45, and this score is in line to findings in different elite sports (Hanin 2000). Mean score was 28.03 and the standard deviation was 5.44. The correlation analyses revealed only a significant inverse association between refereeing experience and level of anxiety ( $r = -.24$ ,  $p = .03$ ). **Discussion** The findings revealed that more experienced referees typically reported lower level of anxiety. This may be due to their experience in ability to 'read' the football game and thereby know to handle the different perceptual-cognitive demands. However, it should be investigated further if there are other background variables that help to reduce anxiety and tension level before and during a football match. The number of correct and incorrect decisions related to referees personality and perceived refereeing competence are probably factors that influence the trait anxiety and degree of stress officials have to cope throughout a game of football. **References** Hanin, Y.L. (2000). Human Kinetics: US Helsen, W. & Bultynck, J.B. (2004). J Sports Sci, 22 (2): 179-189 Spielberger, C.D. (1983). Palo Alto, CA: Mind Garden.

### ACCURACY AND REPRODUCIBILITY OF A GPS DEVICE TO ASSESS SPRINTING PERFORMANCE

Urbano, R., Suárez-Arrones, L., Suárez, G., Núñez, F.J.

*Pablo de Olavide University*

**Introduction** The accuracy of GPS devices to measure distance covered in team sports and their use as an alternative to photocells to evaluate sprint and RSA performance, has been described previously (Barbero-Alvarez et al., 2010; Coutts and Duffield, 2010). The purpose of the present study has been to determine the validity of the GPS device model (VX300) to assess performance in sprint and to determine its reproducibility test-retest. **Methods** This study has been carried out in two parts involving 75 physically active athletes. The first test consisted in performing a lineal sprint of 50-m carrying the GPS (VX300) device, with timings taken through photocells at the distances of 30 and 50-m (N=75). The second phase consisted in repeating the same test with some of the athletes 6 hours later to measure the reproducibility (N=20). **Results** The average time of the athletes at 30-m (T30) and 50-m (T50) were 4.5 and 7 s respectively, while the average time between these distances 30\_50-m (T30\_50) was 2.4 s. The information obtained using the GPS, shows that the average maximum peak in velocity (PS) was 30.9 km/h. There were significant correlations ( $P < 0.01$ ) between the T30 y PS (-0.89), between the T50 y PS (-0.91), and between the T30-50 y PS (-0.91). The results to determine the test-retest reliability during the lineal sprint show for the T30, T50 and PS some coefficients of variation (CV) de 0.9, 0.9, y 1.8% respectively. **Discussion** The results of the study show that there exists a strong correlation between the times obtained through the photocells and the peak of speed reported by the GPS device. In spite of these high correlations, the results show a slight decrease in values found in another study however carried out with different devices and distances (Barbero-Alvarez et al., 2010). **References** Barbero-Alvarez J.C., Coutts A., Granda J., Barbero-Alvarez V., Castagna C.

(2010) The validity and reliability of a global positioning satellite system device to assess speed and repeated sprint ability (RSA) in athletes. *J Sci Med Sport* 13:232-5. Coutts A.J., Duffield R. (2010) Validity and reliability of GPS devices for measuring movement demands of team sports. *J Sci Med Sport* 13:133-5.

### ACCURACY OF A GPS DEVICE TO ASSESS RSA

Suárez, G., Suarez-Arrones, L., Urbano, R., Núñez, F.J.

*Pablo de Olavide University*

**Introduction** The accuracy of GPS devices to measure distance covered in team sports and their use as an alternative to photocells to evaluate sprint and RSA performance, has been described previously (Barbero-Alvarez et al., 2010; Coutts and Duffield, 2010). The purpose of the present study has been to determine the validity of the GPS device model (VX300) to assess performance in repeated sprint ability none linear (Shuttle Sprint test). **Methods** This study has been 30 physically active athletes. They did a RSA test with change of direction (Shuttle Sprint Test), times obtained using photocells and carrying the GPS device. The variables obtained by RSA test have been: the best time or the highest peak of velocity (RSABest), the average time or average peaks of velocity (RSAMean) and the fatigue rate (RSAIFF). **Results** Through the "RSA Test", using fotocell, the athletes obtained an average time of 7.33 s for the RSABest, a RSAMean of 7.81 s and a RSAIFF of 6.54. Using the GPS device, the RSABest was 26.09 km•h<sup>-1</sup>, a RSAMean of 23.94 km•h<sup>-1</sup> and a RSAIFF of -8.21. The correlations found between both devices being -0.81 in the RSABest, of -0.95 in RSAMean and of -0.38 in the RSAIFF. **Discussion** The results of the study show that there exists a strong correlation between the times obtained through the photocells and the peak of speed reported by the GPS device. Similar results have been found in another study however carried out with different devices and distances (Barbero-Alvarez et al., 2010) **References** Barbero-Alvarez J.C., Coutts A., Granda J., Barbero-Alvarez V., Castagna C. (2010) The validity and reliability of a global positioning satellite system device to assess speed and repeated sprint ability (RSA) in athletes. *J Sci Med Sport* 13:232-5. Coutts A.J., Duffield R. (2010) Validity and reliability of GPS devices for measuring movement demands of team sports. *J Sci Med Sport* 13:133-5.

**14:45 - 15:45**

## Poster presentations

### PP-PM84 Physiology 24

#### QUADRICEPS MUSCLE STRENGTH IN PARKINSON DISEASE

Oliveira, R., Borges, E., Silva, M., Paulista, H., Moraes, A., Santos, T., Lunardi, C., Vidal, S.

*Universidade de Brasília - UnB*

**Introduction** Besides the classic symptoms of Parkinson's disease (PD), such as bradykinesia, shaking palsy and rigidity, recent studies using sensitive equipment, have identified decreased muscle strength in these patients compared with control subjects. A comparison of strength between the members has also been evaluated, but is still poorly documented and the results are conflicting. In order to contribute to more evidence, the objective of this study was to evaluate the strength of the member most involved with the least involved on the knee extension in patients with Parkinson's disease. **Methods** 14 Men diagnosed with PD (mean SD 1: age 64 SD 3.1, body mass index 74.8 SD 13, height 1.68 SD 0.1, BMI 26.6 SD 4) were recruited from outpatient Parkinson's Hospital de Base and the Parkinson's Association members at Distrito Federal - Brasília, the stage of disease between 1 and 3 based on the modified scale Hoehn and Yahr. The test consisted of three sets of 10 repetitions of bilateral knee extension at 90 ° S -1, using an isokinetic dynamometer. We used the paired Student t test and used p <0.05. **Results** There was no significant difference in quadriceps muscle strength between the leg most involved and least involved, p = 0.1. **Discussion** The most involved leg strength was less than the least involved. But the difference was not significant, according to other studies as Malika (2006). Previous studies have found differences between the members (Nokagi and Morimatsu, 1997) at a speed of 90 degrees per second and higher speeds. In the present study, using the speed of these, no difference was found. It is noteworthy that all subjects in the study were physically active, despite having no experience with resistance exercise, a fact not reported in other studies. More studies are needed with larger samples and clinical correlations in assessing the strength in individuals with Parkinson's Disease. **References** Malicka I, Chamela-Bilinska D, Koszewicz M. (2006). *Med Rehabil*, 10, 29-37. Nogaki H, Morimatsu M. (1997). *IRMA VIII*, 1163-1166.

#### EFFECTS OF TWO DIFFERENT POTENTIATING PROTOCOLS ON STRENGTH PERFORMANCE AND RATE OF FORCE DEVELOPMENT OF THE KNEE EXTENSORS

Lima, L.C.R., Oliveira, F.B.D., Denadai, B.S.

*UNESP - Rio Claro*

**Effects of two different potentiating protocols on strength performance and rate of force development of the knee extensors.** Lima, L. C. R.; Oliveira, F. B. D.; Denadai, B. S. Human Performance Laboratory - UNESP (Rio Claro, Brazil) **Introduction** In the last two decades, many studies have investigated the enhancement of muscular strength and, mostly, power provided by prior maximal or submaximal contractions. This phenomenon has been described as post-activation potentiation (PAP). Usually, PAP stimuli are applied as warm-up routines in competitions or prior to training to impose a higher intensity training status, which is the concept of complex training. Most studies in the area suggest that this enhancement is better noticed when the protocols are applied on trained subjects and, specially, in resistance trained ones. Therefore, the aim of the present study was to investigate whether athletes without resistance training experience would benefit from the enhancing properties of PAP and, in that case, analyze the enhancements on the rate of force development (RFD) separated in different periods. **Methods** A group of 10 college level handball players participated in the study. Each subject visited the laboratory in 3 different occasions: 2 adaptations to the exercise protocols in the dynamometer and 1 data collection session. Their isometric peak torque (IPT), RFD Peak, RFD in 5 different periods (30, 50, 100, 150 and 200 milliseconds) and electromyographic signal (EMG) of the rectus femoris and vastus lateralis were assessed once, as a baseline contraction (BL), and after 2 different conditioning activity (CA)

protocols: a 9 seconds isometric contraction (C9) or 3 three seconds isometric contractions with 3 seconds rest intervals (C3). Results No significant differences were found between the baseline values and those after both CA protocols for any of the variables ( $p < 0.05$ ) with slight variations for IPT (BL: 295.65 N.m; C9: 294.86 N.m; C3: 298.97 N.m), RFD Peak (BL: 1571.59 N.m.s<sup>-1</sup>; C9: 1592.91 N.m.s<sup>-1</sup>; C3: 1439.33 N.m.s<sup>-1</sup>), and rectus femoris integral EMG signal (BL: 5.10 V; C9: 4.82 V; C3: 5.02 V). However, subject responses were not uniform as some responded positively, and some negatively, to the CA protocols. Discussion The experiment has led us to believe that PAP responses are not determined only by training levels, but also by other individual factors not tested in the current study, but cited in the literature, such as fiber-type distribution and the power-strength ratio (Tillin & Bishop, 2009). The findings in this study suggest that coaches should identify PAP responders prior to submitting athletes to CA in warm-ups or complex training sessions, even when all athletes have passed through the same training protocols. Our data also confirmed that the lack of resistance training experience might compromise PAP response. References Tillin NA, Bishop D. (2009). *Sports Medicine*, 39(2), 147-166.

### **EFFECT OF TRAINING SURFACE ON ACUTE PHYSIOLOGICAL RESPONSES FOLLOWING SPORT-SPECIFIC TRAINING**

Binnie, M., Peeling, P., Pinnington, H., Landers, G., Dawson, B.

*University of Western Australia*

This study compared the effect of sand and grass training surfaces during a sport-specific training session in well-trained team sport athletes ( $n=10$ ). Participants initially completed a preliminary testing session to gather baseline (BASE) performance data for vertical jump (VJ), repeated sprint ability (RSA) and 3 km running time trial (RTT). Three days subsequent to BASE, all athletes completed the first sport-specific training session, which was followed by a repeat of the BASE performance tests the following day (24 h post-exercise). Seven days later, the same training session was completed on the opposing surface, and was again followed 24 h later by the BASE performance tests. During each session, blood lactate (BLa), ratings of perceived exertion (RPE) and heart rate (HR) were recorded, with player movement patterns also monitored via global positioning system (GPS) units. Additionally, venous blood was collected pre-, post-, and 24 h post-exercise, and analysed for serum concentrations of Myoglobin (Mb), Haptoglobin (Hp) and C-Reactive Protein (CRP). Results showed significantly higher HR and RPE responses on SAND ( $p > 0.05$ ), despite significantly lower distance and velocity outputs for the training session ( $p > 0.05$ ). There were no differences in 24 h post-exercise performance ( $p > 0.05$ ), and blood markers of muscle damage, inflammation and hemolysis were also similar between the surfaces ( $p > 0.05$ ). These results suggest that performing a sport-specific training session on a sand (versus grass) surface can result in a greater physiological response, without any additional decrement to next day performance.

### **PROTEIN SUPPLEMENTATION IS REQUIRED TO GAIN MUSCLE MASS DURING PROLONGED RESISTANCE-TYPE EXERCISE TRAINING IN FRAIL ELDERLY PEOPLE**

Tieland, M., Dirks, M., van der Zwaluw, N., van de Rest, O., Verdijk, L.B., de Groot, L.C.P.M.G., van Loon, L.J.C.

*Wageningen University*

Introduction Sarcopenia is a process characterized by progressive loss of muscle mass and function (Cruz-Jentoft, 2010). Resistance-type exercise training might be a promising strategy to augment muscle mass and improve physical performance in frail elderly people. Dietary protein supplementation might enhance the benefits of a resistance-type exercise training. In frail elderly people, however, studies on the effects of protein supplementation on muscle mass and performance during exercise training are scarce and have generated inconsistent findings. Therefore, we investigated the impact of dietary protein supplementation on muscle mass, strength and physical performance during prolonged resistance type exercise training in frail elderly people. Methods Frail (Fried, 2001) elderly ( $78 \pm 1$ ) subjects ( $n = 62$ ) participated in the 24 wk intervention trial. They were all included in a progressive whole body resistance-type exercise program and randomly allocated to receive either a protein (15 g) or placebo supplement twice daily. Lean body mass (DXA), strength (1-RM) and physical performance (SPPB) were assessed at baseline, after 12, and 24 wks of intervention. Furthermore, habitual dietary intake and physical activity data were obtained and blood and muscle samples were collected. Results Lean body mass increased from  $47.2 \pm 1.8$  to  $48.5 \pm 1.8$  kg in the protein supplemented group and did not change in the placebo group (from  $45.7 \pm 1.8$  to  $45.4 \pm 1.8$  kg) following 24 wks of exercise intervention (P-value for treatment x time interaction = 0.006). Both strength and physical performance improved after 24 wks in both groups ( $P < 0.001$ ) with no differences between groups ( $P > 0.05$ ). Discussion Prolonged resistance-type exercise training is a feasible strategy to improve strength and physical performance in frail elderly people. Additional dietary protein supplementation is required, however, to gain muscle mass during resistance-type exercise training in this population. References Cruz-Jentoft et al. (2010). *Age and ageing*;39(4):412-23. Fried et al.(2001). *J Gerontol A Biol Sci Med Sci*;56(3):M146-56.

### **ACCELEROMETER-DETERMINED PHYSICAL ACTIVITY AND ITS ASSOCIATION WITH SELF-REPORTED HEALTH IN A POPULATION OF OLDER ADULTS <65-85 Y>**

Lohne-Seiler, H., Hansen, B.H., Kolle, E., Anderssen, S.A.

*University of Agder*

ACCELEROMETER-DETERMINED PHYSICAL ACTIVITY AND ITS ASSOCIATION WITH SELF-REPORTED HEALTH IN A POPULATION OF OLDER ADULTS (65-85 Y) Lohne-Seiler, H.1,2, Hansen, B.H.2, Kolle, E.2, Anderssen, S.A.2 1University of Agder, Kristiansand, Norway, 2Norwegian School of Sport Sciences, Oslo, Norway Introduction Regular physical activity (PA) in older adults is critically important to ensure healthy aging. The link between PA and prevention of disease, maintenance of independence, and improved quality of life is supported by strong evidence. However, there is a lack of data on population levels of PA among older adults using objective PA assessment methods. Therefore, the aim of this study was to assess PA level objectively and to examine its association with self-reported health in a random national sample of older adults. Methods The present study is a part of a national multicenter study involving 10 universities and university colleges in Norway. Participants for the initial study were randomly selected from the national population registry, and the current study includes those of the initial sample aged 65-85 years. The ActiGraph GTIM accelerometer was used to assess PA for seven consecutive days. Overall PA levels, adjusted for test center, are presented as counts per minute (cpm). A questionnaire was used to register self-reported health. Univariate analysis of variance with Bonferroni post-hoc tests were used for the analysis of multiple comparisons. Results A total of 560 participants fulfilled the accelerometer data inclusion criteria (at least four days or more of at least 10 hours of daily activity registration). Mean age (SD) was 71.8 (5.6) y for women ( $n=282$ ) and 71.7 (5.2) y for men ( $n=278$ ). No sex differences in overall PA were observed. Mean (SEM) overall PA levels were as follows: 65-69 y 317 (9) cpm, 70-74 y 301 (12) cpm, 75-79 y 237 (14) cpm, and 80-85 y 160 (18) cpm. This accounted for a reduction in overall PA of 5% ( $p < 0.05$ ) between the age groups 65-69 and 70-74 y, while a 32% ( $p < 0.05$ )

reduction between the age groups 75-79 and 80-85 y was observed. Self-reported health (%) and mean (SEM) overall PA levels were: "very good health" (19%) 344 (13) cpm, "good health" (54%) 300 (8) cpm, "either good or bad health" (24%) 208 (12) cpm, and "poor/very poor health" (3%) 170 (33) cpm. Significant ( $p < 0.05$ ) differences in overall PA level were observed between all groups, except between those who perceived their health as "either good or bad" and "poor/very poor". Conclusion PA level among older adults living in Norway decreased with increasing age, and the oldest (80-85 y) displayed a 50% lower activity level compared to the youngest (65-70 y). Overall PA levels were associated with self-reported health.

### IS LONG SLOW DISTANCE TRAINING SUFFICIENT TO MAINTAIN INCREASED PERFORMANCE AFTER A HIGH INTENSITY SHOCK MICROCYCLE IN JUNIOR TRIATHLETES

Zinner, C.1,2, Wahl, P.1,3, Krueger, M.1,2, Bloch, W.3, Mester, J.1,2

*German Sport University*

1 Institute of Training Science and Sport Informatics, German Sport University Cologne 2 The German Research Center of Elite Sport, Cologne 3 Department of Molecular and Cellular Sport Medicine, German Sport University Cologne, Germany Introduction: Preparation periods in endurance sports like triathlon are characterized by long slow distance training sessions. Most of the athletes add high intensity training sessions to their "classic" training regime only immediately before the competition period begins. Recent publications have shown that high intensity training also increases performance capacity for long distance athletes. The aim of this study was to investigate how two weeks of high intensity training during the preparation period affect the performance capacity of young triathletes. Methods: 13 junior triathletes took part in this study (10 male, 3 female;  $15.4 \pm 1.9$  years;  $171.0 \pm 8.3$  cm;  $58.3 \pm 8.8$  kg). They conducted two microcycles of different training regimes. In the first two week cycle exclusively high intensity interval training was performed. The second two week cycle included long slow distance training only. One week before and after each training cycle the athletes were tested with a 20 min time trial, a ramp test protocol to determine the  $VO_{2max}$ , and a Wingate Anaerobic Test. For all tests a cycle ergometer (SRM, Schoberer Rad Messtechnik, Juelich, Germany) was used. Results: Relative  $VO_{2max}$  of the athletes showed no changes during the whole preparation period. The mean power output during the time trial, as well as the peak power output during the ramp test was significantly higher after the first (high intensity) training cycle. The second (long slow distance) training cycle did not lead to a further increase of performance in both tests. Peak power output during the Wingate Anaerobic Test was unchanged after both periods. The mean power output and the fatigue index were unchanged after the high intensity training and significantly lower after the long slow distance training cycle. Discussion: The classical model of periodization suggests to perform long slow distance training for the most of the preparation period. We could show that performance in junior triathletes is significantly increased after a high intensity shock microcycle incorporated in the preparation period. A following microcycle with "classical" low intensity training does not lead to a further increase in performance in this study. Additionally we could not detect any sign of overtraining or overreaching in the young athletes as a result of the high intensity training.

### THE EFFECT OF CYCLING AND RUNNING ORDER WITH SIMILAR INTENSITY AND DURATION ON CARDIOVASCULAR VARIABLES

Van Beekvelt, M.C.P., Lovøll, S.M.

*Norwegian University of Science and Technology (NTNU)*

Introduction Triathlon is a multi-event sport that not only comprises the swim, bike and run events, but the actual transitions from one event to the next as well. The transitions are part of the race and of importance with respect to the end outcome. The aim of this study was to investigate the effect of the specific order of the cycling and running events such as occurs in triathlon and to distinguish between the effect of exercise order and the effect of exercise duration. Methods Eight healthy subjects performed four successive laboratory trials: (1) an incremental running test, (2) an incremental cycling test, (3) a cycle-run transition test (TCR), and (4) a run-cycle transition test (TRC). Cycling and running sessions within the transition tests lasted 30 min each and were done at a metabolic intensity of 75% of maximal oxygen consumption ( $VO_{2max}$ ). Oxygen consumption ( $VO_2$ ), heart rate (HR), minute ventilation (VE), respiratory exchange ratio (RER), and cycle cadence (CAD) were measured continuously during all four tests. Blood lactate concentration ( $[La]_b$ ) and loss of water were determined prior to and immediately after each work phase of the transition tests. Results No differences in  $VO_{2max}$  were found between cycling (C) and running (R) ( $P = 0.214$ ), but  $HR_{max}$  during running was slightly higher than that during cycling ( $P = 0.037$ ). For the transition tests, no differences were found in cycling distance ( $P = 0.691$ ), running distance ( $P = 0.220$ ), cycling intensity ( $P = 0.351$ ), running intensity ( $P = 1.000$ ), or CAD ( $P = 0.605$ ), comparing exercise with and without preceding exercise. Absolute work rates were identical within each discipline, but cycling intensity had to be decreased during the tests resulting in a significantly lower intensity than that during running (68.3%, CI: 64.7-71.9% and 74.3%, CI: 73.6-75.0%, respectively,  $P = 0.005$ ). There was a significant effect of exercise duration on the response of HR (C:  $P < 0.001$ , R:  $P < 0.001$ ), VE (C:  $P = 0.025$ , R:  $P = 0.027$ ), and RER (C:  $P < 0.001$ , R:  $P = 0.001$ ), but no effect was found for  $VO_2$  (C:  $P < 0.784$ , R:  $P < 0.429$ ). On average, cycling and running as second discipline occurred at a higher HR than that during the first discipline (C: 7.6%, R: 4.1%). A similar effect was seen for VE (C: 16.5%, R: 8.4%). Discussion/Conclusion The main findings of this study were 1) that exercise duration seemed to influence HR, VE and RER whereas it did not seem to affect  $VO_2$ , and 2) that the effect of exercise duration on HR, VE and RER was more pronounced in cycling than in running. These results indicate that despite the awkward transition from cycling to running, as reported frequently by triathletes, the order of cycling followed by running seems to be preferred above that of running followed by cycling as the effect of duration seems to be more pronounced in cycling as compared to running.

### WHAT IS THE METHOD TO ASSESS SKELETAL MUSCLE MASS WITH THE BEST ASSOCIATION WITH STRENGTH IN ADOLESCENTS?

Correas, L.G.1, Martin, N.S.1, Alvero-Cruz, J.R.2, Carnero, E.A.1

*University of Malaga*

Introduction The assessment of skeletal muscle mass (SM) may be an important concern to analyze the relationship between body composition, strength and performance. Regarding adolescents, there is a lack of valid models to estimate accurately SM. Considering this previous rationale, it should be pertinent to analyze if known models to estimate SM have a good association with strength performance in order to evaluate their construct validity. Our purpose was to compare one laboratory method with one field method, and their individual associations with isometric strength tests. Methods Seventy-five healthy adolescents (30 girls and 45 boys) were included in the analysis ( $15.4 \pm 1.5$  years; fat mass percentage ( $26.6 \pm 7.3$ )). Body composition was assessed by dual-energy X-ray absorptiometry (DXA)

and anthropometry (ANT). SM was estimated using DXA-based Kim's model (SM\_X) for adolescents (Tanner<5) and for adults (Tanner≥5). SM estimations ANT-based (SM\_A) were calculated with Poortmans' (<16-years) and Lee's models. Upper (right and left hands) and lower limbs muscle strength was measured with dynamometers (hand-grip and extension squat). Maturation was defined by Tanner's stages. Pearson's and Spearman's correlations were carried out to analysis associations between SM and strength values for both genders. Independent samples T-test were used to compare differences between methods. Results SM\_X and SM\_A showed significant differences for all participants (19.1±4.5 and 20.6±5.4kg respectively; p≤0.001). Positive correlations were found between SM and strength for all groups, except for SM\_A of girls (rho=0.30 for right hand, r=0.32 for left hand and r=0.23 for lower-limb strength). The best association was found between SM\_X and left handgrip (rho=0.84; p≤0.001) and the lowest was for boys between SM\_A and lower limbs strength (r=0.39; p≤0.01). The correlation between SM\_X and left handgrip was the highest either for boys (r=0.73; p≤0.001) and girls (r=0.54; p≤0.01). Different results were found for the same analysis with SM\_A (r=0.60 for boys; p≤0.001; non-significant for girls). Discussion Our results did not confirm agreement between models and the associations between SM and strength showed different magnitudes. The differences would be partially explained by reference method used to validate the models, so Kim and Poortmans assessed SM with MRI and DXA respectively. Since DXA is not considered a gold-standard to measure SM, the construct validity of Poortmans' model (SM\_A) should be lower than Kim's model (SM\_X). Further analysis must be necessary to confirm our conclusions.

### EMG SIGNAL PROCESSING DURING WHOLE-BODY VIBRATION: A PRELIMINARY STUDY

Lienhard, K.1,2, Cabasson, A.1, Meste, O.1, Colson, S.S.2

*University of Nice-Sophia Antipolis*

EMG SIGNAL PROCESSING DURING WHOLE-BODY VIBRATION: A PRELIMINARY STUDY University of Nice-Sophia Antipolis, Nice France 1:13S; 2:LAMHES, Faculty of Sports Sciences Introduction Whole-body vibration (WBV) has become one of the most popular alternative exercise modality. To investigate the mechanisms leading to increased neuromuscular performance following WBV exercises, numerous studies have examined the neuromuscular adaptations by recording surface electromyography signal (sEMG). However, sEMG during WBV is problematic since it contains sharp peaks at the vibration frequency and its multiple harmonics. So far, different approaches have been conducted to cut out the excessive sEMG bursts which consist of exclusion of a wide band-width frequency (Hazell et al. 2007) and elimination of the signal at the vibration frequency and its harmonics with the help of band-stop filters (Abercromby et al. 2007) or interpolation technique (Wakeling et al. 2002). Hence, there is no scientific consensus about the most adequate method to process sEMG during WBV. Another issue to be addressed is the sEMG analysis after the filtering process. For instance, the sEMG has been compared between sham and WBV conditions and/or normalized to the sEMG measured during a maximal voluntary contraction (MVC). However, to our knowledge, the normalization of the sEMG to the electrophysiological response (i.e., M-wave) evoked by nerve stimulation has never been done for WBV. Therefore, the aim of this study was to compare: 1) sEMG processing methods during WBV, namely band-stop filters vs. the interpolation technique and 2) sEMG normalization procedures (i.e., sEMG of a MVC vs. M-wave). Methods 15 physical education students performed isometric semi-squats during sham and WBV conditions (4 frequencies and two amplitudes) on a vertically vibrating platform while measuring the sEMG of the quadriceps femoris muscles. Femoral nerve electrical stimulation served for the assessment of M-wave responses. MVC of the knee extensor muscles were also performed. sEMGrms values were computed in the frequency domain after signal processing by using a band-stop filter or interpolation technique. These sEMGrms values were then normalized either to the sEMGrms value obtained during an MVC or to the respective muscle M-wave. Results We are currently collecting the data of this experiment. Due to the wide variability of results in the literature, it is hazardous to formulate a hypothesis. However, since the M-wave is the electrical equivalent of the recruitment of all motor units, we assumed that the normalization of the sEMG to this parameter will provide a better method and thus improve the scientific knowledge related to WBV exercise. References: Abercromby et al. (2007). *Med Sci Sports Exerc* 39:1642-1650. Hazell et al. (2007). *Appl.Physiol.Nutr.Metab.* 32,1156-1163. Wakeling et al. (2002). *J. Appl. Physiol.* 93:1093-1103.

### MUSCLE DAMAGE AFTER A SIMULATED TENNIS MATCH IN YOUNG TENNIS PLAYERS

Santos, R.O.1, Gomes, R.V.1, Nosaka, K.2, Moreira, A.1, Aoki, M.S.1

*1 - University of São Paulo, São Paulo, Brazil; 2 - Edith Cowan University, Western Australia, Australia.*

Introduction: The present study investigated changes in indirect markers of muscle damage following a simulated tennis match using nationally ranked young (17.6 ± 1.4 years) male tennis players. Methods: Ten young tennis players played simulated matches in which each player had three one-hour matches against three players on outdoor red clay courts following the International Tennis Federation rules. Muscle soreness, plasma creatine kinase activity (CK), serum myoglobin concentration (Mb), one repetition maximum (1RM) squat strength, and squat jump (SJ) and counter movement jump (CMJ) heights were assessed before, immediately after, and 24 and 48 hours after the matches. Results: A one-way repeated measures ANOVA and post-hoc Tukey test revealed significant but small increases in muscle soreness, CK and Mb at 24-48 hours post-match, and decreases in 1RM squat strength (-35.2 ± 10.4%), SJ (-7.0 ± 6.0%) and CMJ (-10.0 ± 6.3%) heights immediately post-match (p<0.05). At 24 hours post-match, the 1RM strength and jump heights were not significantly different from the baseline values for the average, but several players showed lower values of these measures and required another day for the full recovery. Conclusion: The simulated tennis match induced mild muscle damage, but tennis players could recover in 48 hours.

### PHYSIOLOGICAL DEMANDS IN AN IRONMAN TRIATHLON

Barrero, A., Chaverri, D., Erola, P., Iglesias, X., Rodriguez, F.A.

*INEFC*

Introduction To optimize training and determine performance factors in a triathlon, we need to know the bioenergetic requirements and physiological response during competition. However, the physiological demands for an entire triathlon in relation to the individual metabolic capacities of triathletes have not been characterized yet. Here we aimed to provide the first comprehensive description of the physiological demands of an entire ultra-endurance triathlon. Methods Ten well-trained ultra-endurance triathletes (mean ± SD: age 37.1 ± 5.3 years, mass 74.9 ± 6.4 kg, height 1.74 ± 0.06 m, BMI 24.7 ± 1.8 kg/m<sup>2</sup>, VO<sub>2</sub>peak = 4.92 ± 0.5 l•min<sup>-1</sup>) participated in the study. To investigate exercise intensity, heart rate (HR) was recorded during a competition using portable monitors. Before the ultra-endurance triathlon, subjects performed graded exercise tests involving cycle ergometry, treadmill running and swimming to determine peak oxygen uptake (VO<sub>2</sub>peak) and heart rate corresponding to the first and second ventilatory thresholds (VT1 and VT2). Results The HR in the swimming stage was closely related to the HR at VT1 (r = 0.77, P = 0.01) and related to the HR at VT2 (r = 0.68, P = 0.03). The HR in the cycling stage

was not related to the HR at VT1 and VT2. The HR in the running stage was related to the HR at VT2 ( $r = 0.64$ ,  $P = 0.048$ ) but not to the HR at VT1. The HR during the swimming stage was significantly higher than the HR at VT1 ( $P = 0.00$ ), but there were no differences between the HR during the swimming stage and the HR at VT2. The HR in the cycling and running stages were significantly lower than the HR corresponding to VT1 ( $P = 0.01$  and  $P = 0.01$ , respectively) and VT2 ( $P = 0.00$  and  $P = 0.00$ , respectively). Discussion This study is the first to characterise the relative intensity (HR related to ventilatory thresholds) during the race of the three stages of a triathlon. The differences in HR between the swimming and cycling stages correlate with the marathon time and the overall time. The triathletes with the greatest difference in HR in the swimming stage and HR during the cycling stage had the worst cycling times. As stated in Laursen et al. (2005), working beyond capacity in one stage makes recovery difficult, leading to worse performance in the next stage. This correlation can also be seen in HR differences for the swimming and running stages, as a large difference in values is associated with a reduction in the marathon time. References Laursen, P., Knez, W., Shing, C., Langill, R., Rhodes, E., & Jenkins, D. (2005). Relationship between laboratory-measured variables and heart rate during an ultra-endurance triathlon. *J Sports Sci*, 23(10), 1111-1120.

### OBSERVATION OF AGE-RELATED DECLINE IN TRANSVERSE ABDOMINIS MUSCLE

Davies, P.1, Sculthorpe, N.1, Ferguson, R.A.2, Lewis, M.P.

*University of Bedfordshire*

Observation of age-related decline in Transverse Abdominis muscle P. Davies 1, N. Sculthorpe 1, R. A. Ferguson 2, M. P. Lewis 1,2,3,4. 1Institute of Sport and Physical Activity Research (ISPAR), University of Bedfordshire, UK 2Musculoskeletal Biology Research Group, School of Sport, Exercise and Health Sciences, Loughborough University, UK 3School of Life and Medical Sciences, University College London, UK 4Cranfield Health, Cranfield University, UK Background Ageing is associated with a decline in muscle performance (Reynolds, 1991) however the degree of decline in deep lying postural muscles has received limited attention. The core abdominal muscles provide support to the low back (Hodges et al, 2003) with weakness and poor coordination having been associated with low back pain (Hodges and Richardson, 1996). The aim of the present study was to assess the response time of the Transverse Abdominis (TA) between younger and older adults. Additionally comparisons were made between these in vivo measures and the gene expression of old and young muscle cells in vitro. Method 18 young adults ( $27 \pm 7$  yrs) and 8 older adults ( $58 \pm 3$  yrs) were tested in a side lying position during a weighted shoulder abduction. Synchronised ultrasound images of the TA and EMG trace of the deltoid were acquired. The duration (D) between the onset of shoulder EMG and the activation of TA movement was assessed between groups. In vitro, C2C12 mouse myoblasts of low and high passage number were used to stimulate ageing.  $1.15 \times 10^7$  cells were used to create collagen-based, tissue engineered skeletal muscles (TESM). TESM were assessed throughout culture for the degree of bowing as a surrogate for contraction. Following this, collagen gels were cut in half and fixed for histology or had RNA extracted for PCR analysis. Gene expression analysis was measured on matrix degrading enzyme MMP9. Results In vivo: There was no significant difference between groups with respect to D ( $-0.023 \pm 0.031$  ms versus  $-0.006 \pm 0.025$  ms for old and young respectively  $p=0.099$ ). In vitro: The age of the cells was shown to have an effect on gel performance with the younger cells being more contractile over a 14 day period. The results for gene expression showed that MMP9 was expressed early in the culture, but declined afterwards. Discussion The results of the in vivo experiment suggest that deep lying postural muscles (and the TA specifically) appear resistant to age-related decline. However methodological advances to reduce the large standard deviations may warrant further investigation. In order to determine the mechanisms underpinning this observation, robust in vitro models are required. Initial observations indicate that this is feasible although work is required to validate the in vitro data against the in vivo data. References Hodges, P. et al. (2003) *Spine*, 28 (23), 2594-2601 Hodges, P & Richardson, C (1996) *Spine*, 21(22), 2640-2650 Reynolds, P. (1991) *Physiotherapy Theory and Practice*, 7, 157-162

**14:45 - 15:45**

### Poster presentations

#### PP-PM85 Sports Medicine 8

### THE EFFECT OF ACUTE AEROBIC EXERCISE ON TASK SWITCHING IN UNDERGRADUATES WITH DIFFERENT LEVELS OF PHYSICAL ACTIVITY

Tsai, C.L.1, Chou, F.Y.1,2, Chen, T.C.1

*1: National Cheng Kung University (Tainan, Taiwan), 2: Chi Mei Medical Center (Tainan, Taiwan)*

Introduction Although a few numbers of studies have assessed the effect of acute exercise on executive control function, the results are somewhat inconclusive in individuals with different levels of physical activity (PA). The present study was thus carried out to examine the influence of an acute bout of moderate aerobic exercise on executive control function engendered by a task switching paradigm in undergraduates with different levels of PA by comparing behavioral and electrophysiological performance. Methods Thirty-two male college students, aged between 19 to 23, were divided into two groups, low and high, according their level of general physical activity using the International Physical Activity Questionnaire. Before and after a 30-min session of acute aerobic exercise on a treadmill with a carefully controlled workload intensity (60%  $VO_{2max}$ ), each student performed a task switching paradigm which consisted of two conditions, a pure task condition with a repeated single task (e.g., 111111...), and a mixed-task condition with different tasks using an alternating-runs paradigm (e.g., 112211...), while the behavioral and event-related potential (ERP) indices were collected. Behavioral performance (reaction times and accuracy) and ERP measures (P3 latency and P3 amplitude) were separately submitted to a mixed-model analysis of variance (ANOVA). Results Before acute exercise, the low PA group had significantly longer reaction time (RT) and smaller P3 amplitude than the high PA group. After acute exercise, only the high PA group showed significantly smaller switching cost on RTs and significantly larger P3 amplitude in the mixed-task condition when compared to the pre-exercise session. Additionally, the P3 amplitude was significantly larger for the high PA group relative to the low PA group after the acute exercise. Discussion Physical activity and acute moderate aerobic exercise have been promoted as two factors that have beneficial effects on executive control of cognitive function (Pontifex et al., 2009). In the current study, the male college students with a high PA level exhibited a more efficient executive function than the ones with low PA level before and after acute exercise based on the behavioral and ERP performance when performing the task switching paradigm. The potential mechanism was that the individuals with high PA level may efficiently allocate more attentional resources in the

mixed-task condition, not only during the pre-exercise sessions, but also during the post-exercise ones (Kamijo and Takeda, 2010). References Kamijo K, Takeda, Y. (2010). *Int J Psychophysiol*, 75, 304-311. Pontifex MB, Hillman CH, Fernhall B., Thompson KM, Valentini. (2009). *Med Sci Sports Exerc*, 41(4), 927-934.

### PREDICTION OF MAXIMAL OXYGEN OF NORMAL ADULT MAN WITHOUT EXERCISE TESTING

Jeon, Y.J.1, Ryu, J.Y.2, Lee, B.K.3, Kim, C.H.4, Kim, B.W.5, Im, J.H.6

1,2,6 : KAIST(Daejeon, S.Korea), 3 : SangMyung U.(Seoul, S.Korea), 4,5 : Daejeon U.(Daejeon, S.korea)

**Introduction** There are two methods to estimate maximal oxygen, direct and indirect methods. Predicting maximal oxygen through sub-maximal exercise or non-exercise is more convenient for modern people because it needs less time and effort than measuring maximal oxygen directly. Therefore, aim of this study is to make the equation which can predict maximal oxygen of adult man (age from 35 to 54) without any exercising. We analyzed parameters such as age, BMI, heart rate at rest in multiple regression analysis to estimate maximal oxygen of adult man. This study may be helpful for designing therapeutic exercise and exercising program due to predicting maximal oxygen scientifically and securely. **Method** The subjects were consisted of 175 Korean adult male aging from 35 to 54. Each of maximal oxygen was measured with metabolic test system. Multiple regression analysis was applied with enter method to draw the equation of maximal oxygen. Especially, we regulated non-exercise parameters with SPSS PASW Statics 18 program. After finding the equation, we compared predicted maximal oxygen with measured maximal oxygen in scatter plot. **Result** We established the model which could estimate VO<sub>2</sub> max of adult man. Multiple correlation coefficient of this model was 0.642, and square of multiple correlation was 0.412. Standard error of estimate was 5.60ml/kg/min and coefficient of variability was 14.42% (p<0.01). The equation we made was VO<sub>2</sub> max =101.522-0.267\*(age) -0.241\*(heart rate at rest) -1.222\*(BMI). **Discussion** Many researchers studied predicting maximal oxygen without exercise (Heil, 1995, Jackson, 1990, Sanada, 2007). Heil found predicted VO<sub>2</sub>max model whose multiple R of total variable model was 0.88 and standard error of estimate was 4.90 ml/kg/min(p<.01). Jackson's also established the model whose multiple R was 0.81 and SEE was 5.35 ml/kg/min(p<.01). Compared to our study whose multiple R was 0.642 and SEE was 5.60ml/kg/min(p<.01), they have slightly higher multiple R and lower SEE. However, the equations from western countries can't exactly estimate maximal oxygen of Koreans, because Koreans have different body features(Lee Byung-keun, 1992). According to Lee's study, maximal oxygen of western people was different from Koreans about 5~14 ml/kg/min. As we used only Korean data, our study will be a greatly helpful tool for estimating maximal oxygen and designing exercising model for Koreans. In addition, because non-exercising model doesn't need any effort or time, our equation will be exclusively helpful for patients who can't walk or have serious diseases. **Reference** Heil DP, Freedson PS, Ahlquist LE, Price J, and Rippe JM. (1995). *Med Sci Sports Exerc*, 27(4): 599-606. Jackson AS, Blair SN, Mahar MT, Wier LT, Ross RM, and Stuteville JE. (1990). *Med Sci Sports Exerc*, 22(6): 863-870. Lee Byung-keun. (1992). Research for Seoul national university master's degree. Sanada, K, Midorikawa, T., Yasuda, T., Kearns, C. F., & Abe, T.(2007). 99(2): 143-148.

### NMES IS NOT EFFECTIVE AS A RECOVERY INTERVENTION BETWEEN TWO BOUTS OF MAXIMAL AEROBIC EXERCISE

Malone, J.K., Blake, C., Caulfield, B.

*University College Dublin*

**NMES IS NOT EFFECTIVE AS A RECOVERY INTERVENTION BETWEEN TWO BOUTS OF MAXIMAL AEROBIC EXERCISE** Malone, J.K.1, Blake, C.2, Caulfield, B.1 1: Stim XDP Research Group, Institute for Sport & Health; 2: School of Public Health, Physiotherapy and Population Science, University College Dublin (Dublin 4, Ireland). **Introduction** There are many situations in sport, where inadequate recovery can limit performance (Higgins et al. 2011). Previous studies investigating the effectiveness of neuromuscular electrical stimulation (NMES) as a short-term (< 1 h) recovery intervention have been inconclusive (Heyman et al. 2009; Malone et al. 2011). The aim of this study was to compare NMES to traditional methods during short-term (30 min) recovery between 2 bouts of maximal aerobic exercise. **Methods** On 3 separate days, 19 trained male cyclists performed a 3 min maximal aerobic exercise bout @ 105% VO<sub>2</sub>max on a cycle ergometer, prior to a 30 min randomly assigned recovery intervention of either: i) passive (PASS), ii) active (ACT - cycling @ 30% VO<sub>2</sub>max) or iii) NMES (5 Hz / 4 pulses @ 620 μs). Immediately after, a second bout @ 95% VO<sub>2</sub>max to exhaustion (TLim) was performed. Heart rate (HR) and blood lactate (BLa) were recorded at designated time-points throughout. Data were analyzed using repeated measures ANOVA with Tukey's HSD post hoc test. **Results** TLim was significantly longer for ACT compared to NMES (P < 0.05), but not PASS. TLim was not significantly different between NMES and PASS. BLa was significantly lower, and HR significantly higher during the recovery intervention period for ACT compared to NMES and PASS (P < 0.001), with no significant differences between NMES and PASS. **Discussion** The findings for NMES in this study differ to our previous study (Malone et al. 2011), which found no significant performance differences compared to ACT and PASS, when used as a short-term recovery intervention (30 min) between two sessions of multiple supra-maximal anaerobic exercise bouts. The reasons for these findings are unknown but are likely to be multifactorial. In conclusion, NMES is less effective than active recovery when used during short-term recovery between 2 bouts of maximal aerobic cycle bouts in trained male cyclists. **References** Heyman E, B DEG, Mertens I, Meeusen R (2009) Effects of four recovery methods on repeated maximal rock climbing performance. *Med Sci Sports Exerc* 41:1303-1310 Higgins TR, Heazlewood IT, Climstein M (2011) A Random Control Trial of Contrast Baths and Ice Baths for Recovery during Competition in U/20 Rugby Union. *J Strength Cond Res* 25:1046-1051 Malone JK, Coughlan GF, Crowe L, Gissane GC, Caulfield B (2011) The physiological effects of low-intensity neuromuscular electrical stimulation (NMES) on short-term recovery from supra-maximal exercise bouts in male triathletes. *European Journal of Applied Physiology* doi: 10.1007/s00421-011-2212-9.

### CENTRAL AND PERIPHERAL VISUAL ACUITY WITH TILTED PRESCRIPTION LENSES IN CURVED SPORTS-FRAMES IN COMPARISON TO CONTACT LENSES COMBINED WITH PLANE SPORTS GLASSES

Hobé, M.1, Jendrusch, G.2, Lingelbach, B.3

1: *Vision Science and Business-Optometry, Aalen University (Aalen, Germany)*, 2: *Dep. of Sports Medicine, Ruhr-Universität Bochum (Bochum, Germany)*, 3: *Inst. of Optometry Aalen (Leinroden, Germany)*

**Introduction** In the currently used curved frames for sports glasses prescription lenses are often optimized to suit the curved shape of the spectacle. A particular calculation is needed to produce glasses with optimized aberration characteristics looking through peripheral parts of the lens. But do these glasses work well? The aim of the study was to analyze in which way visual performance changes looking sideways through the optimized curved lens (in comparison to changes wearing contact lenses combined with plane sports glasses). **Methods** The central visual acuity and peripheral visual performance (gaze angles: 0°, 15°, 25° and 35°) was measured with optimized sports eyeglasses. In a second step the same subjects were corrected with contact lenses and were then tested centrally and peripheral-

ly with sports glasses without refractive power. Finally 40 subjects completed the entire clinical study. The average age of the participants was  $39.6 \pm 9.5$  years (age range: 17 - 51 years). On average men ( $n = 21$ ;  $43.8 \pm 7.8$  years) were significantly older than women ( $n = 19$ ;  $35.0 \pm 9.3$  years;  $2p = 0.002$ ). In all tests visual acuity was examined using „Landolt-rings“. Results The mean visual acuity while wearing contact lenses and looking straight at the optotypes (gaze angle =  $0^\circ$ ) was  $1.20$  ( $- = 0.33$ ;  $+ = 0.45$ ). At the extreme peripheral visual gaze angle of  $35^\circ$  sideways the subjects attained a similar visual acuity of  $1.17$  ( $- = 0.35$ ;  $+ = 0.49$ ). The results with modern prescription sports glasses were similar. Visual acuity was hardly noticeable reduced from  $1.38$  ( $- = 0.40$ ;  $+ = 0.55$ ) at a visual angle of  $0^\circ$  to  $1.36$  ( $- = 0.34$ ;  $+ = 0.44$ ) on the periphery of  $35^\circ$ . Visual acuity kept constant without significant variation in different gaze angles ( $0^\circ$ ,  $15^\circ$ ,  $25^\circ$  and  $35^\circ$ ), independent from the kind of visual aid (sports glasses vs. contact lenses;  $p = 0.331$ ). Discussion In both conditions, optimized eyeglasses and contact lenses, there was no significant change of visual performance in relation to different peripheral gaze angles. But the visual performance was significantly better when using optimized sports eyeglasses ( $p = 0.008$ ) than it was when contact lenses were used.

## BESPOKE SODIUM SUPPLEMENTATION INCREASES PHYSICAL PERFORMANCE

WEATHERALL, L., JUTLEY, R.S., BLOW, A., NANJIAH, P., VOYSEY, V.

### PRECISION HYDRATION

Bespoke Sodium Supplementation Increases Physical Performance Weatherall, L., Jutley, R., Blow, A. et al. Introduction The loss of sodium during exercise has significant effects on performance ranging from mild cognitive impairment to fatal hyponatraemia. Sodium losses in human sweat vary 9-fold(1, 2) which when considering the high variation in sweat losses can lead to massive net sodium losses as high as 13-fold between athletes in the same session(3). In this study we evaluate the influence of replacing sweat sodium losses using a bespoke sodium electrolyte solution based on individual sweat sodium levels on physical performance under controlled conditions. Methods Randomised crossover study comparing H2ProHydrate (500, 1000 or 1500 mg/l sodium) to Evian water (5mg/L sodium) in 7 elite male athletes. Pre-trial all underwent VO<sub>2</sub> max testing and the Precision Hydration pilocarpine-induced sweat sodium analysis. Randomisation was to water or H2ProHydrate allowing ad libitum drinking for 72 hrs pre-trial. Cross-over was undertaken 2 weeks later. Athletes maintained 70% VO<sub>2</sub> max in a climate chamber at 28C, 55% humidity for 60 min followed by a 15-min blinded performance time trial (TT). End points included power output during chamber exposure and TT, RPE (Borg Scale), heart rate (HR), core body temperature (CBT) and lactate levels. Results Mean sweat sodium concentration was 1043mg/L (range 430-1640). One athlete failed to complete the trial while on water due to nausea and dizziness and was therefore excluded from analysis. Chamber Exposure The athletes were expected to maintain an output of 70% VO<sub>2</sub> max equating to 233 W. On H2Pro the group maintained 215 W and on water alone, 206 W (a 4.4% performance gain). The mean RPE was similar in both groups(16.27 on water, 16.03 on H2Pro). Mean heart rates were 4.3% lower with H2Pro compared to water (162/min vs. 169/min) as was mean CBT (38.4C vs. 38.6C). Mean lactate levels were similar; 4.8 mmol/L H2Pro, 4.7 mmol/L water Performance Time Trial During the blinded TT, athletes on H2Pro demonstrated a 7.3% performance gain compared to water (235 W vs. 219 W) Conclusion Compared to water, appropriate sodium supplementation increases performance during severe sustained exercise in the heat and during blinded performance time trials by 4.4% and 7.3% respectively. During sustained exercise the gains are seen while maintaining a lower heart rate and core body temperature and the equivalent lactate and RPE. Our study indicates that appropriate sodium supplementation maintains a more physiological state during extreme exercise. References 1. Riedi et al. Comparison of conductivity with sodium determination in the same sweat sample. *J Pediatr(Rio J)*.2000;76:443-6 2. Bates et al. Sweat rate and sodium loss during work in the heat. *J Occup Med Toxicol*.2008;29;3:4 3. Godek et al. Sweat rates, sweat sodium concentrations, and sodium losses in 3 groups of professional football players. *J Athl Train*.2010;45:364-71

## ASSOCIATIONS BETWEEN VITAMIN D STATUS, PREDOMINANT TRAINING ENVIRONMENT, MEDICAL HISTORY AND SUN PROTECTION PRACTICES.

Peeling, P.1,2, Fulton, S.1, Binnie, M.1,2, Goodman, C.1

1: *Western Australian Institute of Sport*, 2: *The University of Western Australia*.

Introduction Vitamin D plays an important role in immune function, bone health, and potentially athletic performance. This study assessed the influence of gender, body composition and predominant training environment on the Vitamin D status of Western Australian athletes. Additionally, associations between Vitamin D status and recent injury / health status, or sun protection practices were investigated. Method Seventy-two athletes were recruited to participate in this study. Athletes underwent an anthropometric assessment, provided a venous blood sample for the assessment of Vitamin D (25(OH)D) status, and filled out a questionnaire relating to their recent training and injury history, and their routine sun protection practices. The athlete cohort were then divided by predominant training environment as either indoor, outdoor, or mixed training environment athletes. Results The average 25(OH)D levels of the group were  $111 \pm 37$  nmol/L. There were no differences between genders; however, it was noted that the levels of the indoor training group were significantly lower than those of the outdoor, and the mixed training groups ( $p < 0.05$ ). Despite these differences, the 25(OH)D levels of all groups was within a range considered healthy, with only 4.2% of the entire population ( $n=3$ ) presenting a Vitamin D deficiency. Further analysis showed that all 3 deficient athletes were members of the indoor training group (8.3% of this population). Significant correlations suggested that older, heavier and taller athletes had higher 25(OH)D levels. Furthermore, higher 25(OH)D levels were associated with a greater body composition; however, lower 25(OH)D levels were associated with a greater number of daily training hours. Finally, there were no associations between the 25(OH)D levels and the incidence of injury, illness or sun protection practice. Discussion The results of this investigation show that the Vitamin D status of Western Australian athletes may not be an issue over the summer months. The significant correlations between the anthropometric markers and the higher 25(OH)D levels are likely due to the outdoor athletes (i.e. rowers and kayakers) encountering more sun exposure, whilst being significantly taller, heavier and older than their indoor counterparts (i.e. gymnasts and divers). Although within a healthy range, the significant differences in 25(OH)D levels between outdoor and indoor trained athletes should be considered, and as such coaches or medical practitioners working with indoor trained athletes may wish to monitor their Vitamin D levels at regular intervals throughout the year (i.e. with the change in season), to avoid any possibilities of a deficiency.



### UNDERESTIMATION OF ENERGY EXPENDITURE WITH THE SENSEWEAR ARMBAND DURING UPHILL AND LEVEL TREADMILL EXERCISE.

Koehler, K.1,2, Olivar, R.1, Wallmann, B.1, Sperlich, B.3, Mester, J.1,2

1. German Sport University (Cologne, Germany) 2. German Research Centre of Elite Sport (Cologne, Germany) 3. University of Wuppertal (Wuppertal, Germany)

Purpose: The correct assessment of energy expenditure (EE) in young adults is important to ensure that physical activity (PA) requirements are met to ensure health and wellness. Accurate measurement devices can give people self awareness in the amount of energy they are expending to meet PA recommendations. The Sensewear Pro3 armband (SWA) is a multisensor device used for the individual assessment of EE. Previous studies have shown that the SWA is valid at moderate exercise intensities but may underestimate EE at higher intensities. So far, there is only little data on the validity during inclined/graded/uphill locomotion. The aim of this study was to validate the SWA for the assessment of EE in uphill and level treadmill exercise. Methods: The SWA was worn by 30 male and female volunteers from the German Sport University Cologne's faculty and student body. In average, the participants were 24.2 +/- 3.1 years of age. Each participant had to perform a treadmill exercise, which consisted of eleven five minute exercise intervals. Between each interval the participants had roughly 1 to 2 minutes before starting the next interval. Following each interval, treadmill speed and or treadmill inclination were altered in order to obtain an incremental pattern of exercise intensity. Treadmill speed ranged from 0.9 to 3.5 m/s, inclination was altered between 0, 9, and 20% and for speeds greater or equal 2.5 m/s, participants were asked to run. EE was measured with the SWA and in parallel with indirect calorimetry (IC) as reference. Results: When measured with IC, EE increased significantly between all speed intervals and at inclinations of 9 and 20%. When compared with level exercise, inclinations of 9 and 20% resulted in a significant elevation of EE. Maximum EE was recorded at 3.5 m/s and 0% inclination (16.3+- 3.0 METs). When EE was recorded with the SWA, EE increased significantly only between treadmill speeds of 0.9 and 2.5 m/s but reached a plateau between 2.5 to 3.5 m/s (9.8 +/-2.4 METs to 11.0 +/- 2.3 METs). At an inclination of 9% the increase in Sensewear EE was only marginal and not statistically significant when compared to level walking. At an inclination of 20% Sensewear EE was only significantly higher at 1.3 m/s when compared to level exercise (6.0+- 1.7 (20%) vs. 5.1 +/- 1.0 (0%) METs). The difference between IC and SWA grew with increased treadmill speed and inclination Conclusion: When the SWA is used for assessment of PA and EE during walking and running, customers, practitioners, and researchers should be aware of the limitations, especially during higher workloads and intensities. The SWA potentially underestimates EE during running (2.5-3.5 m/s) as well as uphill walking.

### EFFECT OF ACUPUNCTURE ON SALIVARY HUMAN BETA DEFENSIN 2 AFTER A BOUT OF INTENSE EXERCISE

Hanaoka, Y., Shimizu, K., Matsubara, Y., Tanimura, Y., Kimura, F., Akama, T., Kono, I., Miyamoto, T.

University of Tsukuba, Kyoto Prefectural University, Waseda University

Introduction Acupuncture has been used for treatment of injury, reduction of fatigue and management of physical condition in athletic fields. Additionally, acupuncture has been reported to modulate immune function. Intense training induces impairment of immune function, leading to increased susceptibility to infection in athletes. Human  $\beta$ -defensin2 (HBD-2) plays a crucial role in anti-viral and anti-bacterial activity. However, there is no information on relationship between HBD-2 secretion and acupuncture treatment. The aim of this study was to examine the effect of acupuncture treatment on the mucosal immune function after a single period of intense exercise by measuring salivary HBD-2. Methods Ten young sedentary males ( $23.6 \pm 1.1$  years) participated in this study with a crossover design. They subjects exercised on bicycle ergometers for 60 min at 75% of their  $VO_{2max}$ . Acupuncture treatment (ACP) was applied to meridian points (LU6, LU4, ST36 and ST6), for 30 min after the exercise session. The control treatment (CON) was rest without acupuncture and that the order of the treatment was randomized. Saliva samples were collected before (Pre) and after (P0) the exercise, and at 1 h (P1), 3 h (P3), and 24 h (P24) after the exercise session. Samples were measured for the HBD-2 concentrations by using ELISA. HBD-2 secretion rate (pg/2min) was calculated by multiplying absolute HBD-2 concentration (pg/ml) by saliva flow rate (ml/2min). Result Saliva flow rate showed significant group  $\times$  time interaction ( $p < 0.05$ ). Saliva flow rate in ACP was significant higher at P1 and P24 than that at Pre ( $p < 0.05$ ), while the rate in CON did not show significant change. Although there was no significant group  $\times$  time interaction in HBD-2 concentration, the values in both APT and CON were significant higher at P24 than that at P3 ( $p < 0.05$ ). In CON, HBD-2 concentration was significant lower P3 than that at Pre ( $p < 0.05$ ). HBD-2 secretion rate did not show significant group  $\times$  time interaction. Although HBD-2 secretion rate in CON was lower at P3 than that at Pre ( $p < 0.05$ ), ACP did not show significant change during the study period. Conclusion Acupuncture treatment might inhibit the decrease in HBD-2 secretion induced by intense exercise, leading to low susceptibility to infection in athletes. Reference Matsubara Y, Shimizu K, Tanimura Y, Miyamoto T, Akimoto T, Kono I. (2010). *Acupunct Med*, 28(1):28-32. Akimoto T, Nakahori C, Aizawa K, Kimura F, Fukubayashi T, Kono I. (2003). *Med Sci Sports Exerc*. 35(8):1296-302.

### INFLUENCE OF L-CARNOSINE ON PRO-ANTIOXIDANT STATUS IN ELITE KAYAKERS AND CANOEISTS

Slowinska-Lisowska, M.

University of Physical Education

INFLUENCE OF L-CARNOSINE ON PRO-ANTIOXIDANT STATUS IN ELITE KAYAKERS AND CANOEISTS Slowinska-Lisowska, M.1, Zembron-Lacny, A.2, Kopec, W.3, Kasperska, A.2, Rynkiewicz, M.2, Rynkiewicz, T.2 1:USPE(Wroclaw, Poland), 2:USPE (Poznan, Poland) 3:UELS (Wroclaw, Poland) Introduction Carnosine ( $\beta$ -alanyl-L-histidine) occurs in high concentration in skeletal muscle with the highest concentrations in type II fibers. Carnosine is synthesised in muscle and CNS tissue from histidine and the non-proteogenic amino acid,  $\beta$ -alanine. It has a number of biochemical functions in vertebrate species including a role as an antioxidant and in  $Ca^{2+}$  sensitization. Carnosine may play a significant role in attenuating the decline in intracellular pH during intense exercise and consequently any increase in skeletal muscle could potentially improve performance in exercise where pH decline is a major contributor to fatigue (Kendrick, 2008). The study was designed to investigate the influence of carnosine intake on pro-antioxidant status in athletes performed intensive physical exercise. Methods Fourteen male athletes participated in a placebo-controlled, double-blind study and were supplemented orally for 2 wk with either 4 g.day<sup>-1</sup> carnosine or placebo. Blood samples were collected before and at 30 min, 24 h and 48 h after 2000-m exercise trial on canoe ergometer. In blood were measure: nitric oxide (NO), myoglobin (Mb), C-reactive Protein (CRP), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), 8-Izoprostane, nitrotyrosine (3 Nitro-L-Tyrosine), total Antioxidant Potential (AOP-450), superoxidase dismutase (SOD), Thiol Redox Status (GSH/GSSG) and lactate. Results The effort test influence on levels : NO, Mb, CRP, H<sub>2</sub>O<sub>2</sub>, 8- Izoprostane, Nitrotyrosine, AOP-450, SOD, Thiol Redox Status and Lactate. No statistically significant different between supplementation (carnosine vs placebo) groups were found. The obtained results may suggest the 4 g.day<sup>-1</sup> carnosine supplementation for 2 weeks does not influence on antioxidant activity. Dis-

discussion Contrary to the previously published (Decker 2000) results we did not confirm statistically significant influences carnosine supplementation on reduction of the oxidation stress after the effort. References Kendrick IP, Harris RC, Kim HJ et al (2008) Amino acids 34: 547-54. Boldyrev AA. (2000) Biochem 65,751-756 This study was supported by a grant N R12 004006 from the Ministry of Science and Higher Education, Poland. We are grateful for successful cooperation with polish canoe federation in Gorzów Wlkp .

# Authors index

## A

|                    |                                        |                    |                                   |                         |                         |
|--------------------|----------------------------------------|--------------------|-----------------------------------|-------------------------|-------------------------|
| AAGAARD, P.        | 280, 339, 385, 387, 499                | ALLGROVE, J.E.     | 181                               | ANSON, J.M.             | 181                     |
| AAGE, R.           | 285                                    | ALMEIDA NETO, A.F. | 414                               | ANTIC, T.               | 89, 203, 370, 454, 585  |
| AAMOT, I.          | 473                                    | ALMEIDA, F.        | 436                               | ANTONIO, R.             | 338, 413                |
| ÁBALOS, X.         | 533                                    | ALMEIDA, N.R.      | 475                               | ANTONY, V.C.            | 568, 640                |
| ABAYOMI, J.C.      | 92, 94                                 | ALMEIDA, T.        | 527, 629                          | ANTOSIEWICZ, J.         | 378                     |
| ABBISS, C.         | 102, 165, 245, 298, 404, 469, 599, 612 | ALMSTROM, P.       | 414                               | ANTSON, H.              | 592                     |
| ABBISS, C.R.       | 165, 245, 298, 404, 599                | AL-RAHAMNEH, H.    | 106                               | ANZANO, A.              | 197                     |
| ABELN, V.          | 146, 267                               | ALRENI, A.         | 446                               | AOI, W.                 | 336                     |
| ABO, M.            | 311                                    | AL-SHANTI, N.      | 300, 325                          | AOKI, M.S.              | 151, 399, 585, 637, 645 |
| ABOALMATY, H.      | 446                                    | ALT, W.            | 250                               | AOKI, R.                | 108                     |
| ABREU, S.          | 136, 371                               | ALTAREKI, N.       | 369                               | AONUMA, K.              | 407                     |
| ACHTEN, E.         | 92, 176                                | ALTENMÜLLER, E.    | 67                                | AOYAMA, S.              | 342                     |
| ACHTZEHN, S.       | 61, 625                                | ALVARES, T.        | 360                               | AOYAMA, T.              | 177, 342                |
| ACKEL-DE ELIA, C.  | 408, 627                               | ALVERO-CRUZ, J.R.  | 120, 644                          | APHAMIS, G.             | 379                     |
| ACKERMANN, M.A.    | 554                                    | ALVES, C.R.R.      | 335, 475                          | APITZSCH, E.            | 488                     |
| ADAMSON, S.        | 54                                     | ALVES, E.S.        | 627                               | APOSTOLIDIS, N.         | 124, 196                |
| ADORJÁNNÉ, O.A.    | 572                                    | ALVES, F.          | 180, 473, 474, 527, 580, 629, 630 | APPLETON, P.            | 114                     |
| AERENHOUDTS, D.    | 534                                    | ALVES, O.          | 136                               | AQUINO, G.              | 445                     |
| AERENHOUTS, D.     | 196, 238                               | ALVIM, M.          | 473, 474                          | ARA, I.                 | 138, 223                |
| AERTS, I.          | 85                                     | AMANN, M.          | 101                               | ARACIL, A.              | 444, 589, 640           |
| AERTS, J.M.        | 202                                    | AMARANTINI, D.     | 492                               | ARAGONÉS, D.            | 75                      |
| AFONSO, J.         | 113, 129                               | AMARO, N.          | 149, 304, 305, 389                | ARAI, A.                | 631                     |
| AGERGAARD, J.      | 272                                    | AMATI, F.          | 504                               | ARAI, K.                | 410                     |
| AGGHA-ALINEJAD, H. | 531                                    | AMBROSIO, F.F.     | 354                               | ARAKANE, K.             | 363, 373                |
| AGUIAR, M.         | 387, 536                               | AMESBERGER, G.     | 267, 480                          | ARAKANE, K.             | 363, 610, 623           |
| AHMADI, P.         | 563, 601                               | AMIGO, T.          | 626                               | ARAKELIAN, V.           | 219, 313, 410, 603      |
| AHMADIZAD, S.      | 377                                    | AMINIAGHDAM, S.    | 628                               | ARAKELIAN, V.M.         | 219, 603                |
| AHMAIDI, S.        | 111                                    | AMINIAN, K.        | 76                                | ARAKI, M.               | 416                     |
| AHMETOV, I.        | 320, 357                               | AMIOT, V.          | 636                               | ARAMPATZIS, A.          | 278, 498                |
| AHN, N.            | 283, 332                               | AMIRIDIS, I.       | 195, 278                          | ARARIPE MEDEIROS, A.    | 113                     |
| AIBAR, A.          | 94                                     | AMIRY, M.          | 200                               | ARAÚJO, B.H.S.          | 494                     |
| AIELLO, P.         | 203                                    | AMORIM, F.T.       | 520                               | ARAÚJO, C.              | 427                     |
| AIKAWA, M.         | 628                                    | AMORIM, H.A.       | 494                               | ARAÚJO, D.              | 143, 199                |
| AINGE, H.          | 300                                    | AMORIM, I.         | 356                               | ARAÚJO, G.G.            | 303, 554                |
| AINSWORTH, B.      | 133, 522                               | AMORIM, M.         | 200                               | ARAÚJO, H.S.S.          | 313                     |
| AIRES, L.          | 622                                    | AMPOMAH, I.        | 70                                | ARCELLI, E.             | 403                     |
| AIZAWA, S.         | 595                                    | AMUSA, L.          | 506                               | ARDUINI, A.             | 550, 622                |
| AJISAKA, R.        | 121, 410, 433                          | ANDERSEN, H.C.     | 453                               | ARELLANO, R.            | 21, 425                 |
| AKAGI, R.          | 616                                    | ANDERSEN, J.L.     | 98                                | ARGEITAKI, A.           | 124                     |
| AKAHORI, M.        | 103                                    | ANDERSEN, L.F.     | 146                               | ARGEITAKI, P.           | 125, 343, 603           |
| AKALIN, T.C.       | 279                                    | ANDERSEN, L.L.     | 339, 499                          | ARGEMI, R.              | 427                     |
| AKAMA, T.          | 177, 649                               | ANDERSEN, P.R.     | 160, 432                          | ARGIOLAS, C.            | 539                     |
| AKDOGAN, E.        | 418                                    | ANDERSON, M.       | 88, 322                           | ARGUBI-WOLLESEN, A.     | 42                      |
| AKIMOTO, T.        | 597                                    | ANDERSON, M.J.     | 322                               | ARGYROPOULOU, E.        | 205, 566                |
| AKIRA, I.          | 185                                    | ANDERSSON, S.A.    | 643                               | ARIDA, R.               | 358, 494                |
| AKIYAMA, M.        | 515, 631                               | ANDERSSON, E.      | 77, 288                           | ARIDA, R.M.             | 358                     |
| AL HADDAD, H.      | 44, 368, 434                           | ANDERTEN, M.       | 267                               | ARMADA-DA-SILVA, P.A.S. | 356                     |
| ALAERTS, K.        | 82                                     | ANDJELKOVIC, M.    | 89, 203, 370, 454, 585            | ARMENIS, E.             | 630                     |
| ALBERICI, L.C.     | 176                                    | ANDO, S.           | 30, 337                           | ARMOUR, K.              | 459                     |
| ALBERTI, G.        | 384, 391, 403, 444, 533                | ANDO, Y.           | 570                               | ARMSTRONG, S.           | 74                      |
| ALBERTON, C.L.     | 214, 218                               | ANDRADE, B.        | 420                               | ARNAIZ LASTRAS, J.      | 611                     |
| ALCARAZ, P.E.      | 27, 136, 153, 184, 356                 | ANDRADE, M.S.      | 412                               | ARNAL, P.J.             | 290                     |
| ALEGRE, L.         | 273                                    | ANDRÉ, H.I.        | 252                               | ARNDT, S.               | 629                     |
| ALES, M.           | 568                                    | ANDRESS, M.        | 272                               | ARNON, M.               | 530                     |
| ALEXANDER, N.      | 250                                    | ANDREW, J.G.       | 300, 325                          | ARRUDA, A.F.S.          | 151, 399                |
| ALFARO, J.         | 157                                    | ANDREW, M.         | 442                               | ARRUDA, M.              | 442                     |
| ALFERMANN, D.      | 20, 293                                | ANDRIACCHI, T.A.   | 625                               | ARSAN, N.               | 451                     |
| ALIS, R.           | 186, 522, 550, 622                     | ANDRIEIEVA, E.     | 537                               | ARTUSO, P.              | 524                     |
| ALKARMI, A.        | 261                                    | ANDRIES, C.        | 56                                | ARVANITAKI, C.          | 278                     |
| ALLAERT, F.A.      | 593                                    | ANDROUET, P.       | 152, 195                          | ARVISAS, D.             | 385                     |
| ALLE, L.F.         | 359                                    | ANGELINI, F.       | 636                               | ASADA, K.               | 628                     |
| ALLEN, M.          | 352, 639                               | ANGUERA, M.T.      | 199, 330                          | ASAI, T.                | 571                     |
| ALLEN, S.V.        | 191                                    | ANGULO-BARROSO, R. | 541, 542                          | ASAKA, M.               | 169                     |
| ALLGROVE, J.       | 181, 299                               | ANNICCHIARICO, M.  | 477                               | ASANO, S.               | 118                     |
|                    |                                        | ANNONI, I.         | 158                               | ASCENSAO, A.            | 280, 458                |
|                    |                                        | ANSON, J.          | 181, 624                          | ASHTON, K.              | 254                     |
|                    |                                        |                    |                                   | ASKEW, C.D.             | 57, 88, 261             |
|                    |                                        |                    |                                   | ASSLÄNDER, L.           | 487                     |

ASSUMPCAO, B.P. .... 440  
 ASTRATENKOVA, I.V. .... 320  
 ATALAY, M. .... 554, 585  
 ATAN, T. .... 573, 610  
 ATHERTON, P.J. .... 23, 47  
 ATKINSON, G. .... 52, 598  
 ATTENE, G. .... 150  
 ATTISANI, G. .... 134, 432  
 ATTISANI, I. .... 134  
 ATTUX, C. .... 420  
 AUDIFFREN, M. .... 173, 345, 421, 423  
 AUGHEY, R.J. .... 297, 322  
 AUNEAU, G. .... 252  
 AVELA, J. .... 41, 193, 242  
 AVIGNON, A. .... 237  
 AYÁN, C. .... 539, 611  
 AYLWIN, A.J.M. .... 475  
 ÄYRÄMÖ, S. .... 41  
 AYTON, T. .... 64  
 AZEVEDO, L. .... 361, 553  
 AZEVEDO, L.B. .... 361  
 AZEVEDO, P.H.S.M. .... 603  
 AZIZ, N. .... 61  
 AZIZI MASOULE, M. .... 601  
 AZIZI, M. .... 563  
 AZNAR, S. .... 138, 223

**B**

BABATUNDE, O. .... 213  
 BABAUT, N. .... 467, 593  
 BABAUT, N. .... 476  
 BABAYIGIT IREZ, G. .... 448  
 BABIC, V. .... 412, 621  
 BABIEL, S. .... 544  
 BABRAJ, J.A. .... 54, 589  
 BACA, A. .... 76, 341  
 BACHININ, A. .... 393  
 BACHL, N. .... 255  
 BACURAU, A. .... 398  
 BADAAM, K.M. .... 161  
 BADER, P. .... 629  
 BAEYENS, J.P. .... 196  
 BAGATINI, N.C. .... 214  
 BAGIOS, I. .... 208  
 BAGUET, A. .... 92, 176  
 BAHR, R. .... 153, 154, 243, 480  
 BAILEY, D. .... 274, 311  
 BAILEY, T.G. .... 52  
 BAKER, J. .... 40, 81, 424  
 BAKER, J.S. .... 40  
 BAKER, M. .... 501  
 BALAGUÉ, N. .... 75  
 BALAGUER, I. .... 638, 641  
 BALAS, J. .... 447, 448, 537  
 BALÁS, J. .... 588  
 BALÁZ, M. .... 147  
 BALDASSARRE, G. .... 203  
 BALDISSERA, V. 219, 312, 313, 390, 410, 603  
 BALDUCCI, P. .... 170  
 BALDUCCI, S. .... 319  
 BALLAY, Y. .... 467  
 BALOGH, L. .... 224, 333, 365  
 BALTOPOULOS, P. .... 630  
 BAN, Y. .... 608  
 BANDELOW, S. .... 227  
 BANDHOLM, T. .... 339  
 BANTING, L.K. .... 322  
 BANYARD, H. .... 477  
 BANZER, W. .... 211, 455, 500, 629

BAPTISTA, F. .... 510  
 BAPTISTA, S. .... 321  
 BARALIC, I. .... 203, 370, 454, 585  
 BARBADO, D. .... 633, 635  
 BARBANTI, V.J. .... 578  
 BARBOSA, A. .... 197, 330  
 BARBOSA, L.F. .... 455  
 BARBOSA, M.R. .... 176  
 BARDEN, J. .... 22  
 BARISIC, V. .... 623  
 BARLA, C. .... 152, 159, 195  
 BARLA, C. .... 159  
 BARLIC, I. .... 89  
 BARMENTLO, H. .... 204  
 BARNES, C. .... 269, 356, 612  
 BARNES, J. .... 355, 567  
 BARNOUIN, R. .... 264  
 BARONI, B. .... 218  
 BARRERA, J.E. .... 600  
 BARRERO, A. .... 113, 533, 579, 645  
 BARRES, R. .... 300  
 BARRETT, E. .... 178  
 BARRETT, T.G. .... 39, 387  
 BARRIOPEDRO, M.I. .... 20  
 BARROSO, E. .... 383  
 BARRY, B. .... 269  
 BARRY, P. .... 291  
 BARTELS, M. .... 40, 566  
 BARTESAGHI, M. .... 309  
 BARTLETT, J. .... 54, 483  
 BARTRAM, J. .... 263, 366, 476, 612  
 BARUDZIC, N. .... 381  
 BASKIN, K. .... 327  
 BASTERRA, J. .... 550, 622  
 BASTIAANS, J.J. .... 614  
 BASTOS, E. .... 180  
 BASTOS, F. .... 128, 235, 440  
 BATISTA, D. .... 360  
 BATISTA, F. .... 107  
 BATISTA, S. .... 419  
 BATTAGLIA, G. 198, 346, 372, 389, 445  
 BATTERHAM, A.M. .... 553  
 BAUDRY, S. .... 294, 326, 395  
 BAUER, C. .... 454, 561  
 BAUM, O. .... 51, 170  
 BAUMANN, F.T. .... 517  
 BAUMEISTER, J. .... 229, 494  
 BAUMGART, C. .... 448  
 BAUTMANS, I. .... 508  
 BAYER, M.L. .... 274  
 BAZZUCCHI, I. .... 552  
 BEAVEN, C. .... 64  
 BECARI, C. .... 550  
 BECK, W. .... 302, 587, 619  
 BECK, W.R. .... 587, 619  
 BECKERT, P. .... 107  
 BEELEN, M. .... 238  
 BEHRENS, M. .... 542, 615  
 BEIJER, A. .... 43  
 BEKKERS, E. .... 228  
 BELAN, V. .... 147  
 BELAVY, D. .... 529  
 BELCASTRO, A. .... 282  
 BELHAGE, B. .... 254  
 BELLAFIORE, M. 198, 346, 372, 389, 445  
 BELL, T. .... 554, 587, 619  
 BELLOMIO, C. .... 386  
 BELLOMO, R.G. .... 251, 428  
 BEL-SERRAT, S. .... 94  
 BELTRAMI, F.G. .... 441, 456  
 BELTRAN CONTRERAS, S. .... 512  
 BELTRAN VALLS, R.M. .... 98, 322

BEN, R. .... 317  
 BENATTI, F.B. .... 335  
 BENCKE, J. .... 339, 499  
 BENDAHAN, D. .... 292  
 BENEDIK, E. .... 439  
 BENETTI, M. .... 235, 440, 581  
 BENIGNI, J.P. .... 593  
 BENITO, P.J. .... 235, 373, 379, 464, 512, 538  
 BENNETT, G. .... 342  
 BENNETT, S.J. .... 155  
 BENTLEY, D. .... 92  
 BENTO, T. .... 188, 333  
 BENVENUTI, P. .... 319  
 BENZINGER, S. .... 59, 229  
 BERCKMANS, D. .... 202, 244, 451  
 BERGAMIN, M. .... 319  
 BERGH, I.H. .... 146  
 BERGMANN, J. .... 100  
 BERISHA, A. .... 144  
 BERMEJO J.L. .... 619  
 BERNARDI, E. .... 309, 587  
 BERNARDI, L. .... 306  
 BERNARDO, R. .... 527  
 BERNHOERSTER, M. .... 211  
 BERRYMAN, N. .... 385  
 BERTHOIN, S. .... 61, 592, 593  
 BERTON, E. .... 41, 159  
 BERTON, R. .... 411  
 BERTUCCI, D. .... 312, 410  
 BERTUZZI, R. .... 112  
 BERTZ, H. .... 33  
 BESANCON, B. .... 630  
 BEST, S. .... 381  
 BEST, T. .... 184, 497  
 BEUKES, E. .... 234  
 BEZERRA, P. .... 287  
 BHAMBHANI, Y. .... 495  
 BHARI, S.M. .... 563  
 BHERER, L. .... 173  
 BIANCALANA, V. .... 505  
 BIANCHI, F. .... 70  
 BIANCO, A. .... 334, 346, 372, 389, 534, 568, 596  
 BIDAURRAZAGA-LETONA, I. .... 167  
 BIDDLE, S. .... 257, 566  
 BIDDLE, S.J.H. .... 566  
 BIELDERMAN, A. .... 222  
 BIERBAUM, S. .... 498  
 BIEUZEN, F. .... 264  
 BILLAUT, F. .... 104  
 BILLOT, M. .... 495  
 BILSBOROUGH, J. .... 307, 374, 519  
 BILSBOROUGH, J.C. .... 307, 374  
 BILZON, J. .... 108, 598  
 BINNIE, M. .... 164, 643, 648  
 BIRCH, S.L. .... 205, 206, 262  
 BIRDSEY, L. .... 217  
 BIRK, G.K. .... 52  
 BISCHOFF, C. .... 472  
 BISHOP, D. .... 66, 88, 104, 150, 168, 322, 502, 521, 531  
 BISHOP, D.J. .... 88, 322, 521  
 BISSAS, A. .... 279  
 BISSET, L. .... 274  
 BITTENCOURT, L.R.A. .... 627  
 BIZZINI, M. .... 510  
 BJELLAND, M. .... 146  
 BJÖRKLUND, G. .... 54  
 BJØRNESTAD, J.O. .... 639, 641  
 BLACK, K. .... 637  
 BLACKMORE, T. .... 414

|                            |                                               |                             |                    |                             |                                    |
|----------------------------|-----------------------------------------------|-----------------------------|--------------------|-----------------------------|------------------------------------|
| BLACKWELL, G. ....         | 500                                           | BOSIO, A. ....              | 524, 614           | BRUNO, P.M. ....            | 383, 630                           |
| BLAIN, G. ....             | 83                                            | BOSNYÁK, E. ....            | 321, 447, 588, 608 | BRUSEGHIN, P. ....          | 571                                |
| BLAKE, C. ....             | 647                                           | BOSQUET, L. ....            | 173, 385           | BRUSEGHINI, P. ....         | 348, 511                           |
| BLANQUAERT, L. ....        | 91                                            | BOSELUT, G. ....            | 387                | BRYANT, E. ....             | 138, 206                           |
| BLASCO, E. ....            | 145, 344, 421                                 | BOSSOLASCO, S. ....         | 86                 | BRYANT, E.S. ....           | 206                                |
| BLAT, S. ....              | 313                                           | BOTELHO, G. ....            | 387, 536           | BUBECK, D. ....             | 250                                |
| BLAZEVIC, I. ....          | 412                                           | BOTELHO, M. ....            | 419, 427           | BUCCHIONI, G. ....          | 480                                |
| BLAZEVIČ, A. ....          | 27, 46, 68, 102, 152,<br>162, 276, 397        | BOTTARO, M. ....            | 214, 218, 357      | BUCHER, S. ....             | 241, 246                           |
| BLAZEVIČ, A.J. ....        | 27, 68, 102, 152, 397                         | BOUCHER, C. ....            | 154                | BUCHHEIT, M. ....           | 44, 307, 434, 435, 519,<br>553     |
| BLETSOU, A. ....           | 381                                           | BOUGHORBEL, S. ....         | 465                | BUCHMANN, J. ....           | 452                                |
| BLOCH, W. ....             | 61, 531, 644                                  | BOURBON, M. ....            | 473, 474           | BUCKERIDGE, E. ....         | 78                                 |
| BLOCH-LAURIDSEN, H. ....   | 499                                           | BOURDAS, D. ....            | 271                | BUCKLEY, J.D. ....          | 512                                |
| BLOEMENDAL, A. ....        | 583                                           | BOURDIN, M. ....            | 463, 541           | BUCKTHORPE, M.W. ....       | 31                                 |
| BLOW, A. ....              | 214, 648                                      | BOURDON, P. ....            | 519                | BÜRGI, R. ....              | 470                                |
| BOCCOLINI, G. ....         | 444                                           | BOURGOIS, J. ....           | 92, 458            | BÜSCH, D. ....              | 219, 438                           |
| BOCK, S. ....              | 553                                           | BOUSHEL, R. ....            | 254                | BUJIE, H. ....              | 68                                 |
| BODDY, L.M. ....           | 92, 94                                        | BOUVARD, M. ....            | 446                | BULL, A. ....               | 78                                 |
| BOEHMERT, W. ....          | 441                                           | BOUZID, M.A. ....           | 232                | BULLING, B. ....            | 215                                |
| BOEKSCHOTEN, M.V. ....     | 179                                           | BOWEN, L. ....              | 402                | BULMER, A. ....             | 254                                |
| BOEN, F. ....              | 93, 116, 122, 123, 230, 249,<br>296, 451, 500 | BOWTELL, J. ....            | 283                | BUNC, V. ....               | 448, 537                           |
| BOER, P. ....              | 140, 364                                      | BOYD, S. ....               | 68                 | BUND, A. ....               | 419                                |
| BOERSMA, N. ....           | 222                                           | BOYKO, A. ....              | 519                | BURD, N.A. ....             | 174                                |
| BOES, K. ....              | 59                                            | BOZKURT, O. ....            | 451                | BURDON, C. ....             | 166, 210                           |
| BOESEN, A. ....            | 271, 272                                      | BRABANT, G. ....            | 273                | BURGER, M. ....             | 179                                |
| BOETJE, J. ....            | 490                                           | BRACEY, S. ....             | 481                | BURKE, L. ....              | 55, 88, 108, 366, 528, 599,<br>637 |
| BOFFI, G. ....             | 243                                           | BRADDE, C. ....             | 165                | BURKE, L.B. ....            | 366                                |
| BOFILL-RÓDENAS, A. ....    | 142                                           | BRADLEY, H. ....            | 97                 | BURKE, L.M. ....            | 88, 108, 599                       |
| BOGAERTS, A. ....          | 93                                            | BRAEMS, G. ....             | 509                | BURNISTON, J.G. ....        | 24                                 |
| BOGDANIS, G.C. ....        | 360, 604                                      | BRAENDVIK, S.M. ....        | 291                | BURNS, V.E. ....            | 115                                |
| BOGERD, C.P. ....          | 492                                           | BRAGE, S. ....              | 133                | BURREN, C.P. ....           | 319                                |
| BOGUSZEWSKI, M.C.S. ....   | 361                                           | BRAMANI, S. ....            | 150                | BURT, D. ....               | 458                                |
| BÖHME, M.T. ....           | 125, 128                                      | BRANDENBURG, J.P. ....      | 73, 596            | BURTIN, C. ....             | 428                                |
| BOHN, J. ....              | 101                                           | BRANDES, M. ....            | 257                | BURTSCHER, M. ....          | 306, 580, 636                      |
| BOHUS, M. ....             | 234, 471                                      | BRANDON, R. ....            | 543                | BURY, T. ....               | 157                                |
| BOIS, J. ....              | 94                                            | BRASILI, P. ....            | 394                | BUSQUETS, A. ....           | 541, 542                           |
| BOISSEAU, N. ....          | 167, 310                                      | BRATANIC, B. ....           | 439                | BUTRAGENO, J. ....          | 611                                |
| BOJSEN-MØLLER, J. ....     | 153, 278                                      | BRAUMANN, K.M. ....         | 376                | BUTRAGUENO, J. ....         | 235, 512                           |
| BOLATOGLOU, T. ....        | 124, 196                                      | BRAUN, H. ....              | 90, 237, 360       | BUTTERFIELD, T.A. ....      | 184                                |
| BOLEEVA, G. ....           | 407                                           | BRAVO, V.A. ....            | 607                | BUYSE, L. ....              | 61                                 |
| BONATO, M. ....            | 86                                            | BRAZAITIS, M. ....          | 431                |                             |                                    |
| BONDAREV, D. ....          | 248, 452                                      | BREEBAART, J. ....          | 465                | <b>C</b>                    |                                    |
| BONELLO, R. ....           | 490                                           | BREED, R. ....              | 281                | CABALLERO LOSCOS, M.J. .... | 332                                |
| BONETE, E. ....            | 640                                           | BREEDVELD, K. ....          | 350                | CABALLERO, C. ....          | 558                                |
| BONFANTI, L. ....          | 403                                           | BREEN, L. ....              | 236                | CABALLERO, M.J. ....        | 331, 332                           |
| BONITCH-DOMÍNGUEZ, J. .... | 436                                           | BRESSAN, R.A. ....          | 420                | CABANAC, M. ....            | 75, 164                            |
| BONITCH-GÓNGORA, J. ....   | 436                                           | BRESTOVCI, B. ....          | 144                | CABASSON, A. ....           | 645                                |
| BOOGHS, C. ....            | 395                                           | BRETIN-MAFFIULETTI, K. .... | 232                | CABLE, N.T. ....            | 24, 52, 61, 171, 261               |
| BOOMSMA, D.I. ....         | 40, 566                                       | BREWER, C.P. ....           | 527                | CABLE, T. ....              | 24                                 |
| BOON, N. ....              | 63, 89                                        | BRIDGE, C.A. ....           | 620                | CABRAS, S. ....             | 317                                |
| BOONE, J. ....             | 458                                           | BRINK, M.S. ....            | 44                 | CABRI, J. ....              | 22, 243, 278, 463, 534             |
| BOOTH, J. ....             | 269                                           | BRISSWALTER, J. ....        | 531                | CACEK, J. ....              | 438                                |
| BOOTSMA, R.J. ....         | 117                                           | BRITO, J. ....              | 600                | CACHÓN-ZAGALAZ, J. ....     | 127, 401, 402                      |
| BORBA-PINHEIRO, C.J. ....  | 409                                           | BRITO, L. ....              | 315, 439           | CADEFEAU, J.A. ....         | 161                                |
| BOREHAM, C. ....           | 187, 299                                      | BRIXIUS, K. ....            | 502                | CADORE, E. ....             | 214, 218                           |
| BORER, K.T. ....           | 95                                            | BROICH, H. ....             | 330                | CADORE, E.L. ....           | 218                                |
| BORGES, E. ....            | 642                                           | BROOKS, N.E. ....           | 510                | CAILLAUD, C. ....           | 300, 381, 531                      |
| BORGES, G.F. ....          | 180, 580                                      | BROOKS, P. ....             | 274                | CALAHORRO, F. ....          | 127, 401, 402                      |
| BORGHOUTS, L. ....         | 133                                           | BROWN, N. ....              | 250                | CALBET, J.A. ....           | 47, 161, 176, 306                  |
| BORGHOUTS, L.B. ....       | 133                                           | BROWN, R. ....              | 637                | CALBET, J.A.L. ....         | 47, 176, 306                       |
| BORK, H. ....              | 452                                           | BROWN, W. ....              | 256, 286           | CALCAGNO, G. ....           | 445                                |
| BORK-JENSEN, J. ....       | 23                                            | BROWN, W.J. ....            | 286                | CALDERÓN, C. ....           | 533                                |
| BORN, D.P. ....            | 526                                           | BROWNELL, S. ....           | 301                | CALDERÓN, F.J. ....         | 235                                |
| BOROVÍK, O. ....           | 537                                           | BRUCE-LOW, S. ....          | 414                | CALDERÓN, F.J. ....         | 512                                |
| BORRANI, F. ....           | 100                                           | BRUCH, A. ....              | 60, 593            | CALDERS, P. ....            | 234, 472                           |
| BORZYKH, A. ....           | 407                                           | BRUCH, H. ....              | 60                 | CALLISTER, R. ....          | 519                                |
| BOS, I. ....               | 282                                           | BRÜGEMANN, J. ....          | 84                 | CALO, C.M. ....             | 394, 539                           |
| BÖS, K. ....               | 229                                           | BRUG, J. ....               | 256                | CALVO, L. ....              | 332                                |
| BOSCH, J.A. ....           | 115, 567                                      | BRUHN, S. ....              | 615                | CAMARDA, S.R. ....          | 327                                |
| BOSCHERO, A.C. ....        | 378                                           | BRUM, P.C. ....             | 398, 475           |                             |                                    |
| BOSCOLO, R.A. ....         | 391                                           | BRUNELLI, A. ....           | 98, 322            |                             |                                    |
|                            |                                               | BRUNNER, R. ....            | 76                 |                             |                                    |
|                            |                                               | BRUNO, P. ....              | 383, 629, 630      |                             |                                    |

|                     |                                 |                      |               |                      |                            |
|---------------------|---------------------------------|----------------------|---------------|----------------------|----------------------------|
| CAMBIER, D.         | 234, 472                        | CASTLE, P.           | 186, 551      | CHRISTIAN, R.        | 104                        |
| CAMERON-SMITH, D.   | 254                             | CASTRO, A.           | 414           | CHRISTIE, C.         | 74                         |
| CAMLIGUNEY, F.      | 559                             | CASTRO, M.A.         | 543           | CHRISTIE, J.W.       | 59                         |
| CAMPANICO, J.       | 197, 199, 330                   | CASTRO-GACIO, X.     | 44, 545       | CHRISTOFI, E.        | 360                        |
| CAMPI, F.           | 497                             | CATALDO, M.C.        | 534           | CHUL-HO, S.          | 429                        |
| CAMPOLIER, M.       | 310                             | CATER, P.            | 545           | CHUNG, W.            | 88                         |
| CAMPOS, A.          | 140, 200, 202, 349              | CATOIRE, M.          | 179           | CIACCI, S.           | 242                        |
| CAMPOS, P.          | 637                             | CAULFIELD, B.        | 647           | CICEK, G.            | 610                        |
| CAMPOS, R.M.S.      | 408                             | CAVAGGIONI, L.       | 391           | CIKATIC, B.          | 618                        |
| CAMPOS-FERRAZ, P.L. | 335, 475                        | CAVAGLIERI, C.       | 411           | CIMINELLI, E.        | 98                         |
| CAMY, J.            | 231                             | CAVAGNOLLI, D.A.     | 358           | CINQUE, P.           | 86                         |
| CANATO, M.          | 168, 384                        | CAVALHEIRO, E.A.     | 494           | CIOROBOIU, A.        | 429                        |
| CANAVARRO, J.       | 248                             | CAVALLO, A.          | 480           | CIRAMI, I.           | 432                        |
| CANCELA, J.M.       | 539, 611                        | CECIC-ERPIC, S.      | 248           | CIRASELLA, M.        | 158                        |
| CANCELLARA, P.      | 168, 384                        | CELIKSOY, S.         | 126           | CLARK, J.A.          | 47                         |
| CANESTRELLI, C.     | 268                             | CENTINEO, V.         | 534           | CLARKSON, S.L.       | 263                        |
| CANON, F.           | 492                             | CERMAK, N.           | 63, 97        | CLARYS, J.P.         | 508                        |
| CÁNOVAS, J.F.       | 153, 184                        | CERMAK, N.M.         | 63            | CLARYS, P.           | 238, 534                   |
| CAO, Z.B.           | 177                             | CERRAH, A.O.         | 375           | CLAXTON, D.          | 513                        |
| CAPELLI, C.         | 380                             | CESCOTTO, S.         | 630           | CLEMENTE, F.         | 563, 564                   |
| CAPITANI, C.D.      | 585, 637                        | CEUX, T.             | 122, 295, 451 | CLEMENTS, R.E.       | 529, 591                   |
| CAPKAUSKIENE, S.    | 334                             | CHA, J.H.            | 602           | CLIJSEN, R.          | 196, 534                   |
| CAPOGROSSO, M.      | 405, 549                        | CHACON-MIKAHIL, M.P. | 411           | CLOES, M.            | 347, 388, 505              |
| CAPOROSI, D.        | 98, 322                         | CHAE, H.J.           | 602           | CLOIX, J.F.          | 434                        |
| CAPRANICA, L.       | 349, 457                        | CHAMARI, K.          | 111, 150, 403 | CLOSE, G.L.          | 24, 54, 599, 620           |
| CAPT, R.            | 100                             | CHAMBON, N.          | 41            | COBLEY, J.N.         | 24                         |
| CAPUTO, F.          | 612                             | CHAMPELY, S.         | 427           | COCHRAN, A.J.        | 54                         |
| CARAMAZZA, G.       | 346, 372, 389, 445              | CHANG, E.C.          | 578           | COCKS, M.            | 97, 171                    |
| CARANTI, D.A.       | 408                             | CHANG, H.K.          | 433, 556      | CODECASA, F.         | 174                        |
| CARBALLEIRA, E.     | 44, 545                         | CHANG, J.M.          | 97, 382       | COELHO E SILVA, M.J. | 464                        |
| CARBONI, D.         | 539                             | CHANG, K.M.          | 421           | COELHO, D.           | 367                        |
| CÁRDENAS, D.        | 35                              | CHAO, K.L.           | 421           | COELHO, E.           | 354, 564                   |
| CARDINALE, M.       | 291, 600                        | CHAPELLE J.P.        | 36            | COELHO-E-SILVA, M.J. | 315, 359, 361,<br>439, 540 |
| CARDON, G.          | 139, 256, 606                   | CHAPELLE, J.P.       | 245           | COETZEE, B.          | 456, 521                   |
| CARDOZO, A.C.       | 414                             | CHAPMAN, P.          | 166, 210      | COGO, A.             | 309, 587                   |
| CARIA, A.           | 197, 317, 320                   | CHARDON, F.          | 295           | COLADO, J.C.S.       | 214                        |
| CARIS, A.           | 185, 308                        | CHARDONNENS, J.      | 243, 479      | COLAK, R.            | 474                        |
| CARITÁ, R.A.C.      | 612, 615                        | CHAUDHARI, A.        | 497           | COLETTE, J.          | 273                        |
| CARLOMAGNO, D.      | 614                             | CHAUDHARI, S.P.      | 161           | COLIGE, A.           | 630                        |
| CARMO, E.C.         | 112                             | CHAVERRI, D.         | 113, 579, 645 | COLLERAN, G.         | 187, 299                   |
| CARNEIRO, E.        | 312, 378                        | CHAVES, D.           | 637           | COLLINS, D.K.        | 122, 445                   |
| CARNEIRO, E.M.      | 378                             | CHEN, C.H.           | 458           | COLLINS, M.          | 179                        |
| CARNERO, A.         | 489                             | CHEN, C.L.           | 135           | COLLINS, N.          | 373                        |
| CARNERO, E.A.       | 120, 600, 644                   | CHEN, F.             | 576           | COLLOMP, K.          | 434, 636                   |
| CARNEVALI JR, L.C.  | 475                             | CHEN, H.L.           | 458           | COLLU, G.            | 603                        |
| CARNIDE, F.         | 252                             | CHEN, H.W.           | 366, 584      | COLOMBANI, P.C.      | 64                         |
| CARNIER, J.         | 408                             | CHEN, T.C.           | 458, 646      | COLSON, S.S.         | 396, 645                   |
| CARPENTIER, A.      | 154, 359                        | CHEN, W.S.           | 508           | COMBES, M.           | 310                        |
| CARR, A.            | 35                              | CHEUNG, C.M.         | 421           | COMOTTO, S.          | 183                        |
| CARRARA, P.         | 427                             | CHEUNG, I.S.         | 366, 584      | CONCEICAO, F.        | 518                        |
| CARROLL, R.         | 122                             | CHESTER, A.L.        | 553           | CONCEICAO, M.        | 218                        |
| CARSTENS, M.        | 536                             | CHEUNG, S.           | 61, 309       | CONDE, E.            | 20                         |
| CARTER, H.          | 52, 54                          | CHEUNG, S.S.         | 309           | CONDE-GONZALEZ, J.   | 35                         |
| CARTES, M.A.        | 142                             | CHIA, E.             | 419           | CONDELLO, G.         | 74, 77, 528                |
| CARVALHO, G.        | 535                             | CHIA, Y.H.M.         | 319           | CONNOLLY, D.         | 524                        |
| CARVALHO, H.M.      | 315, 359, 439, 464              | CHIANG, H.           | 508           | CONNOR, J.           | 20                         |
| CARVALHO, J.        | 200                             | CHIANG, Y.L.         | 135           | CONRAADS, V.         | 50                         |
| CARVALHO, P.        | 600                             | CHIAVAROLI, S.       | 367           | CONTE, D.            | 244                        |
| CASAIS, L.          | 328                             | CHIBA, N.            | 494           | CONTE-JUNIOR, C.     | 360                        |
| CASAJÚS, J.A.       | 105, 138, 140, 141, 390,<br>392 | CHIKARA, N.          | 185           | CONTI, A.            | 552                        |
| CASEROTTI, P.       | 98                              | CHINCHILLA, J.L.     | 489           | COOK, J.             | 436                        |
| CASOLINO, E.        | 74, 105, 528                    | CHINCHILLA, J.M.     | 600           | COOLS, W.            | 56                         |
| CASOLO, F.          | 348, 511, 571                   | CHIRILA, D.          | 362           | COOMBES, B.          | 274                        |
| CASSAN, C.          | 237                             | CHIU, Y.C.           | 584           | COOMBES, J.S.        | 524                        |
| CASSAR, S.          | 377                             | CHO, C.J.            | 305           | CORATELLA, G.        | 477                        |
| CASSILHAS, R.C.     | 420                             | CHO, I.H.            | 602           | CORBI, F.            | 142                        |
| CASTAGNA, A.        | 134, 432                        | CHO, J.Y.            | 392, 602      | CÓRDOVA, C.          | 410                        |
| CASTAGNA, C.        | 111, 150, 401, 403              | CHOI, D.H.           | 556           | CORDY, J.            | 307, 374, 519              |
| CASTIELLO, U.       | 480                             | CHOU, C.C.           | 487           | CORMERY, B.          | 446                        |
| CASTILLO, I.        | 638, 641                        | CHOU, F.Y.           | 646           | CORMIE, P.           | 287                        |
| CASTILLO, M.        | 94                              | CHRISTENSEN, K.K.    | 432           | CORNACCHIA, M.       | 174                        |
|                     |                                 | CHRISTENSEN, M.K.    | 293           |                      |                            |

|                                        |                              |                                            |                    |                                       |                                                       |
|----------------------------------------|------------------------------|--------------------------------------------|--------------------|---------------------------------------|-------------------------------------------------------|
| CORONA, F. ....                        | 203                          | CUSSÓ, R. ....                             | 161                | DE LA CALLE, J. ....                  | 306                                                   |
| CORREA, A. ....                        | 421                          | CUTHBERTSON, D.J. ....                     | 61, 171            | DE LA CALLE-HERRERO, J. ....          | 47                                                    |
| CORREAS GÓMEZ, L. ....                 | 120                          | CUTTERT, S. ....                           | 164                | DE LA CRUZ-SÁNCHEZ, E. ....           | 617                                                   |
| CORREAS, L.G. ....                     | 644                          | CUTUK, H. ....                             | 616                | DE LA LLAVE, M.J. ....                | 223                                                   |
| CORREDEIRA, R. ....                    | 143, 417                     | CYRINO, E.S. ....                          | 540                | DE MARTELAER, K. ....                 | 56, 239                                               |
| CORREIA, C. ....                       | 456                          | CZUDKOVA, E. ....                          | 310, 314           | DE MELLO, M.T. ....                   | 185, 308, 358, 420, 391                               |
| CORRION, K. ....                       | 268                          |                                            |                    | DE MELO, C.M. ....                    | 540                                                   |
| CORTESI, M. ....                       | 634                          | <b>D</b>                                   |                    | DE METTELINGE, T.R. ....              | 234                                                   |
| CORTEZ, J.A.A. ....                    | 235, 440                     |                                            |                    | DE MOOR, M.H.M. ....                  | 40                                                    |
| CORTINHAS, A. ....                     | 333                          | DA BOIT, M. ....                           | 380                | DE PAUW, K. ....                      | 443, 594                                              |
| CORTIS, C. ....                        | 349, 457                     | DA FONSECA, R.M. ....                      | 45                 | DE POEL, H.J. ....                    | 462                                                   |
| COSSIO-BOLANOS, M.A. ....              | 442                          | DA SILVA, D.F. ....                        | 588                | DE RIDDER, J.H. ....                  | 233, 234                                              |
| COSTA JR, J. ....                      | 312                          | DA SILVA, P.M.A. ....                      | 303                | DE RUITER, C.J. ....                  | 221, 601                                              |
| COSTA, A. ....                         | 180, 288, 304                | DAANEN, H. ....                            | 73, 520            | DE SÁ PINTO, A.L. ....                | 335                                                   |
| COSTA, J. ....                         | 378, 540                     | DABROWSKA, G. ....                         | 382                | DE SOUZA, E.O. ....                   | 45, 398                                               |
| COSTA, N. ....                         | 444                          | DACAR, M. ....                             | 367                | DE TERESA-GALVAN, C. ....             | 35                                                    |
| COSTANTINO, D. ....                    | 346, 573                     | DADASHI, F. ....                           | 76                 | DE VILLIERS, J.E. ....                | 467                                                   |
| COTTER, J. ....                        | 170, 500                     | DAHL, R. ....                              | 330                | DE VITO, G. ....                      | 187, 299                                              |
| COTTER, J.D. ....                      | 170                          | DAI, U. ....                               | 224                | DE VRIES, S.T. ....                   | 134                                                   |
| COTUK, B. ....                         | 559                          | DAISUKE, Y. ....                           | 185                | DE WANDELE, I. ....                   | 472                                                   |
| COUBARD, R. ....                       | 245                          | DALEN, H. ....                             | 473                | DEAKIN, G.B. ....                     | 217                                                   |
| COUCEIRO, M. ....                      | 563, 564                     | DALEY, T. ....                             | 243                | DECLERCK, M. ....                     | 107                                                   |
| COUCEIRO, M.S. ....                    | 564                          | DALLAS, G. ....                            | 343                | DECRAMER, M. ....                     | 428                                                   |
| COUFFIGNAL, V. ....                    | 245                          | DALLAWAY, N. ....                          | 243                | DECROOS, S. ....                      | 122                                                   |
| COURTEIX, D. ....                      | 540                          | DALLONGEVILLE, J. ....                     | 94                 | DEEG, D.J.H. ....                     | 221                                                   |
| COUSTERE, O. ....                      | 87                           | DALY, D. ....                              | 107, 143           | DEFLANDRE, D. ....                    | 157                                                   |
| COUTINHO, S.S. ....                    | 147, 206                     | DANIELS, M. ....                           | 298                | DEFORCHE, B. ....                     | 139, 238                                              |
| COUTO, M. ....                         | 136                          | DANIUSEVICIUTE, L. ....                    | 431                | DEFRAIGNE, J.O. ....                  | 630                                                   |
| COUTTS, A. 92, 307, 374, 518, 519, 637 |                              | DANNO, Y. ....                             | 515                | DEGENS, H. ....                       | 69                                                    |
| COUTTS, A.J. ....                      | 374, 518, 519, 637           | DANTAS, W.S. ....                          | 637                | DEIDDA, M. ....                       | 317, 320                                              |
| COWAN, D.T. ....                       | 40                           | DARUKA, L. ....                            | 333                | DEJONGHE, T. ....                     | 36                                                    |
| COX, V. ....                           | 262                          | DASCOMBE, B. ....                          | 92, 215, 519       | DEL GUIDICE, A. ....                  | 347                                                   |
| COZZONE, P.J. ....                     | 292                          | DASCOMBE, B.J. ....                        | 519                | DELA, F. ....                         | 23, 45, 62, 98, 99, 160, 163, 165, 169, 254, 330, 432 |
| CRAMPTON, D. ....                      | 518                          | DAVIDOWITZ, K.J. ....                      | 520                | DELATTRE, N. ....                     | 41, 251                                               |
| CRANGUS, N. ....                       | 362                          | DAVIES, I.G. ....                          | 92, 94             | DELDICQUE, L. ....                    | 23                                                    |
| CRESPO COCO, C. ....                   | 332                          | DAVIES, P. ....                            | 646                | DELECLUSE, C. ....                    | 93, 500                                               |
| CRESPO, C. ....                        | 331, 332                     | DAVIS, E. ....                             | 47                 | DELEY, G. ....                        | 593                                                   |
| CRESSWELL, S. ....                     | 474                          | DAVIS, L. ....                             | 198                | DELEY, G. ....                        | 476                                                   |
| CRETENAND, F. ....                     | 76                           | DAVIS, P. ....                             | 198                | DELHEYE, P. ....                      | 231                                                   |
| CREUZNACHER, U. ....                   | 220                          | DAVISON, G. ....                           | 186, 596           | DELLAL, A. ....                       | 111, 259, 289, 328, 470                               |
| CREVENNA, R. ....                      | 273                          | DAWSON, B. 35, 92, 164, 165, 174, 527, 643 |                    | DEMAZIERES, A. ....                   | 264                                                   |
| CREWITHER, B.T. ....                   | 151, 399                     | DAWSON, E.A. ....                          | 261                | DEMEYER, H. ....                      | 428                                                   |
| CRIELAARD, J.M. ....                   | 273, 547, 591, 630           | DE ALMEIDA, A.A. ....                      | 494                | DEMİNICE, R. ....                     | 313                                                   |
| CRITCHLEY, K. ....                     | 323                          | DE ANGELIS, M. ....                        | 367                | DEMOULIN, C. ....                     | 591                                                   |
| CRIVELLI, G. ....                      | 100                          | DE BACKER, M. ....                         | 122, 123, 295, 451 | DENADAI, B.S. 327, 455, 612, 615, 642 |                                                       |
| CROISIER, J.L. ....                    | 157, 188, 273, 394, 591, 630 | DE BAERE, I. ....                          | 183                | DENADAI, B.S. ....                    | 301, 303                                              |
| CRONIN, J. ....                        | 150, 547                     | DE BEUKELAAR, T. ....                      | 82                 | DENCKER, M. ....                      | 169                                                   |
| CRONIN, N. ....                        | 49                           | DE BOEVER, P. ....                         | 282                | DENDALE, P. ....                      | 174                                                   |
| CROSSLAND, H. ....                     | 23                           | DE BOSSCHER, V. 20, 48, 49, 125, 128, 249  |                    | DENUZILLER, J. ....                   | 380                                                   |
| CROWE, M. ....                         | 553                          | DE BOSSCHER, V. ....                       | 19                 | DENUZILLER, J. ....                   | 476                                                   |
| CRUZ, L. ....                          | 540, 557                     | DE BOURDEAUDHUIJ, I. ....                  | 139, 256           | DERAVE, W. ....                       | 55, 91, 92, 176                                       |
| CSAJÁGI, E. ....                       | 96                           | DE BROUWER, A.J. ....                      | 462                | DERIEMAERKER, P. ....                 | 534                                                   |
| CSAPO, R. ....                         | 273                          | DE CARVALHO, M. ....                       | 230                | DESBROW, B. ....                      | 254                                                   |
| CUADRADO-PENAFIEL, V. ....             | 518                          | DE CLERCQ, D. ....                         | 606                | DETHIOUXC, S. ....                    | 505                                                   |
| CUBRILLO, D. ....                      | 381                          | DE COCKER, K. ....                         | 256                | DEWANDELE, I. ....                    | 234                                                   |
| CUENCA GARCÍA, M. ....                 | 94, 319                      | DE CRAEMER, M. ....                        | 139                | DI CAGNO, A. ....                     | 445                                                   |
| CUGUSI, L. ....                        | 317, 320, 400                | DE CROOCK, S. ....                         | 20                 | DI GIOVINE, D. ....                   | 329                                                   |
| CULLEN, S. ....                        | 557                          | DE CUYPER, B. ....                         | 116, 123, 296, 451 | DI MICHELE, R. ....                   | 242, 529, 634                                         |
| CUMMING, J. ....                       | 115                          | DE DECKER, E. ....                         | 139, 316           | DI MUZIO, D. ....                     | 183                                                   |
| CUMMING, K.T. ....                     | 187, 409                     | DE GEUS, B. ....                           | 28                 | DI PALO, G. ....                      | 403                                                   |
| CUNHA, A.S. ....                       | 303                          | DE GEUS, E.J.C. ....                       | 40, 566            | DI PANCAZIO, L. ....                  | 251, 428                                              |
| CUNHA, S.A. ....                       | 158, 587, 619                | DE GREEF, M.H.G. ....                      | 84, 222            | DI SALVO, V. ....                     | 98                                                    |
| CUNHA, T.C.A. ....                     | 627                          | DE GROOT, C.P.G.M. ....                    | 63                 | DI TORE, A. ....                      | 203, 296                                              |
| CUNLIFFE, D. ....                      | 487                          | DE GROOT, K. ....                          | 465                | DI TORE, S. ....                      | 203, 204                                              |
| CUNNIFFE, B. ....                      | 600                          | DE GROOT, L.C.P.M.G. ....                  | 643                | DIANA, A. ....                        | 539                                                   |
| CUPEIRO, R. ....                       | 235, 626                     | DE HAAN, A. 32, 73, 221, 320, 520, 601     |                    | DIAS, G. ....                         | 563, 564                                              |
| CURCIC, D. ....                        | 89, 203, 370, 454, 585       | DE JESUS, K. ....                          | 302                | DIAS, P. ....                         | 149, 304, 305                                         |
| CURCIC, D.J. ....                      | 89, 454, 585                 | DE KONING, J. ....                         | 73, 230, 298, 520  | DICKINSON, R.K. ....                  | 159                                                   |
| CURRIE, K.D. ....                      | 53, 172                      | DE KONING, J.J. ....                       | 105                | DIDERIKSEN, K.J. ....                 | 62, 282, 333                                          |
| CURTIS, D. ....                        | 339, 499                     |                                            |                    | DIERCKS, R.L. ....                    | 44, 211                                               |
| CURY-BOAVENTURA, M.F. ....             | 139                          |                                            |                    |                                       |                                                       |

DIGELIDIS, N. .... 355  
 DIKETMÜLLER, R. .... 253  
 DIKIC, N. .... 89, 203, 370, 454, 585  
 DIMAURO, I. .... 98, 322  
 DINGENEN, B. .... 508, 575, 577  
 DINNING, S. .... 198  
 DIOGO, F. .... 346, 570  
 DIOGUARDI, G. .... 581  
 DIPLA, K. .... 523  
 DIRKS, M. .... 174, 643  
 DIRKS, M.L. .... 174  
 DISLEY, B.X. .... 78, 380, 381  
 DJAOU, L. .... 470  
 DJORDJEVIC, B. .... 203, 454  
 DJORDJEVIC, D. .... 381, 400  
 DJORDJEVIC, S. .... 69, 489  
 DJUROVIC, M. .... 400  
 DODGE, C. .... 74, 528  
 DOESSING, S. .... 333  
 DOIPHODE, R.S. .... 161  
 DOIX, A.C. .... 291  
 DOLMAN, G.M. .... 212  
 DOMA, K. .... 217  
 DOMINGOS, M. .... 312  
 DOMINGOS, M.B. .... 158  
 DOMINGOS, M.M. .... 313  
 DOMINGUEZ, R. .... 21  
 DOMINGUEZ-CASTELLS, R. .... 21, 425  
 DOMÍNGUEZ-MARTÍN, M.A. .... 507  
 DONATH, L. .... 271, 329, 544  
 DONATI, S. .... 405  
 DONATTO, F. .... 367  
 DONG-HYUN, S. .... 132, 429  
 DONNE, B. .... 21, 194, 518  
 DONTJE, M.L. .... 84  
 DONYAMALI, A. .... 531  
 DORADO, C. .... 47, 161  
 DORADO, M. .... 489, 600  
 DORADO, M.G. .... 600  
 DORAN, D.A. .... 445  
 DOS REIS, I. .... 302, 447  
 DOS REIS, I.G.M. .... 554, 587, 619  
 DOS REIS, I.G.M. .... 447  
 DOSENKO, V. .... 626  
 DOUSKAS, T. .... 603  
 DOWNS, A. .... 352  
 DRAGO, G. .... 151  
 DRAPER, N. .... 500, 596  
 DREGER, P. .... 234, 471  
 DRENOWATZ, C. .... 95, 315, 464, 481  
 DRESCHER, U. .... 502  
 DREYHAUPT, J. .... 95  
 DRIGO, A.J. .... 547  
 DRINKWATER, E.J. .... 111, 244  
 DRION, P. .... 630  
 DROZDOVSKA, S. .... 537, 626  
 DRUST, B. .... 54, 55, 258, 401, 620  
 DRYBURGH, I. .... 194  
 DUCHATEAU, J. .... 2, 154, 395, 396, 493  
 DUCHE, P. .... 167, 310  
 DUCKER, K. .... 92  
 DUCKWORTH, K. .... 511  
 DUCLAY, J. .... 492  
 DUCLOS, M. .... 167, 310  
 DUDA, J. .... 39, 114, 115, 387, 452, 481  
 DUDA, J.L. .... 39, 115, 387, 452, 481  
 DÜNNWALD, T. .... 306  
 DUFFIELD, R. .... 475  
 DUFFY, P. .... 459  
 DUHAMEL, G. .... 292  
 DUMANGIU, M. .... 429  
 DUNCAN, M.J. .... 205, 206, 262, 583

DUNCAN, S. .... 275, 484  
 DUNN, P. .... 108  
 DUPONT, G. .... 593  
 DUPUY, O. .... 173, 385  
 DURAND, T. .... 289  
 DUVINAGE, K. .... 139  
 DUYSSENS, J. .... 50  
 DVORAK, J. .... 510  
 DVORÁK, M. .... 365, 588  
 DZIEDZIC, C.E. .... 108  
 DZIUBEK-ROGOWSKA, W. .... 382

**E**

EARLE, K. .... 423  
 EASTHOPE, C.S. .... 531  
 EASTWOOD, P. .... 174  
 ECKERT, K. .... 464, 610  
 EDA, N. .... 177  
 EDELER, CH. .... 398  
 EDGE, J.A. .... 553  
 EDOUARD, P. .... 461, 463  
 EDWARDS, A. .... 485, 553  
 EDWARDS, B.J. .... 586  
 EFFENBERG, A.O. .... 57, 209, 216  
 EGUCHI, K. .... 410  
 EHRIG, A. .... 605  
 EIJNDE, B.O. .... 132  
 EIJSVOGELS, T. .... 85  
 EIKEBU, A. .... 265  
 EIRALE, C. .... 624  
 EKBLUM, B. .... 245  
 EKEBERG, M. .... 278  
 ELBE, A. .... 496  
 ELBE, A.M. .... 496  
 ELIÖZ, M. .... 573  
 ELKHATEB, N. .... 220, 546  
 ELLEFSEN, S. .... 187  
 ELLENBECKER, T.S. .... 415  
 ELLIOTT, D. .... 155  
 ELLIOTT, J. .... 25  
 ELLISON, G.M. .... 24, 468  
 ELMAHGOUN, S. .... 234, 472  
 EL-MASSIOUI, F. .... 267  
 ELMER, S. .... 101  
 ELNEMR, A. .... 220, 546  
 ELNEMR, O. .... 220, 546  
 EL-SAYED, M.S. .... 187, 525  
 ELVIRA, L. .... 145  
 EMA, R. .... 154, 175  
 EMERY, E. .... 185  
 EMMERTON, L. .... 587  
 ENDO, H. .... 107  
 ENDO, N. .... 430  
 ENDO, S. .... 372, 422  
 ENE, D. .... 429  
 ENGBRETSSEN, L. .... 154, 301  
 ENGELBRECHT, L. .... 57  
 ENGELHARDT, A. .... 482, 483  
 ENGELMANN, J. .... 229  
 ENOKA, R.M. .... 247, 396  
 ENOMOTO, I. .... 577  
 ENOMOTO, M. .... 119  
 ERELIN, J. .... 338  
 ERICSSON, F. .... 602  
 ERIKSRUD, O. .... 153, 278  
 ERINDI, A. .... 255, 342, 437  
 EROGLU KOLAYIS, I. .... 397  
 EROLA, P. .... 113, 579, 645  
 ERSKINE, R.M. .... 466  
 ERTAN, H. .... 375, 397, 418, 624

ESAKI, K. .... 525  
 ESHIMA, H. .... 337  
 ESKELINEN, J.J. .... 173, 233, 581  
 ESPADA, M. .... 527, 629  
 ESPARZA-ROS, F. .... 136, 356  
 ESPINO, L. .... 138  
 ESTERHUIZEN, A. .... 510  
 ESTEVAN, I. .... 619  
 ESTEVE, H. .... 145  
 ESTEVES, A.M. .... 358  
 ESTON, R. .... 106  
 ETTEMA, G. .... 143, 246, 406  
 ETXEBARRIA, N. .... 166  
 EVANGELISTA, I. .... 107  
 EVERAERT, I. .... 91, 176  
 EXADAKTYLOS, V. .... 451  
 EYRE, E.L.J. .... 262

**F**

FABER, I.R. .... 111, 258  
 FABRA, P. .... 638, 641  
 FABRE, C. .... 232  
 FABRE, O. .... 237  
 FAGGIAN, D. .... 596  
 FAGO, A. .... 254  
 FAINA, M. .... 432  
 FAIRCLOUGH, S.J. .... 25, 92, 94  
 FAIRCLOUGH, S.J., .... 25  
 FALCO, C. .... 619  
 FALKE, A.K. .... 110  
 FALLAH OMRAN, S. .... 377  
 FALLAH OMRAN, S. .... 281  
 FALLAN, C. .... 600  
 FALLER, H. .... 431, 452  
 FALUDI, J. .... 447  
 FAN, J.L. .... 495  
 FAN, P.W. .... 225  
 FANTAUZZO, V. .... 389  
 FANTOZZI, S. .... 242, 634  
 FARIAS, L.B. .... 301  
 FARINA, D. .... 58, 323, 541  
 FARKAS, A. .... 588, 608  
 FAROOQ, A. .... 265, 307, 624  
 FASSETT, R.G. .... 524  
 FAUDE, O. 110, 120, 271, 297, 329, 544, 587  
 FAULHABER, M. .... 306, 636  
 FAULKNER, S. .... 25  
 FAULL, O.K. .... 170  
 FAUTRELLE, L. .... 467  
 FAY, T. .... 111  
 FAYAZMILANI, R. .... 392, 393  
 FEDEROLF, P. .... 278, 479  
 FEDEROLF, P.A. .... 479  
 FEDOTOVA, V. .... 340, 561  
 FEICHTINGER, R. .... 272  
 FEIJOO, D. .... 47  
 FEIJÓO, D. .... 306  
 FELDER, H. .... 250  
 FELSENBURG, D. .... 86, 529  
 FELSZEGHY, K. .... 71  
 FELTON, L. .... 567  
 FELTZ, D. .... 292, 567  
 FEMIA, P. .... 425  
 FENTON, S.A.M. .... 39, 387  
 FERGUSON, R.A. .... 25, 646  
 FERICHE, B. .... 436, 533  
 FERNADEZ-DEL-OLMO, M. .... 151  
 FERNANDES, B. .... 107  
 FERNANDES, M.B. .... 216



|                                |                                                           |
|--------------------------------|-----------------------------------------------------------|
| FERNANDES, O.....              | 543                                                       |
| FERNANDES, R.J.....            | 143, 302                                                  |
| FERNANDES, R.J.....            | 301, 303                                                  |
| FERNÁNDEZ GARCÍA, J.C.....     | 120                                                       |
| FERNÁNDEZ GARRIDO, D.....      | 147                                                       |
| FERNÁNDEZ VÁZQUEZ, R.....      | 120                                                       |
| FERNANDEZ, H.....              | 117                                                       |
| FERNANDEZ, J.....              | 265                                                       |
| FERNÁNDEZ-ALVIRA, J.M.....     | 139                                                       |
| FERNÁNDEZ-BLASCO, M.J.....     | 444                                                       |
| FERNÁNDEZ-CUEVAS, I.....       | 182, 611                                                  |
| FERNÁNDEZ-DE-LAS-PENAS, C..... | 507                                                       |
| FERNANDEZ-FERNANDEZ, J.....    | 585                                                       |
| FERNANDEZ-RODRIGUEZ, M.....    | 138                                                       |
| FERNANDO, C.....               | 295, 426                                                  |
| FERNHALL, B.....               | 140, 266, 433                                             |
| FERRAO, A.....                 | 387, 536                                                  |
| FERRARESI, C.....              | 219, 410, 603                                             |
| FERRAUTI, A.....               | 110, 544                                                  |
| FERREIRA JÚNIOR, J.B.....      | 357                                                       |
| FERREIRA, F.C.....             | 313, 390                                                  |
| FERREIRA, M.....               | 107, 136                                                  |
| FERREIRA, M.J.....             | 107                                                       |
| FERREIRA, S.A.....             | 147                                                       |
| FERREIRA, S.M.....             | 378                                                       |
| FERRETTI, G.....               | 405                                                       |
| FERRI, A.....                  | 521                                                       |
| FERRI, I.....                  | 208                                                       |
| FERRIOLI, E.....               | 137                                                       |
| FERUNAJ, P.....                | 255, 342, 437                                             |
| FERUNAJ, P.F.....              | 437                                                       |
| FETAHOVIC, DZ.....             | 616                                                       |
| FIALHO, A.A.....               | 354                                                       |
| FIATARONE SINGH, M.A.....      | 531                                                       |
| FIDLER MIS, N.....             | 439                                                       |
| FIGUEIRAS, T.....              | 353                                                       |
| FIGUEIREDO, C.....             | 563, 564                                                  |
| FIGUERAS, S.....               | 345                                                       |
| FILHO, E.A.R.....              | 303                                                       |
| FILLET, M.....                 | 36, 245                                                   |
| FINKENZELLER, T.....           | 267                                                       |
| FINNI, T.....                  | 471                                                       |
| FIORILLI, G.....               | 445                                                       |
| FISCHBACH, N.....              | 93, 95, 315, 481                                          |
| FISCHER, L.....                | 81                                                        |
| FISCHETTI, F.....              | 439                                                       |
| FISHER, J.....                 | 30                                                        |
| FISHER, S.....                 | 587                                                       |
| FLATAU, J.....                 | 231                                                       |
| FLEMING, N.....                | 21, 194                                                   |
| FLETCHER, D.....               | 21                                                        |
| FLETCHER, G.....               | 466                                                       |
| FLETCHER, I.....               | 329                                                       |
| FLETCHER, J.R.....             | 167                                                       |
| FLYVBJERG, A.....              | 271                                                       |
| FOISSAC, M.....                | 413                                                       |
| FOLLAND, J.P.....              | 31, 466, 542                                              |
| FONSECA, R.....                | 540, 557                                                  |
| FONSECA, S.....                | 354, 561                                                  |
| FONSECA-ALANIZ, M.H.....       | 361                                                       |
| FONTAINE, P.....               | 60                                                        |
| FONTANA, K.E.....              | 236                                                       |
| FONTENELLE, V.....             | 117                                                       |
| FONTES, E.B.....               | 547                                                       |
| FONTES-RIBEIRO, C.A.....       | 321                                                       |
| FORMENTI, D.....               | 384, 533                                                  |
| FÖRSTER, H.....                | 272                                                       |
| FORTE, C.....                  | 559                                                       |
| FORTHOMME, B.....              | 630                                                       |
| FOSCHI, E.....                 | 497                                                       |
| FOSTER, C.....                 | 58, 73, 74, 77, 105, 213,<br>230, 244, 250, 298, 528, 553 |
| FOURNET, D.....                | 163                                                       |
| FOWEATHER, L.....              | 25                                                        |
| FRAGOSO, I.....                | 148, 258                                                  |
| FRAMPTON, C.....               | 500                                                       |
| FRANCA, M.....                 | 356                                                       |
| FRANCAUX, M.....               | 23                                                        |
| FRANCIONI, F.....              | 192                                                       |
| FRANCISCO, R.C.....            | 581                                                       |
| FRANCO-MÁRQUEZ, F.....         | 376                                                       |
| FRANCO-SOLA, M.....            | 345                                                       |
| FRANK, M.K.....                | 358                                                       |
| FRANKE, J.....                 | 215, 233                                                  |
| FRANKLIN, C.....               | 262                                                       |
| FRANKLIN, D.W.....             | 29                                                        |
| FRANSEN, K.....                | 116, 451                                                  |
| FRANTZIS, D.....               | 604                                                       |
| FRANZEN, R.....                | 630                                                       |
| FRATTINI, G.....               | 348, 571                                                  |
| FRECHENGUES, E.....            | 446                                                       |
| FREEMAN, P.....                | 39, 115                                                   |
| FREETHE, E.....                | 178                                                       |
| FREIRE, C.....                 | 207, 270, 370, 371, 372                                   |
| FREITAS, A.M.P.....            | 638                                                       |
| FREITAS, S.A.....              | 151, 399, 419                                             |
| FREITAS, C.G.....              | 151, 399                                                  |
| FREITAS, E.C.....              | 137                                                       |
| FREIWALD, J.....               | 448                                                       |
| FRICKE, H.....                 | 398                                                       |
| FRIESENBICHLER, B.....         | 86                                                        |
| FRISCH, A.....                 | 213                                                       |
| FROBERG, K.....                | 144                                                       |
| FRUSSA-FILHO, R.....           | 358                                                       |
| FRY, A.....                    | 542                                                       |
| FUCHSLOCHER, J.....            | 124                                                       |
| FUENTES, J.P.....              | 564                                                       |
| FUENTES, T.....                | 47                                                        |
| FÜRST, P.....                  | 498                                                       |
| FUJII, K.....                  | 117, 155, 157                                             |
| FUJIKAKE, H.....               | 628                                                       |
| FUJIMOTO, H.....               | 121                                                       |
| FUJIMOTO, T.....               | 494                                                       |
| FUJITA, S.....                 | 72, 323                                                   |
| FUJIWARA, Y.....               | 570                                                       |
| FUKAO, K.....                  | 109                                                       |
| FUKUBASHI, T.....              | 118                                                       |
| FUKUBAYASHI, T.....            | 120, 577, 632                                             |
| FUKUBAYASHI, T.....            | 525                                                       |
| FUKUDA, T.....                 | 454                                                       |
| FUKUMOTO, T.....               | 134                                                       |
| FUKUMURA, K.....               | 454                                                       |
| FUKUNAGA, T.....               | 314, 536                                                  |
| FUKUTANI, A.....               | 102, 154                                                  |
| FULTON, S.....                 | 648                                                       |
| FURALYOV, V.....               | 393                                                       |
| FURUKAWA, M.....               | 139, 464, 465, 535                                        |
| FURUMOTO, K.....               | 386, 623                                                  |
| FURUSAWA, A.A.....             | 228                                                       |
| FURUTANI, O.....               | 340                                                       |
| FURUYA, E.....                 | 119                                                       |
| FYSH, M.....                   | 513                                                       |
| <b>G</b>                       |                                                           |
| GABBETT, T.J.....              | 57, 297                                                   |
| GABEL, K.A.....                | 217                                                       |
| GABRIEL, E.....                | 235, 440, 581                                             |
| GABRIEL, E.A.....              | 440, 581                                                  |
| GABRYS, L.....                 | 500                                                       |
| GADELHA, A.L.....              | 420                                                       |
| GAEINI, A.A.....               | 392, 393                                                  |
| GAETZ, M.....                  | 73, 596                                                   |
| GAFFURINI, P.....              | 323                                                       |
| GAGNON, D.D.....               | 98, 263                                                   |
| GAGNON, S.S.....               | 98, 263                                                   |
| GAIVAO, I.....                 | 188, 333                                                  |
| GALANIS, E.....                | 387                                                       |
| GALINDO, M.....                | 626                                                       |
| GALLARDO, L.....               | 20                                                        |
| GALLEN, A.....                 | 299                                                       |
| GALLI, L.....                  | 86                                                        |
| GALVANI, C.....                | 158, 511                                                  |
| GALVAO, D.A.....               | 287                                                       |
| GANEKO, M.....                 | 558, 597                                                  |
| GANEN, A.P.....                | 408                                                       |
| GANT, N.....                   | 484, 553                                                  |
| GANTENBEIN, C.....             | 242                                                       |
| GAOUA, N.....                  | 265, 267                                                  |
| GAPEYEVA, H.....               | 338                                                       |
| GARALDI, M.....                | 533                                                       |
| GARCIA, S.....                 | 75                                                        |
| GARCÍA-CONCEPCIÓN, M.A.....    | 182                                                       |
| GARCIA-CUARTERO, B.....        | 138                                                       |
| GARCÍA-FERNANDEZ, J.C.....     | 600                                                       |
| GARCÍA-HORTAL, M.....          | 379                                                       |
| GARCÍA-VAQUERO, M.P.....       | 635                                                       |
| GARCIN, M.....                 | 132, 430                                                  |
| GARCZAREK, U.....              | 89                                                        |
| GARDON-MOLLARD, C.....         | 593                                                       |
| GARGANO, M.....                | 384, 533                                                  |
| GARNACHO-CASTANO, M.V.....     | 518                                                       |
| GARNIER, S.....                | 252                                                       |
| GARRIDO, N.....                | 304                                                       |
| GARTHE, I.....                 | 409                                                       |
| GÄRTNER, A.....                | 356                                                       |
| GARVICAN, L.A.....             | 624                                                       |
| GASOL, X.....                  | 541, 542                                                  |
| GASTIN, P.....                 | 281, 342, 436, 591                                        |
| GASTIN, P.B.....               | 591                                                       |
| GATTA, G.....                  | 634                                                       |
| GATTERER, H.....               | 306, 580, 636                                             |
| GATTO, C.D.V.G.....            | 219                                                       |
| GATTO, C.V.G.....              | 313                                                       |
| GAUBERT, I.....                | 252                                                       |
| GAUTHIER, S.....               | 591                                                       |
| GAVIN, J.P.....                | 529, 591                                                  |
| GAZE, D.....                   | 172                                                       |
| GEESMANN, B.....               | 89                                                        |
| GEHRING, D.....                | 57, 479, 498                                              |
| GEISLER, G.....                | 640                                                       |
| GELADAS, N.....                | 271, 630                                                  |
| GENERELO, E.....               | 94                                                        |
| GENIN, J.....                  | 490                                                       |
| GEORGE, K.....                 | 52, 94, 212, 549, 551                                     |
| GEORGE, K.P.....               | 94, 212                                                   |
| GEORGIADIS, G.....             | 160, 399                                                  |
| GEORGOULIAS, P.....            | 381                                                       |
| GEORGOULIS, A.....             | 326                                                       |
| GERONA, T.....                 | 150                                                       |
| GERRETT, N.....                | 25                                                        |
| GERZEVIC, M.....               | 43, 492                                                   |
| GETTE, P.....                  | 76                                                        |
| GEYER, H.....                  | 237                                                       |
| GHANI ZADEH HESAR, N.....      | 509                                                       |
| GHEZA, A.....                  | 549                                                       |
| GHIU, E.....                   | 484                                                       |
| GHORAYEB, N.....               | 581                                                       |
| GI DUCK, P.....                | 132, 409, 429                                             |
| GIAKAS, G.....                 | 387                                                       |
| GIANFELICI, A.....             | 432                                                       |
| GIBALA, M.....                 | 54, 55, 446, 449                                          |
| GIBALA, M.J.....               | 54, 55                                                    |
| GIJSEN, A.P.....               | 238                                                       |
| GIL PÉREZ, T.....              | 318                                                       |

|                             |                                              |                            |                        |                            |                             |
|-----------------------------|----------------------------------------------|----------------------------|------------------------|----------------------------|-----------------------------|
| GIL, S. ....                | 112, 167, 403                                | GONZÁLEZ-MORALES, M. ....  | 223                    | GUELINCKX, I. ....         | 264                         |
| GIL, S.M. ....              | 167                                          | GONZÁLEZ-RAVÉ, J.M. ....   | 184                    | GUERRA BALIC, M.E. ....    | 386                         |
| GIL-CAMPOS, M. ....         | 26                                           | GONZÁLEZ-VERGAZ, A. ....   | 138                    | GUERRA, B. ....            | 47, 161                     |
| GILGIEN, M. ....            | 243, 479                                     | GONZÁLEZ-ZARAGOZA, M. .... | 153                    | GUERRA, M. ....            | 345, 358                    |
| GILL, S. ....               | 178, 474                                     | GOODMAN, C. ....           | 174, 648               | GUERRERO, M. ....          | 161                         |
| GILL, S.K. ....             | 474                                          | GOOSSENS, L. ....          | 606                    | GUIDOTTI, F. ....          | 349                         |
| GILLEN, J.B. ....           | 55                                           | GORE, C. ....              | 35, 624                | GUILLEN, S. ....           | 589                         |
| GIMENEZ, P. ....            | 461                                          | GÖRGEN, C. ....            | 110                    | GUILLÉN, S. ....           | 444                         |
| GIMENIS, D.P. ....          | 361                                          | GORGULU, R. ....           | 116                    | GUILLÉN-BALLESTER, A. .... | 390, 392                    |
| GINEVICIENE, V. ....        | 180                                          | GORJAO, R. ....            | 139                    | GUILLET-DESCAS, E. ....    | 422                         |
| GINIS, P. ....              | 249                                          | GOROSTIAGA, E. ....        | 157, 280, 288          | GUIMARAES, B.R. ....       | 465, 535                    |
| GIOMBINI, A. ....           | 445                                          | GORSKI, T. ....            | 441                    | GUIMARAES, E.A. ....       | 362, 363                    |
| GIOVANARDI, A. ....         | 242                                          | GOSENS, W. ....            | 133                    | GUIMARAES, J.T. ....       | 600                         |
| GIOVANI, D. ....            | 369                                          | GOSELINK, R. ....          | 428                    | GUIMARAES, T.M. ....       | 627                         |
| GIOVANNI, A. ....           | 309                                          | GOTHOT, A. ....            | 273                    | GUINET, S. ....            | 467                         |
| GIRARD, N. ....             | 264                                          | GÖTZ, J.K. ....            | 303                    | GULBIN, J. ....            | 159                         |
| GIRARD, O. ....             | 104, 396                                     | GOUGH, C.E. ....           | 624                    | GULLIKSEN, A. ....         | 291                         |
| GJAKA, M. ....              | 136, 144                                     | GOULART, K.N.O. ....       | 188, 520               | GULSEN, M. ....            | 137                         |
| GLEESON, M. ....            | 115, 178, 299, 379, 482                      | GRABAU, C. ....            | 83                     | GUMUS, M. ....             | 279                         |
| GLOSE, G.L. ....            | 24                                           | GRABOW, V. ....            | 110                    | GUNGA, H.C. ....           | 59, 529                     |
| GOBATO, C. ....             | 302, 303, 447, 554, 587, 619                 | GRACH, D. ....             | 606                    | GUNTER, H. ....            | 89, 585                     |
| GOBATO, C.A. ....           | 303, 447, 554, 587, 619                      | GRAHAM, D. ....            | 485                    | GUROL, B. ....             | 150, 444                    |
| GOBBI, R. ....              | 92, 94                                       | GRAHAM, P.L. ....          | 490                    | GURR, S. ....              | 368                         |
| GOBBO, M. ....              | 323, 549                                     | GRAM, M. ....              | 45, 163, 165           | GUSI, N. ....              | 138                         |
| GODSON, N. ....             | 474                                          | GRAMMATIKAKI, E. ....      | 139                    | GUTIÉRREZ-GARCÍA, C. ....  | 66                          |
| GOEDECKE, J. ....           | 536                                          | GRANADOS, C. ....          | 167                    | GYÖRE, I. ....             | 321                         |
| GOEKINT, M. ....            | 66                                           | GRANATA, C. ....           | 72, 521                | GYORI, A. ....             | 600                         |
| GÓES, S.M. ....             | 315, 439                                     | GRANATA, C.A. ....         | 72                     | GYSEL, T. ....             | 472                         |
| GOFFAUX, S. ....            | 245                                          | GRAND, J. ....             | 169                    |                            |                             |
| GOHARROSTAMI, H. ....       | 200                                          | GRASGRUBER, P. ....        | 438                    | <b>H</b>                   |                             |
| GOLD, W. ....               | 484                                          | GRASSMANN, V. ....         | 391                    | HAAKONSEN, D. ....         | 22, 463                     |
| GOLJA, P. ....              | 439                                          | GRAU, A.G. ....            | 160                    | HAAKONSEN, E. ....         | 528                         |
| GOLLHOFER, A. ....          | 33, 49, 78, 80, 325, 385, 435, 479, 487, 498 | GRECO, C. ....             | 327, 455, 612, 615     | HAAS, C. ....              | 184, 473                    |
| GOLUBEV, V.N. ....          | 308                                          | GRECO, C.C. ....           | 455, 615               | HADIDA, E.M. ....          | 525                         |
| GOLZARI, Z. ....            | 142                                          | GRECO, C.C. ....           | 301, 303               | HADJICHARALAMBOUS, M. .... | 509                         |
| GOMES DA SILVA, S. ....     | 494                                          | GREEN, D. ....             | 52, 61, 171, 261, 262  | HAGER, A. ....             | 482, 483                    |
| GOMES, B. ....              | 180                                          | GREEN, D. ....             | 52                     | HAGIO, S. ....             | 155                         |
| GOMES, E.C. ....            | 188, 520                                     | GREEN, D.J. ....           | 61, 171, 261, 262      | HAKKERS, S. ....           | 507                         |
| GOMES, M. ....              | 354                                          | GREEN, K. ....             | 478                    | HÄKKINEN, A. ....          | 260                         |
| GOMES, R.V. ....            | 585, 637, 645                                | GREEN, S. ....             | 88, 261                | HÄKKINEN, K. ....          | 103, 288, 554, 585          |
| GÓMEZ CARMONA, P. ....      | 182                                          | GREENFIELD, S. ....        | 351, 574               | HALLE, M. ....             | 59, 266                     |
| GOMEZ, F. ....              | 203                                          | GREENHAFF, P. ....         | 46, 90, 379, 409, 605  | HALLÉN, J. ....            | 241, 470                    |
| GOMEZ, M. ....              | 413                                          | GREENHAFF, P.L. ....       | 90, 379, 409, 605      | HALLÉN, J. ....            | 91                          |
| GÓMEZ-BRUTON, A. ....       | 105, 140, 141, 390, 392                      | GREENWAY, K. ....          | 374                    | HALSON, S. ....            | 72, 174, 263, 366, 476, 612 |
| GOMEZ-CABELLO, A. ....      | 138                                          | GREEVES, J. ....           | 108, 598               | HALSON, S.L. ....          | 72, 263, 366, 476, 612      |
| GÓMEZ-CABELLO, A. ....      | 98, 105, 140, 141, 390, 392                  | GREGSON, W. ....           | 24, 52, 54, 174, 212   | HAMACHER, D. ....          | 83, 429                     |
| GONCALVES, C.E. ....        | 346, 570                                     | GRENIER, J.G. ....         | 104                    | HAMAOKA, T. ....           | 72, 525                     |
| GONÇALVES, J. ....          | 321                                          | GRIFFITHS, L. ....         | 407                    | HAMAR, D. ....             | 590                         |
| GONÇALVES, M. ....          | 193                                          | GRIJOTA PÉREZ, F. ....     | 332                    | HAMAR, P. ....             | 566, 572                    |
| GONÇALVES, M. ....          | 414                                          | GRIJOTA, F. ....           | 331, 332               | HAMARSLAND, H. ....        | 409                         |
| GONDIN, J. ....             | 292                                          | GRIMMINGER, E. ....        | 487                    | HAMEETMAN, C.W. ....       | 614                         |
| GONDOH, Y. ....             | 494                                          | GRINFELD, E. ....          | 256                    | HAMLIN, M. ....            | 25, 500, 595                |
| GONDOLA, M. ....            | 384                                          | GROEN, B. ....             | 238                    | HAMMOND, L.E. ....         | 277                         |
| GONJO, T. ....              | 634                                          | GROOTHUIS, J.T. ....       | 598                    | HAMSON-UTLEY, J. ....      | 627                         |
| GONZALEZ, J.T. ....         | 238                                          | GROPPA, M. ....            | 271                    | HAMSTRA, M. ....           | 211                         |
| GONZÁLEZ, L. ....           | 638, 641                                     | GROSDENT, S. ....          | 591                    | HAN, A. ....               | 411, 532                    |
| GONZALEZ, M.D. ....         | 145                                          | GROSPRETRE, S. ....        | 32                     | HAN, A. ....               | 411, 532                    |
| GONZÁLEZ, M.D. ....         | 140, 200, 349                                | GROVES, E.M. ....          | 475                    | HANAKAM, F. ....           | 110, 581                    |
| GONZÁLEZ-AGÜERO, A. ....    | 105, 140, 141, 390, 392                      | GRUBER, M. ....            | 49, 100, 289, 325, 473 | HANAKI, K. ....            | 317                         |
| GONZÁLEZ-ALONSO, J. ....    | 260                                          | GRÜTZMACHER, N. ....       | 386                    | HANAOKA, Y. ....           | 121, 649                    |
| GONZÁLEZ-BADILLO, J.J. .... | 150, 328, 376, 545                           | GRYADUNOV-MASUTTI, L. .... | 255                    | HANKEY, J. ....            | 310, 583                    |
| GONZALEZ-GROS, M. ....      | 138                                          | GRYDELAND, M. ....         | 146                    | HANLEY, B. ....            | 279                         |
| GONZÁLEZ-GROSS, M. ....     | 94                                           | GRZYWACZ, T. ....          | 378                    | HANNEMANN, M. ....         | 82, 493                     |
| GONZALEZ-IZAL, M. ....      | 323                                          | GUADALUPE GRAU, A. ....    | 161, 254               | HANNUKAINEN, J. ....       | 173, 233, 581               |
| GONZÁLEZ-IZAL, M. ....      | 218                                          | GUADALUPE, A. ....         | 306                    | HANNUKAINEN, J.C. ....     | 173                         |
| GONZÁLEZ-LAMUNO, D. ....    | 626                                          | GUADALUPE-GRAU, A. ....    | 47, 176                | HANON, C. ....             | 250, 502                    |
|                             |                                              | GUALANO, B. ....           | 335, 367, 475          | HANSEN, A.V. ....          | 45, 99, 163, 165            |
|                             |                                              | GUAN-LING, H. ....         | 457                    | HANSEN, B.H. ....          | 643                         |
|                             |                                              | GUARDASCIONE, C. ....      | 524                    | HANSEN, D. ....            | 132, 174, 266               |
|                             |                                              | GUBSER, M. ....            | 51, 170                | HANSEN, M. ....            | 99, 271                     |
|                             |                                              | GUÉGUEN, N. ....           | 413                    | HANSMEIER, T. ....         | 494                         |
|                             |                                              | GUELI, K.J. ....           | 64, 419, 527           |                            |                             |

|                      |                                                       |                    |                                           |                                                            |                         |
|----------------------|-------------------------------------------------------|--------------------|-------------------------------------------|------------------------------------------------------------|-------------------------|
| HAN-YONG, L.         | 429                                                   | HERNANDEZ, R.      | 138                                       | HOPKINS, W.G.                                              | 190, 191, 263, 366, 470 |
| HARLEY, S.           | 397                                                   | HERNÁNDEZ-DAVÓ, H. | 562                                       | HOPMAN, M.                                                 | 85, 262, 356, 598       |
| HARRIS, N.           | 547                                                   | HERPERS, R.        | 35                                        | HOPMAN, M.T.E.                                             | 262, 598                |
| HARRISON, C.L.       | 377                                                   | HERRERA, C.P.      | 267, 307                                  | HOPPE, M.W.                                                | 448                     |
| HARRISON, M.         | 192                                                   | HERZIG, K.H.       | 98, 263                                   | HOPPELER, H.                                               | 51, 170, 441, 521       |
| HART, N.             | 71                                                    | HESPEL, P.         | 23, 52                                    | HORIE, M.                                                  | 119                     |
| HARTMANN, U.         | 303, 605                                              | HESS, J.           | 482, 508                                  | HORIE, S.                                                  | 571                     |
| HARUKA, M.           | 625                                                   | HESSELINK, M.      | 133, 504                                  | HORIKAWA, H.                                               | 536                     |
| HASEGAWA, H.         | 34, 225, 226                                          | HETTINGA, F.       | 106, 141, 167, 298                        | HORITA, T.                                                 | 340                     |
| HASELER, L.          | 254                                                   | HETTINGA, F.J.     | 106, 167                                  | HORNIKX, M.                                                | 428                     |
| HASHIZUME, S.        | 69, 152, 154                                          | HEUZE, J.P.        | 115, 387                                  | HORSAK, B.                                                 | 76                      |
| HATAMIYA, N.         | 484                                                   | HEVOR, T.          | 434                                       | HORTOBÁGYI, T.                                             | 501                     |
| HATAMOTO, Y.         | 526                                                   | HEYER, L.          | 124                                       | HOSOYA, M.                                                 | 638                     |
| HATANAKA, E.         | 489                                                   | HEYMAN, E.         | 60, 61                                    | HOSSEINI, S.                                               | 281                     |
| HATTORI, Y.          | 571                                                   | HEY-MOGENSEN, M.   | 165                                       | HOTTA, N.                                                  | 405                     |
| HATZIGEORGIAIDIS, A. | 496                                                   | HEYNDELS, B.       | 19                                        | HOWATSON, G.                                               | 543, 592                |
| HATZITAKI, V.        | 278                                                   | HIAS, J.           | 202                                       | HOWE, P.R.C.                                               | 512                     |
| HAUSSWIRTH, C.       | 264                                                   | HICKLEY, A.J.R.    | 553                                       | HRASKY, P.                                                 | 537                     |
| HAUTALA, A.J.        | 269, 602                                              | HIDETAKA, T.       | 532                                       | HRAZDIRA, E.                                               | 438                     |
| HAUTIER, C.          | 170, 182, 259, 289, 470, 517                          | HIGAKI, Y.         | 337, 526                                  | HREBICKOVA, S.                                             | 438                     |
| HAVENITH, G.         | 25, 163, 164                                          | HIGASHI, A.        | 416                                       | HRISTOVSKI, R.                                             | 75                      |
| HAVIKO, T.           | 338                                                   | HIGASHI, T.        | 538                                       | HSIEH, S.Y.                                                | 382                     |
| HAVU, M.             | 471                                                   | HIGASHIHARA, A.    | 118, 120                                  | HSIN-LIAN, C.                                              | 457                     |
| HAXHI, J.            | 552                                                   | HIGGINS, T.        | 353, 595                                  | HUANG, H.P.                                                | 97                      |
| HAXHOLLI, K.         | 252                                                   | HIGHAM, D.G.       | 181                                       | HUANG, J.                                                  | 286                     |
| HAXHOLLI, M.         | 252                                                   | HIGHTON, J.        | 298, 458                                  | HUANG, Y.C.                                                | 508                     |
| HAXHOLLI, S.         | 252                                                   | HIGUCHI, M.        | 169, 177, 555, 556                        | HUANG, Z.                                                  | 307                     |
| HAYASHI, S.          | 363                                                   | HIKIHARA, Y.       | 314, 608                                  | HUBER, G.                                                  | 471, 610                |
| HAYASHI, S.          | 386, 610, 623                                         | HILDEBRAND, C.     | 182                                       | HUBNER-WOZNIAK, E.                                         | 336                     |
| HAYASHI, T.          | 121                                                   | HILHORST, J.E.C.   | 506                                       | HUDZIAK, J.J.                                              | 566                     |
| HAYES, A.            | 256                                                   | HILL, C.           | 613, 620                                  | HÜLSDÜNKER, T.                                             | 82, 493                 |
| HAYES, B.            | 627                                                   | HILL, K.           | 256                                       | HUERTAS, F.                                                | 344, 415, 421, 423, 424 |
| HAYES, S.J.          | 155                                                   | HINRICHS, T.       | 84, 215, 411, 532, 539                    | HUGHES, M.G.                                               | 217, 442                |
| HAZAMA, Y.           | 559                                                   | HIRAKOBA, K.       | 621                                       | HUME, D.J.                                                 | 536                     |
| HÉBERT-LOSIER, K.    | 414, 562, 602                                         | HIRANO, Y.         | 597, 616                                  | HUMENBERGER, M.                                            | 272                     |
| HEDAYATI, M.         | 393                                                   | HIRASAWA, A.       | 226, 523                                  | HUN-KYUNG, K.                                              | 318                     |
| HEDENBORG, S.        | 350                                                   | HIRATA, K.         | 102, 154                                  | HUNTER, A.                                                 | 543                     |
| HEDGES, C.           | 521                                                   | HIRATSUKA, K.      | 221, 615                                  | HUNTER, S.                                                 | 594                     |
| HEER, M.             | 625                                                   | HIRAYAMA, K.       | 616                                       | HUPPERETS, M.                                              | 25                      |
| HEERSEMA, D.J.       | 86                                                    | HIRONO, M.         | 372                                       | HUPPERTZ, C.                                               | 40, 566                 |
| HEGER, D.            | 229                                                   | HIROSHI, K.        | 625                                       | HUREAU, T.                                                 | 83                      |
| HEIGENHAUSER, G.J.F. | 300                                                   | HIRVENSALO, M.     | 270                                       | HURST, H.T.                                                | 602                     |
| HEIN, V.             | 481                                                   | HISASHI, K.        | 532                                       | HUTCHISON, S.K.                                            | 377                     |
| HEINE, O.            | 613                                                   | HISATOMI, M.       | 223                                       | HUYBERS, T.                                                | 20                      |
| HEINEMEIER, K.M.     | 62, 274                                               | HOBÉ, M.           | 647                                       | HUYBRECHTS, L.                                             | 137                     |
| HEINONEN, I.         | 233, 581                                              | HOCKEY, R.         | 286                                       | HWANG, S.                                                  | 567                     |
| HEINZ, G.            | 203                                                   | HOCKING, J.        | 307, 374, 519                             | HYODO, K.                                                  | 103, 108                |
| HEINZMANN, P.        | 470                                                   | HODDER, S.G.       | 25                                        | HYRKÁS, H.                                                 | 594                     |
| HEITMANN, A.         | 257                                                   | HODGSON, A.        | 63, 89, 283                               |                                                            |                         |
| HELBO, S.            | 254                                                   | HODGSON, A.B.      | 63, 89                                    |                                                            |                         |
| HELGE, J.            | 31, 45, 50, 98, 99, 160, 163, 165, 169, 254, 330, 432 | HODY, S.           | 188, 394                                  |                                                            |                         |
| HELGE, J.W.          | 45, 98, 99, 160, 163, 165, 169, 254, 330, 432         | HOENISCH, J.       | 350                                       | IBANEZ, S.                                                 | 186, 522                |
| HELLAND, C.          | 153                                                   | HOFFMANN, A.       | 219                                       | ICHIKAWA, D.                                               | 125                     |
| HELLEMANS, J.        | 25                                                    | HOFFMANN, U.       | 502                                       | ICHIKAWA, M.                                               | 526                     |
| HELSEN, W.F.         | 80                                                    | HOFFMANN, J.       | 452                                       | ICHIMURA, S.                                               | 404                     |
| HENDERSON, B.        | 436                                                   | HOFFMANN, P.       | 613                                       | IEMITSU, M.                                                | 72, 323, 373            |
| HENDRICKS, S.        | 131, 156                                              | HOFFMUSTER, M.J.   | 462                                       | IEMITSU, M.7, TAKAHASHI, K.8,<br>MIYACHI, M.9, ONODERA, S. | 373                     |
| HENKE, T.            | 210, 212, 606                                         | HOGENOVA, A.       | 268                                       | IGLESIAS, X.                                               | 113, 533, 579, 645      |
| HENNING, B.J.        | 24                                                    | HOKAYEM, M.        | 237                                       | IGLESIAS-SOLER, E.                                         | 44, 545                 |
| HERBAUT, A.          | 413                                                   | HÖKELMANN, A.      | 250                                       | IGUCHI, K.                                                 | 317                     |
| HERBERT, M.          | 503                                                   | HOLDEN, G.         | 91                                        | IHARA, T.                                                  | 218                     |
| HERBST, E.           | 300                                                   | HOLL, N.           | 542                                       | IHARA, Y.                                                  | 221                     |
| HERCEG, M.           | 273                                                   | HOLLOWAY, G.P.     | 300                                       | IHSAN, M.                                                  | 165, 404                |
| HERCHENHAN, A.       | 274                                                   | HOLM, L.           | 62, 271, 282, 333                         | IIDA, K.                                                   | 179                     |
| HERDE, K.            | 327                                                   | HOLMBERG, H.C.     | 54, 77, 176, 241, 288, 414, 515, 562, 602 | IIDA, N.                                                   | 407                     |
| HERDENER, L.         | 258                                                   | HÖLMICH, P.        | 339, 499                                  | IIDA, Y.                                                   | 118, 576                |
| HERLITZ, B.          | 526                                                   | HOLST, J.J.        | 62                                        | IIVONEN, S.                                                | 344                     |
| HERMANN, T.          | 470                                                   | HOMEM, R.          | 557                                       | IZUKA, S.                                                  | 118, 579                |
| HERMSDORF, M.        | 464, 605                                              | HONARI, H.         | 200                                       | IJIRI, T.                                                  | 112                     |
|                      |                                                       | HONDA, A.          | 597                                       | IKEDA, T.                                                  | 597                     |
|                      |                                                       | HOON, M.H.         | 366                                       |                                                            |                         |

IKEGAMI, Y. .... 341  
 IKEGAWA, S. .... 337, 449  
 ILYIN, V. .... 626  
 IM, J.H. .... 425, 433, 556, 647  
 IMAI, H. .... 363  
 IMAI, T. .... 119  
 IMPELLIZZERI, F.M. .... 297, 477, 510  
 IMURA, T. .... 632  
 INDUNI, M. .... 614  
 INKWAN, H. .... 224  
 INO, Y. .... 538  
 INOKO, N. .... 627  
 INOMATA, K. .... 564  
 INOUE, A. .... 297, 346  
 INOUE, N. .... 121  
 INOUE, S. .... 543  
 INT PANIS, L. .... 282  
 INTZOGLOU, K. .... 70  
 INVERNIZZI, P.L. .... 304, 383, 436, 616  
 IODICE, P. .... 251, 428  
 IOTOVA, V. .... 139  
 IPPOLITO, D. .... 480  
 IRAZUSTA, J. .... 167  
 IRÚRTIA, A. .... 579  
 ISACCO, L. .... 167, 310  
 ISAKA, T. .... 323  
 ISANEZHAD, A. .... 531, 629  
 ISHIDA, H. .... 549  
 ISHIDA, K. .... 405, 406  
 ISHIGE, Y. .... 538  
 ISHIHARA, Y. .... 425  
 ISHII, K. .... 494  
 ISHIKAWA TAKATA, K. .... 556  
 ISHIKAWA, M. .... 515, 516, 631  
 ISHIWATA, T. .... 225, 226, 372  
 ISHIZAKI, S. .... 388  
 ISHIZU, T. .... 407  
 ISO, S. .... 383  
 ISOARD-GAUTHEUR, S. .... 422  
 ISOLEHTO, J. .... 242  
 ITO, A. .... 159, 515, 631  
 ITO, S. .... 632  
 ITOH, H. .... 627  
 ITOH, H. .... 543  
 IULIANO, E. .... 445  
 IVANOV, A. .... 368  
 IWAMOTO, E. .... 405, 406  
 IWANUMA, S. .... 69, 152, 154  
 IWASAKI, H. .... 179  
 IWATA, H. .... 559  
 IZARD, R. .... 598  
 IZQUIERDO, M. .... 157, 218, 288, 617

**J**

JAARMSA, T. .... 84  
 JABES, M. .... 111  
 JACKMAN, S. .... 236  
 JACKSON, M.J. .... 24, 468  
 JACKSON, R. .... 354, 424  
 JACOBS, D.M. .... 63, 89  
 JACOMINI, A.M. .... 224  
 JACUBOWSKI, A. .... 146  
 JÄGER, D. .... 234, 471  
 JAGO, R. .... 94, 319  
 JAHNEL, R. .... 243  
 JAIME, S. .... 74, 528  
 JAITNER, T. .... 236, 562  
 JAKEMAN, J.R. .... 54, 589  
 JAKOBSEN, V. .... 153  
 JAKOVljeVIC, V. .... 381, 400

JAMART, C. .... 23  
 JAMES, D.C. .... 594  
 JAMES, M. .... 201  
 JAMISON, S. .... 497  
 JAMURTAS, A.Z. .... 381  
 JANSEN, I.E. .... 40  
 JANSEN, R.J. .... 320  
 JANSSENS, W. .... 428  
 JARIC, S. .... 466, 618  
 JARJOURA, D. .... 184  
 JASPERS, E.G. .... 106  
 JASPERS, R.T. .... 320  
 JAVIDI ATHAR, A. .... 327  
 JELEN, M. .... 590  
 JELOK, I. .... 147  
 JENDRUSCH, G. .... 212, 647  
 JENKINS, D. .... 163, 528, 587, 646  
 JENNER, W.J. .... 600  
 JENSEN, K. .... 233  
 JEON, Y.J. .... 425, 433, 556, 647  
 JESSOP, D. .... 414  
 JESUNATHADAS, M. .... 396  
 JEUKENDRUP, A.E. .... 63, 89, 202, 203, 605  
 JIANG, C.C. .... 508  
 JIANG, R. .... 126  
 JIDOVITSEFF, B. .... 157, 547  
 JIGAMI, H. .... 430  
 JIMENEZ, A. .... 319  
 JOAO, P. .... 129, 149, 188, 333  
 JOAO, P.V. .... 129, 149  
 JOHANSEN, B.T. .... 639, 641  
 JOHANSEN, R. .... 409  
 JOHN, S. .... 125  
 JOHNSON, N. .... 166, 210, 366  
 JOHNSON, N.J. .... 366  
 JOHNSON, U. .... 275, 276  
 JOISTEN, F. .... 182  
 JOLLIN, L. .... 636  
 JONES, A. .... 54, 186, 284, 311, 366  
 JONES, A.M. .... 366  
 JONES, A.W. .... 186  
 JONES, H. .... 52, 61, 171, 212, 598  
 JONES, M. .... 269  
 JOO, C.H. .... 54  
 JORDAN, A. .... 513  
 JOWETT, J. .... 254  
 JOWETT, S. .... 116, 292, 567  
 JUAN-RECIO, C. .... 635  
 JUBEAU, M. .... 290  
 JUBEAU, M. .... 292, 522  
 JUI-HSIN, L. .... 457  
 JULIÁN, J.A. .... 94  
 JULKA, D. .... 352  
 JUNG, M. .... 629  
 JUNGE, A. .... 510  
 JÚNIOR, A.A.J. .... 313  
 JÚNIOR, M.A.H.S. .... 303  
 JUNIOR, V. .... 143  
 JUSSILA, A.M. .... 348, 571  
 JUTLEY, R.S. .... 214, 648

**K**

KACURRI, A. .... 252  
 KADI, F. .... 38, 71, 245  
 KAGAYA, Y. .... 107  
 KAGEYAMA, H. .... 378  
 KAI, Y. .... 218, 632  
 KAI, Y. .... 135  
 KAJI, K. .... 586

KALAB, M. .... 447, 448  
 KALABOVA, M. .... 448  
 KALE, M. .... 149, 150, 444  
 KALICHOVA, M. .... 560  
 KALICHOVÁ, M. .... 560  
 KALINICHENKO, A.N. .... 308  
 KALLIOKOSKI, K. .... 173, 233, 581  
 KALLIOKOSKI, K.K. .... 173  
 KAMIMURA, T. .... 325  
 KAN, M. .... 68  
 KANAKIS, I. .... 278  
 KANAZAWA, A. .... 628  
 KANAZAWA, N. .... 342  
 KANEHISA, H. .... 69, 102, 152, 154, 175, 221, 314  
 KANEKO, Y. .... 119  
 KANEMARU, J. .... 228  
 KANITZ, A.C. .... 214  
 KANOSUE, K. .... 122, 416, 417, 559  
 KANOUE, H. .... 372  
 KAPANEN, J. .... 233, 581  
 KAPO, S. .... 616, 617, 618  
 KARAKASIDOU, E. .... 565  
 KARAMANIDIS, K. .... 493  
 KARAMPATOS, G. .... 160, 399  
 KARGER, K. .... 142  
 KARINEN, H.M. .... 309  
 KARIYA, F. .... 311  
 KARLSEN, T. .... 473  
 KARPUL, D. .... 156  
 KARSAI, I. .... 566, 572  
 KARTEROLIOTIS, K. .... 353, 480  
 KASE, T. .... 422  
 KASPAR, M. .... 86  
 KASPEREK, P. .... 544  
 KASPERSKA, A. .... 336, 382, 582, 649  
 KASPROWICZ, K. .... 378  
 KATAMOTO, S. .... 109, 425  
 KATAYAMA, K. .... 405, 406  
 KATHIRAVEL, Y. .... 25  
 KATIRCI, H. .... 127  
 KATIS, A. .... 195  
 KATLUN, T. .... 212  
 KATO, E. .... 430  
 KATO, H. .... 372, 595  
 KATO, K. .... 417  
 KATO, Z. .... 125  
 KATSIKAS, C. .... 124, 125, 343, 603  
 KATSUKAWA, F. .... 549  
 KATSUMURA, K. .... 119  
 KAUX, J. .... 36, 245, 273, 630  
 KAUX, J.F. .... 36, 245, 630  
 KAVAJA, G. .... 342, 437  
 KAVALIUSKAS, M. .... 528  
 KAVOURAS, S. .... 399  
 KAWAKAMI, T. .... 125  
 KAWAKAMI, Y. .... 69, 102, 152, 154, 175, 314, 536  
 KAWAMOTO, A. .... 595  
 KAWAMURA, R. .... 407  
 KAWANISHI, M. .... 383  
 KAWANO, H. .... 169, 555  
 KAWASHIMA, N. .... 430, 491  
 KAWATA, Y. .... 317  
 KAY, A.D. .... 277  
 KAYANI, A. .... 468  
 KAYSER, B. .... 495  
 KAZI, A. .... 23  
 KAZUMI, F. .... 220  
 KAZUNORI, N. .... 457  
 KECELI, D. .... 191  
 KEDENKO, I. .... 272

|                      |                        |                                       |               |                                |                         |
|----------------------|------------------------|---------------------------------------|---------------|--------------------------------|-------------------------|
| KEECH, A. ....       | 291                    | KLASS, M. ....                        | 396           | KOUGIOUMTZIS, K. ....          | 506                     |
| KELLER, M. ....      | 57, 80                 | KLASSON-HEGGEBØ, L. ....              | 143           | KOULALIS, J. ....              | 70                      |
| KELLIS, E. ....      | 195                    | KLEBER, M. ....                       | 33            | KOULI, O. ....                 | 496                     |
| KELLY, K.B. ....     | 335                    | KLEIN, A. ....                        | 264           | KOUTEDAKIS, Y. ....            | 335, 387                |
| KEMP, G.J. ....      | 61, 171                | KLEIN, C. ....                        | 210           | KOUTSANDRÉOU, F. ....          | 494                     |
| KEMPS, H.M.C. ....   | 502                    | KLEINERT, J. ....                     | 90, 267       | KOU-WEI, T. ....               | 457                     |
| KENNIS, E. ....      | 500                    | KLOHS, J. ....                        | 170           | KOUZAKI, M. ....               | 101, 117, 155, 157, 175 |
| KENTO, N. ....       | 416                    | KLUSEMANN, M.J. ....                  | 111, 244      | KOVÁCS, T. ....                | 224                     |
| KERAMIDAS, P. ....   | 355, 387               | KNAEPEN, K. ....                      | 66, 117       | KOVALENKO, T. ....             | 364                     |
| KERESZTES, N. ....   | 224                    | KNEFFEL, Z. ....                      | 96            | KOWN, I.S. ....                | 392                     |
| KERKHOF, F. ....     | 141                    | KNEIS, S. ....                        | 33            | KOZ, M. ....                   | 137                     |
| KERN, C. ....        | 472                    | KNEZ, K. ....                         | 285           | KOZECHIAN, H. ....             | 200                     |
| KERNOZEK, W.T. ....  | 77                     | KNEZ, W.L. ....                       | 335           | KRAAG ZIEGLER, A. ....         | 169                     |
| KERR, G. ....        | 640                    | KNICKER, A. ....                      | 397, 398, 624 | KRAMER, A. ....                | 325, 356, 435           |
| KERSTEN, S. ....     | 179                    | KNICKER, A.J. ....                    | 398           | KRAMER, F. ....                | 89                      |
| KERSTING, M. ....    | 94                     | KNOLL, K. ....                        | 605           | KRAMER, I.F. ....              | 100                     |
| KERSTING, U. ....    | 240                    | KNOWLES, Z. ....                      | 25            | KRASE, A. ....                 | 399                     |
| KERTING, U.G. ....   | 58                     | KNOX, E.C. ....                       | 40            | KRATKY, S. ....                | 462                     |
| KESOGLOU, I. ....    | 125, 603               | KNUUTI, J. ....                       | 233, 581      | KRAUSE, M. ....                | 187, 299                |
| KETTELHUT, I.C. .... | 176                    | KOBAL, R. ....                        | 112           | KRAUSHAAR, J. ....             | 110                     |
| KETTNER, S. ....     | 95, 315, 481           | KOBAYASHI, D. ....                    | 577           | KRAVCHENKO, I. ....            | 393                     |
| KHALEDI, N. ....     | 392, 393               | KOBAYASHI, K. ....                    | 383, 628      | KRAVCHYCHYN, A.C.P. ....       | 588                     |
| KHAN, S.T. ....      | 161                    | KOBAYASHI, L. ....                    | 236           | KREKOUKIA, M. ....             | 399                     |
| KHANJARI, M. ....    | 437                    | KOBAYASHI, M. ....                    | 557, 628      | KRELL, J. ....                 | 59, 229                 |
| KHODAYARI, A. ....   | 126                    | KOBAYASHI, Y. ....                    | 616           | KRETSCHMANN, R. ....           | 95                      |
| KIDGELL, D. ....     | 436                    | KOBEL, S. ....                        | 95, 315, 481  | KREUSER, F. ....               | 385, 487                |
| KIDOKORO, M. ....    | 569                    | KOCAEKSI, S. ....                     | 451           | KRIJNEN, W.P. ....             | 222                     |
| KIHIRA, A. ....      | 119                    | KOCH, J. ....                         | 59, 529       | KRINSKI, K. ....               | 638                     |
| KILIAN, Y. ....      | 590                    | KODEJSKA, J. ....                     | 447, 448      | KRISTENSEN, M.M. ....          | 23                      |
| KIM, B.W. ....       | 425, 647               | KOEHLER, K.89, 90, 237, 360, 590, 649 |               | KROFF, J. ....                 | 536                     |
| KIM, C. ....         | 392, 425, 602, 647     | KÖHLING, R. ....                      | 220           | KROGSGAARD, M. ....            | 62, 274                 |
| KIM, C.H. ....       | 425, 602, 647          | KOIKE, T. ....                        | 406           | KRÖLL, J. ....                 | 243, 479                |
| KIM, H.J. ....       | 392, 433, 556          | KOJI, N. ....                         | 220           | KROMMIDAS, C. ....             | 387                     |
| KIM, K. ....         | 283, 332, 433, 556     | KOJIMA, S. ....                       | 228, 416      | KROMMIDAS, H. ....             | 355                     |
| KIM, K.H. ....       | 433, 556               | KOJIMA, T. ....                       | 558, 597      | KRSSAK, M. ....                | 147                     |
| KIM, M.J. ....       | 145                    | KOKONECI, G. ....                     | 130           | KRUEGER, M. ....               | 330, 644                |
| KIM, Y.J. ....       | 156                    | KOKUBU, M. ....                       | 323, 416      | KRUEL, L.F. ....               | 214, 218                |
| KIMBER, N. ....      | 500                    | KOLAYIS EROGLU, I. ....               | 624           | KRUSCHE, T. ....               | 272                     |
| KIME, R. ....        | 119                    | KOLB, B. ....                         | 253           | KUBO, A. ....                  | 135                     |
| KIMURA, F. ....      | 649                    | KOLLE, E. ....                        | 143, 643      | KUBOTA, A. ....                | 546                     |
| KIMURA, K. ....      | 570                    | KOMATSU, T. ....                      | 154           | KUBOTA, C. ....                | 558                     |
| KIMURA, M. ....      | 311                    | KOMI, P. ....                         | 444, 515, 516 | KUCINSKAS, V. ....             | 180                     |
| KIMURA, M. ....      | 608                    | KOMI, P.V. ....                       | 444, 515, 516 | KUDO, H. ....                  | 580                     |
| KIMURA, S. ....      | 627                    | KOMKA, ZS. ....                       | 321, 447      | KÜHL, R. ....                  | 234                     |
| KIMURA, Y. ....      | 223, 391               | KOMORI, Y. ....                       | 577           | KÜMMEL, J. ....                | 289                     |
| KINGSLEY, M. ....    | 53                     | KON, M. ....                          | 597           | KUHN, G. ....                  | 484                     |
| KINNUNEN, H. ....    | 585, 593               | KÖNIG, N. ....                        | 83            | KULMALA, J. ....               | 41, 316, 344            |
| KINOSHITA, H. ....   | 212                    | KONO, I. ....                         | 577, 649      | KULMALA, J.P. ....             | 41                      |
| KINOSHITA, N. ....   | 549                    | KONOPKOVÁ, R. ....                    | 596           | KUMAGAWA, D. ....              | 221, 337, 443, 449, 615 |
| KIPP, R.W. ....      | 158, 633               | KONRAD, M. ....                       | 613           | KUMAGAWA, D., TSUNODA, N. .... | 449                     |
| KIRIMOTO, H. ....    | 193                    | KONSTANTOPOULOS, A. ....              | 271           | KUNIIYOSHI, H. ....            | 312                     |
| KIRK, R. ....        | 172, 337               | KOO, S. ....                          | 625           | KUNO-MIZUMURA, M. ....         | 449                     |
| KIRK, R.J. ....      | 172                    | KOOL, J. ....                         | 454, 561      | KUNOROZVA, L. ....             | 255                     |
| KIRKETEIG, A. ....   | 547                    | KOPEC, W. ....                        | 582, 649      | KUNZ, D. ....                  | 529                     |
| KIS, G.K. ....       | 333                    | KOPONEN, A.S. ....                    | 309           | KUPKA, D. ....                 | 59                      |
| KISS, B. ....        | 224                    | KOPPO, K. ....                        | 310, 314      | KURANO, M. ....                | 454                     |
| KISS, M.A.P.D. ....  | 235, 440, 581          | KORDI, M. ....                        | 281, 377, 393 | KURDIOVÁ, T. ....              | 147                     |
| KITA, T. ....        | 125, 571               | KORFF, T. ....                        | 68            | KURIHARA, T. ....              | 72                      |
| KITABATAKE, Y. ....  | 607                    | KORNFEIND, P. ....                    | 341           | KUROBE, K. ....                | 307                     |
| KITADA, K. ....      | 193                    | KOROLEV, Y.N. ....                    | 308           | KUROCHKINA, N. ....            | 393                     |
| KITAMURA, H. ....    | 311, 331, 377          | KORRES, S. ....                       | 418           | KUROSAKA, Y. ....              | 311                     |
| KITAMURA, K. ....    | 207                    | KORSTEN-RECK, U. ....                 | 385, 487      | KUSCH, A. ....                 | 236                     |
| KITANO, N. ....      | 191                    | KORTE, J. ....                        | 487           | KUVARATI, S. ....              | 342, 437                |
| KITAWAKI, T. ....    | 340                    | KORUC, Z. ....                        | 451           | KUZMIN, I. ....                | 407                     |
| KIVINIEMI, A.M. .... | 173, 269, 602          | KORVAS, P. ....                       | 560           | KYPAROS, A. ....               | 523                     |
| KIYONAGA, A. ....    | 526                    | KOS, D. ....                          | 320           | KYROLAINEN, H. ....            | 309                     |
| KIYOSHI, S. ....     | 625                    | KOSCHATE, J. ....                     | 502           | KYROLAINEN, H. ....            | 103                     |
| KIYOTA, N. ....      | 420                    | KOSKEL, S. ....                       | 130           | KYRÖLÄINEN, H. ....            | 98, 263, 554, 585       |
| KIZILDAG, E. ....    | 209                    | KOSSAK-MACHNO, D. ....                | 370           | KYSELOVICOVÁ, O. ....          | 147                     |
| KJÆR, K. ....        | 99, 160                | KOSTEN, L. ....                       | 132           | KYUNG RYUL, C. ....            | 409                     |
| KJÆR, M. ....        | 71, 271, 274, 333, 486 | KÖSTERS, A. ....                      | 45            |                                |                         |
| KJENDLIE, P.L. ....  | 22, 463                | KOSTOPOULOS, N. ....                  | 124, 196      |                                |                         |

## L

- LA TORRE, A. .... 42, 86, 432  
 LABAYEN, I. .... 94  
 LABORDE, S. .... 39  
 LACERDA, D. .... 149  
 LACOME, M. .... 541  
 LAFORGE-MACKENZIE, K. .... 567  
 LAFRENZ, A. .... 352  
 LAGAE, W. .... 36  
 LAGO-PENAS, C. .... 328  
 LAI, C.H. .... 135  
 LAIRES, M.J. .... 473, 474  
 LAMB, K. .... 113  
 LAMBERT, E.V. .... 536  
 LAMBERT, K. .... 237  
 LAMBERT, M. .... 44, 51, 59, 131, 156, 229, 520, 589  
 LAMBERT, M.I. .... 51, 131, 156, 229, 520, 589  
 LAMBERTS, R.P. .... 73, 118, 520  
 LAMBRECHT, L. .... 137  
 LANCASTER, R.E. .... 551  
 LANCHA JR, A.H. .... 475, 637  
 LANCHA, J.A.H. .... 335  
 LANDERS, G. .... 164, 530, 643  
 LANDGRAFF, H. .... 91  
 LANFERDINI, F. .... 218  
 LANGBERG, H. .... 62, 69, 71, 271, 272  
 LANGE, B. .... 453  
 LANGE, M. .... 464, 610  
 LANGER, D. .... 428  
 LANGIN, D. .... 310, 314  
 LANZI, S. .... 174  
 LAPOLE, T. .... 492  
 LAPRAILLE, S. .... 273  
 LARA-SÁNCHEZ, A.J. .... 127, 128, 402  
 LARSEN, C.H. .... 293  
 LARSEN, M.R. .... 99  
 LARSEN, S. .... 330  
 LASKOWSKI, R. .... 378  
 LASNE, F. .... 434, 636  
 LÁSZLÓ, F. .... 224, 333, 365  
 LÁSZLÓ, F.A. .... 333  
 LATESSA MAIETTA, P. .... 497  
 LAU, W.Y. .... 162  
 LAUBER, B. .... 57, 80  
 LAUKKANEN, A. .... 471  
 LAURA, T. .... 470  
 LAURENT, T. .... 245  
 LAURENTINO, G. .... 45, 398  
 LAURENTINO, G.C. .... 398  
 LAURIDSEN, H.B. .... 339  
 LAURSEN, P.B. .... 298, 519, 599  
 LAVRYSEN, A. .... 80  
 LAZAROTTO, L. .... 439  
 LAZARUS, R. .... 254  
 LAZARUS, S. .... 484  
 LE FUR, Y. .... 292  
 LE GOFF, C. .... 36, 245, 273, 630  
 LE MEUR, Y. .... 264  
 LEAO, H.F.P. .... 303  
 LECLAIR, E. .... 60  
 LEE, B. .... 185, 425, 433, 556, 560, 647  
 LEE, B.K. .... 425, 433, 556, 560, 647  
 LEE, D. .... 189  
 LEE, E. .... 177  
 LEE, H.K. .... 145  
 LEE, H.T. .... 156  
 LEE, J. .... 225, 539, 554  
 LEE, P. .... 126  
 LEENDERS, M. .... 90  
 LEFEUVRE, L. .... 313  
 LEFEVER, I. .... 137  
 LEFEVER, J. .... 202  
 LEFTER, M. .... 526  
 LEGERLOTZ, K. .... 277  
 LEIFERT, J.A. .... 33  
 LEIRAS, J. .... 339, 633  
 LEITAO, J. .... 199, 330, 333  
 LEITAO, J.C. .... 333  
 LEITAO, R. .... 321, 482, 535  
 LEITE, N. .... 315, 359, 361, 439, 464, 540  
 LEKO, G. .... 304  
 LEMMEY, A.B. .... 300, 325  
 LEMMINK, K.A.P.M. .... 44  
 LEMOINE-MOREL, S. .... 310, 313  
 LENOIR, M. .... 150, 443, 509  
 LENTI, M. .... 552  
 LEPERS, R. .... 324, 614  
 LEPERS, R. .... 32  
 LEPRINCE, P. .... 188, 394  
 LER, H. .... 162, 513  
 LER, H.Y. .... 162  
 LETIERI, R.V. .... 409  
 LEUKEL, C. .... 57, 67, 80  
 LEUKEL, C., ..... 57  
 LEUNG, F. .... 286  
 LEVADA-PIRES, A.C. .... 139  
 LEVELS, K. .... 73  
 LEVIN, O. .... 80  
 LEWIS, F.C. .... 24  
 LEWIS, M.J. .... 53  
 LEWIS, M.P. .... 394, 646  
 LHERAUD, C. .... 467  
 LI, F.X. .... 78, 243, 380, 402  
 LI, S. .... 566  
 LIANG, Y. .... 122  
 LIBARDI, C. .... 411  
 LIBERTIAUX, V. .... 630  
 LICARI, M.K. .... 419  
 LIDOR, R. .... 448, 530, 570  
 LIEN, N. .... 146  
 LIENHARD, K. .... 645  
 LIMA RIBEIRO, S. .... 540, 638  
 LIMA, F.R. .... 335  
 LIMA, L.C.R. .... 642  
 LIMA, R. .... 180, 540  
 LIMA-SILVA, A.E. .... 521  
 LIMMER, M. .... 366  
 LIN, C.W. .... 135  
 LIN, J.C. .... 306  
 LIN, K.H. .... 508, 578  
 LIN, M.J. .... 458  
 LINDHOLM, H. .... 594  
 LINDINGER, S. .... 515  
 LINDVALL, B. .... 245  
 LINDVALL, L. .... 245  
 LING, J. .... 566  
 LINGELBACH, B. .... 647  
 LINNAMO, V. .... 193, 515, 516  
 LINNAMO, V., ..... 193  
 LINONIS, V. .... 431  
 LINTHORNE, N.P. .... 184  
 LIPHARDT, A.M. .... 68, 625  
 LIPPENS, V. .... 419  
 LIPS, P.T.A. .... 221  
 LIPSKI, M. .... 165, 404  
 LIRA, F.S. .... 185, 308, 475  
 LIVINGSTON, S. .... 519  
 LIVINGSTONE, S. .... 374  
 LIXANDRAO, M. .... 411  
 LIZAMORE, C. .... 25  
 LLANA, S. .... 622  
 LLERENA RUIZ, F. .... 332  
 LLERENA, F. .... 331, 332  
 LLESHI, E. .... 130, 131  
 LLORENS, F. .... 421, 423  
 LLORENTE-CANTARERO, F.J. .... 26  
 LLOYD, A. .... 291  
 LOCATELLI, E. .... 515  
 LOCCUFIER, M. .... 183  
 LOETZERICH, H. .... 613  
 LOGAN, F. .... 500  
 LOHNE-SEILER, H. .... 643  
 LONCARIC-KATUSIN, M. .... 582  
 LONG, S. .... 329  
 LONGO, S. .... 304, 383, 436, 466, 616  
 LONNEUX, V. .... 273  
 LOPES, C. .... 358  
 LOPES, D. .... 136  
 LOPES, H. .... 295, 426  
 LOPES, L. .... 316  
 LOPES, V.P. .... 316, 482  
 LOPEZ DE SUBJANA, C. .... 413  
 LÓPEZ DE SUBJANA, C. .... 20, 338, 414  
 LOPEZ, I. .... 600  
 LOPEZ, R. .... 456  
 LÓPEZ-GULLÓN, J.M. .... 617  
 LÓPEZ-RAMÓN, M.F. .... 344  
 LÓPEZ-ROMÁN, F.J. .... 27  
 LÓPEZ-RUIZ, F. .... 507  
 LORD, S. .... 293  
 LORENZETTI, F.M. .... 637  
 LORIMER, R. .... 589  
 LOSA-REYNA, J. .... 176, 306  
 LOSNEGARD, T. .... 241, 470  
 LOTITO, S.B. .... 63  
 LÖTZERICH, H. .... 215  
 LOUIS, J. .... 152  
 LOUZADA, E. .... 540  
 LOVECCHIO, N. .... 348, 571  
 LOVØLL, S.M. .... 644  
 LU, H.C. .... 584  
 LUCAS, S.J.E. .... 170  
 LUDWIG, N. .... 384, 533  
 LUIG, P. .... 210, 606  
 LUÍS, A.L. .... 356  
 LUKÁSEK, M. .... 560  
 LUKASKI, H. .... 636  
 LUKE, A. .... 484  
 LUKE-ZEITOUN, M. .... 484  
 LUNARDI, C. .... 642  
 LUND, M. .... 62, 99  
 LUND, M.T. .... 62  
 LUNDBY, C. .... 306  
 LUNDBYE-JENSEN, J. .... 29, 80  
 LUNT, H. .... 500  
 LUPIÁNEZ, J. .... 344  
 LUQUE, A. .... 27, 355, 420, 424  
 LUQUE, A.J. .... 27  
 LUSA, S. .... 594  
 LUZ, C.R. .... 637  
 LUZ, G.C.P. .... 627  
 LUZ, M. .... 563  
 LYE, C.T.J. .... 319  
 LYSENKO, O. .... 626  
 LYSTAD, R.P. .... 490

## M

- MA, M. .... 574  
 MACALLISTER, R.J. .... 600  
 MACDONALD, H. .... 68  
 MACDONALD, J. .... 553

|                         |                   |                         |                    |                     |                                      |
|-------------------------|-------------------|-------------------------|--------------------|---------------------|--------------------------------------|
| MACDONALD, M.J.         | 53, 172           | MARZILGER, R.           | 278                | MASUO, Y.           | 314                                  |
| MACGREGOR, O.           | 19                | MARUYAMA, A.            | 227, 345, 416      | MATA, E.            | 138                                  |
| MACHADO, D.R.L.         | 578               | MARTIN, J.              | 101, 298, 375, 451 | MATA, E.            | 223                                  |
| MACHADO, F.             | 588               | MARTIN, L.              | 424, 541           | MATÉ-MUNOZ, J.L.    | 518                                  |
| MACHADO, L.             | 302               | MARTIN, M.              | 145                | MATEO-MARCH, M.     | 420                                  |
| MACHADO, M.             | 252               | MARTIN, N.R.W.          | 394                | MATIAS, C.          | 473, 474                             |
| MACHADO, P.P.           | 185, 308          | MARTIN, N.S.            | 644                | MATKOVIC, A.        | 630                                  |
| MACHADO-RODRIGUES, A.   | 540               | MARTIN, N.S.            | 202                | MATKOVIC, B.R.      | 623, 630                             |
| MACHTSIRAS, G.          | 462               | MARTÍNEZ, G.            | 202                | MATKOWSKI, B.       | 32                                   |
| MACIEJCZYK, M.          | 405               | MARTÍNEZ-GÓMEZ, D.      | 94                 | MATOS, R.           | 149                                  |
| MACINTOSH, B.R.         | 167               | MARTÍNEZ-PARDO, E.      | 136, 356           | MATOS-NETO, E.M.    | 361                                  |
| MACKENZIE, R.           | 185               | MARTÍNEZ-PASCUAL, M.    | 27                 | MATOUSCHEK, S.      | 609                                  |
| MACKINTOSH, K.A.        | 92, 94            | MARTÍNEZ-RUIZ, E.       | 136, 356           | MATRAN, R.          | 60, 132, 430                         |
| MADARAME, H.            | 454               | MARTÍNEZ-VALENCIA, M.A. | 153, 184           | MATRON, G.          | 480                                  |
| MADDEN, L.A.            | 172               | MARTIN-GARCIA, M.       | 138                | MATSUBARA, Y.       | 649                                  |
| MADDISON, P.            | 300, 325          | MARTINI, J.S.C.         | 235, 440           | MATSUBAYASHI, T.    | 339, 597, 621                        |
| MADELEINE, P.           | 102, 259, 507     | MARTINS, A.C.           | 408                | MATSUDO, S.M.M.     | 324, 609                             |
| MÄDER, U.               | 605               | MARTINS, C.             | 353, 437, 622      | MATSUDO, V.K.R.     | 609                                  |
| MADOKORO, K.            | 218, 632          | MARTINS, F.             | 563, 564           | MATSUI, T.          | 34                                   |
| MADSEN, A.              | 300               | MARTINS, J.             | 330, 347, 506      | MATSUMOTO, D.       | 134                                  |
| MADSEN, K.              | 280               | MARTINS, L.E.B.         | 303, 587, 619      | MATSUMOTO, N.       | 373                                  |
| MAEDA, S.               | 433               | MARTINS, R.             | 148, 410           | MATSUO, A.          | 339                                  |
| MAEDER, U.              | 215               | MARTINS, W.             | 540                | MATSUTANI, K.       | 72                                   |
| MAEOKA, H.              | 134               | MÄRTSON, A.             | 338                | MATTA, D.           | 400                                  |
| MAESTRINI, S.           | 174               | MARUSIC, U.             | 43, 492            | MATTEI, C.          | 400                                  |
| MAFFIULETTI, N.A.       | 33, 100, 291, 491 | MARUTANI, Y.            | 346                | MATTERAGLIA, L.     | 485                                  |
| MAGALHAES, J.           | 280, 458          | MARZILGER, R.           | 278                | MATTES, K.          | 42, 216, 441                         |
| MAGNUSSON, K.           | 169               | MASAKI, T.              | 532                | MATTHEWS, B.        | 131                                  |
| MAGUIRE, G.             | 485               | MASCARENHAS, L.P.G.     | 315, 361, 439      | MATTOS, F.          | 315                                  |
| MAHONY, N.              | 274               | MASCARIN, N.            | 411, 412           | MATTSON, N.         | 432                                  |
| MAIA-LIMA, A.           | 188, 520          | MASCARIN, N.C.          | 411, 412           | MATTSSON, C.M.      | 245                                  |
| MAIETTA, P.             | 161               | MASCÓ, D.H.             | 494                | MATTSSON, N.        | 160                                  |
| MAIN, L.C.              | 591               | MASSART, A.             | 180                | MATUMOTO, N.        | 623                                  |
| MAJOR, Z.               | 96                | MASSCHELEIN, E.         | 52                 | MATUTE-LLORENTE, A. | 105, 140, 141, 390, 392              |
| MAKABE, C.              | 570               | MASSIDDA, M.            | 197, 317, 400      | MATZENBACHER, F.    | 435                                  |
| MAKI, Y.                | 513               | MASSIDDA, M.            | 394, 539           | MAUGHAN, R.J.       | 30, 227, 379                         |
| MÄKINEN, T.             | 594               | MASSUCA, L.             | 148, 258           | MAU-MOELLER, A.     | 615                                  |
| MALATESTA, D.           | 174               | MASTALERZ, A.           | 418                | MAURIÉGE, P.        | 252                                  |
| MALBERT, C.H.           | 313               | MASUD, M.M.             | 494                | MAVROS, Y.          | 531                                  |
| MALCATA, R.M.           | 190               | MASUKO, T.              | 222                | MAY, G.             | 557                                  |
| MALDONADO, R.           | 619               | MASUNARI, A.            | 211                | MAYNAR MARINO, M.   | 332                                  |
| MALFAIT, B.             | 508, 575, 577     |                         |                    | MAYNAR, M.          | 331, 332                             |
| MALISOUX, L.            | 213               |                         |                    | MAYO MOURIZ, X.     | 44                                   |
| MALLET, C.J.            | 159               |                         |                    | MAYO, X.            | 545                                  |
| MALONE, J.K.            | 647               |                         |                    | MAYRHOFER, R.       | 253                                  |
| MAMEN, A.               | 389               |                         |                    | MAZANOV, J.         | 20, 270                              |
| MAMMINA, C.             | 534               |                         |                    | MAZZEI, L.          | 125, 128                             |
| MANDOLESI, G.           | 309, 587          |                         |                    | MC GOLDRICK, A.     | 557                                  |
| MANIOS, Y.              | 139               |                         |                    | MCAINCH, A.         | 256                                  |
| MANN, M.                | 499               |                         |                    | MCARDLE, A.         | 24, 55, 468                          |
| MANN, R.                | 76                |                         |                    | MCCANN, B.          | 247                                  |
| MANN, T.                | 51, 59            |                         |                    | MCCLEARY, S.        | 123                                  |
| MANN, T.N.              | 59                |                         |                    | MCCONNELL, A.       | 407                                  |
| MANNERS, D.N.           | 161               |                         |                    | MCDANIEL, J.        | 101                                  |
| MANNHART, C.            | 64                |                         |                    | MCGREGOR, A.        | 78                                   |
| MANNING, P.             | 565               |                         |                    | MCGREGOR, G.S.      | 261                                  |
| MANNION, A.F.           | 33                |                         |                    | MCKAY, B.           | 46                                   |
| MANSUR, M.              | 627               |                         |                    | MCKELVIE, R.S.      | 53, 172                              |
| MANTA, P.               | 160, 399          |                         |                    | MCKENNA, M.J.       | 322                                  |
| MANZANARES SERRANO, A.  | 81, 147, 199, 318 |                         |                    | MCLEAN, D.W.        | 637                                  |
| MANZANO HERNÁNDEZ, F.Y. | 318               |                         |                    | MCLEAN, O.          | 281                                  |
| MANZER, S.              | 441               |                         |                    | MCNARRY, M.A.       | 53                                   |
| MAPELLI, A.             | 158               |                         |                    | MCNAUGHTON, L.R.    | 620                                  |
| MAQUET, D.              | 157               |                         |                    | MCWHANNELL, N.      | 399                                  |
| MARA, F.                | 342               |                         |                    | MEAH, V.            | 172                                  |
| MARAIS, G.              | 60                |                         |                    | MEDDAHI PELLE, A.   | 167, 310                             |
| MARAZZI, G.             | 24                |                         |                    | MEDEIROS, A.        | 113, 129                             |
| MARCHINI, J.S.          | 137               |                         |                    | MEDEIROS, F.        | 540                                  |
| MARCIL, M.M.            | 446               |                         |                    | MEEUS, M.           | 87, 137                              |
| MARCOLIN, G.            | 485               |                         |                    | MEEUSEN, R.         | 61, 66, 117, 225, 282, 298, 443, 594 |
| MARCORA, S.             | 324, 518          |                         |                    |                     |                                      |

|                                                                                |                  |                                          |                   |                                                               |                            |
|--------------------------------------------------------------------------------|------------------|------------------------------------------|-------------------|---------------------------------------------------------------|----------------------------|
| MEHTÄLÄ, A. ....                                                               | 316, 344         | MINGANTI, C. ....                        | 244, 349          | MORENTE-SÁNCHEZ, J. .                                         | 207, 270, 370,<br>371, 372 |
| MEIJER, K. ....                                                                | 76               | MIOTTI, D. ....                          | 168               | MORETTI, B. ....                                              | 439                        |
| MEIJER, L.T.B. ....                                                            | 105              | MISEROCCHI, G. ....                      | 521               | MORGADO, J. ....                                              | 473, 474                   |
| MEJOVSEK, M. ....                                                              | 440              | MISHIMA, S.M. ....                       | 147, 206          | MORI, S. ....                                                 | 193                        |
| MEKARY, S. ....                                                                | 385              | MISIGOJ-DURAKOVIC, M. ....               | 95                | MORIGUCHI, T. ....                                            | 404                        |
| MEKJAVIC, I. ....                                                              | 69               | MITSUISHI, Y. ....                       | 191               | MORIN, J.B. ....                                              | 104, 461, 463              |
| MELA, D.J. ....                                                                | 89               | MIURA, H. ....                           | 513               | MORINO, F. ....                                               | 432                        |
| MELLO, M.T. ....                                                               | 408, 627         | MIYACHI, M. ....                         | 177, 556          | MORIO, C. ....                                                | 152, 159, 195              |
| MELLONI, E. ....                                                               | 587              | MIYAI, N. ....                           | 433               | MORIO, C. ....                                                | 159                        |
| MELON, P. ....                                                                 | 36, 245          | MIYAKAWA, S. ....                        | 119, 211          | MORITA, Y. ....                                               | 344, 420, 558              |
| MENÁRGUEZ PUCHE, J.F. ....                                                     | 318              | MIYAMOTO, N. ....                        | 102, 154, 175     | MORLEY, E. ....                                               | 443                        |
| MENASPÀ, P. ....                                                               | 469, 614         | MIYAMOTO, R. ....                        | 538               | MORNIEUX, G. ....                                             | 78, 498                    |
| MENAYO ANTÚNEZ, R. ....                                                        | 81, 199          | MIYAMOTO, T. ....                        | 121, 649          | MORO, T. ....                                                 | 168, 384                   |
| MENDES, P. ....                                                                | 563, 564         | MIYASHITA, K. ....                       | 433               | MOROUCO, P. .                                                 | 110, 149, 304, 305, 389    |
| MENDES, P.C. ....                                                              | 564              | MIYATAKE, N. ....                        | 177, 556          | MOROZ, A. ....                                                | 393                        |
| MENDES, R. ....                                                                | 563, 564         | MIYAUCHI, S. ....                        | 169               | MORSE, T. ....                                                | 474                        |
| MENDEZ VILLANUEVA, J.A. ....                                                   | 368              | MIYAZAKI, M. ....                        | 209               | MORTARA, R.A. ....                                            | 494                        |
| MENDEZ-VILLANUEVA, A. 44, 374, 375,<br>434, 435, 519, 585                      |                  | MIYAZAKI, M. ....                        | 543               | MORTATTI, A. ....                                             | 399                        |
| MENDT, S. ....                                                                 | 529              | MIZUGUCHI, N. ....                       | 417               | MORTIER, F. ....                                              | 183                        |
| MENESCARDI, C. ....                                                            | 619              | MIZUMURA, S. ....                        | 611               | MORTON, J.P. ....                                             | 24, 54, 445                |
| MENG, K. ....                                                                  | 431, 452         | MIZUSHIMA, K. ....                       | 336               | MORVILLE, T. ....                                             | 99, 160, 432               |
| MENSINK, M. ....                                                               | 179              | MOCHIZUKI, L. ....                       | 362, 427          | MOSCALIUC, C. ....                                            | 429                        |
| MERATI, G. ....                                                                | 86, 220          | MOFFA, S. ....                           | 445               | MOSCHNY, A. ....                                              | 539                        |
| MERATI, M. ....                                                                | 348, 571         | MOGENSEN, M.H. ....                      | 45                | MOSELEY, S.E. ....                                            | 586                        |
| MERCÉ, J. ....                                                                 | 638              | MOIRET, S. ....                          | 422               | MOSER, D. ....                                                | 315, 361, 439              |
| MERCIER, J. ....                                                               | 237              | MOJTAHEDI, S. ....                       | 142, 377          | MOSER, D.C. ....                                              | 315, 439                   |
| MERCURO, G. ....                                                               | 317, 320         | MOJTAHEDI, SH. ....                      | 281               | MOSS, S. ....                                                 | 234, 235, 399              |
| MERNI, F. ....                                                                 | 242, 529         | MOLINA, G.E. ....                        | 236               | MOSS, S.J. ....                                               | 234, 235                   |
| MERRETT, C.K. ....                                                             | 452              | MOLL, T. ....                            | 115               | MOTA, J. ....                                                 | 136, 200, 371, 538, 622    |
| MERRY, K.L. ....                                                               | 592              | MOLNÁR, A. ....                          | 224, 333, 365     | MOTA, M.P. ....                                               | 188, 333                   |
| MERTENS, E. ....                                                               | 238              | MOLNÁR, A.H. ....                        | 333, 365          | MOTOHIKO, M. ....                                             | 625                        |
| MESEGUER ZAFRA, M. ....                                                        | 147, 318         | MOLTUBAKK, M. ....                       | 153               | MOTOYUKI, I. ....                                             | 625                        |
| MESQUITA, I. ....                                                              | 113, 129         | MOLTUBAKK, M.M.H. ....                   | 153               | MOURAO, I. ....                                               | 354                        |
| MESSONNIER, L. ....                                                            | 104              | MONDEN, P. ....                          | 106               | MOURAO-CARVALHAL, M. ....                                     | 564                        |
| MESTE, O. ....                                                                 | 83, 645          | MONDONI, M. ....                         | 205, 604          | MOUTON, A. ....                                               | 388                        |
| MESTER, J. .... 43, 61, 89, 90, 237, 289,<br>330, 360, 531, 590, 625, 644, 649 |                  | MONEDERO, J. ....                        | 373               | MOUZAS, O. ....                                               | 381                        |
| MESTER, J., ..... 43, 90, 237, 289, 360                                        |                  | MONIZ-PEREIRA, V. ....                   | 252               | MOYA, M. ....                                                 | 444, 589, 640              |
| MESTRE, J. ....                                                                | 202              | MONLEÓN, C. ....                         | 344, 421          | MÜLLER, B. ....                                               | 288                        |
| METHENITIS, S. ....                                                            | 160, 399         | MONMA, T. ....                           | 191               | MÜLLER, E. 45, 158, 243, 272, 460, 462,<br>479, 515, 562, 633 |                            |
| METZGER, D. ....                                                               | 264              | MONTAGNANA, L. ....                      | 455               | MÜLLER, J. ....                                               | 483                        |
| MEURER, R. ....                                                                | 215, 613         | MONTEIL, K.M. ....                       | 427               | MÜLLER, K. ....                                               | 386                        |
| MEYER, H. ....                                                                 | 215, 613         | MONTEIRO, A.M. ....                      | 288               | MÜLLER, L. ....                                               | 257                        |
| MEYER, T. ....                                                                 | 110, 120, 297    | MONTEIRO, C.B.M. ....                    | 362, 363          | MÜLLER, M. ....                                               | 179                        |
| MEZZAROBA, P.V. ....                                                           | 588              | MONTEIRO, C.P. ....                      | 473, 474          | MÜNDERMANN, A. ....                                           | 625                        |
| MICHAELS, S. ....                                                              | 476, 612         | MONTEIRO, E. ....                        | 383               | MÜNTE, T. ....                                                | 57                         |
| MICHALLIK, L. ....                                                             | 500              | MONTGOMERY, H.E. ....                    | 52, 600           | MUFTIC, M. ....                                               | 314                        |
| MICHALSIK, L.B. ....                                                           | 280              | MONTIEL, G. ....                         | 502               | MUJICA, I. ....                                               | 385                        |
| MICHIELON, G. .... 304, 383, 436, 616                                          |                  | MOON, K.D. ....                          | 602               | MUKAI, N. ....                                                | 121                        |
| MIDORIKAWA, T. ....                                                            | 314, 608, 647    | MOORE, L. ....                           | 39, 189           | MUKHERJEE, S. ....                                            | 213, 319                   |
| MIERAU, A. ....                                                                | 82, 493          | MOORE, L.J. ....                         | 39, 189           | MUNCH-ANDERSEN, T. .... 99, 160, 432                          |                            |
| MIERAU, J. ....                                                                | 182, 493         | MORA-CUSTODIO, R. ....                   | 545               | MUNIBUDDIN, A. ....                                           | 161                        |
| MIGITA, T. ....                                                                | 621              | MORADI, F. ....                          | 628               | MUNOZ, D. ....                                                | 332                        |
| MIGLIACCIO, G.M. ....                                                          | 603              | MORAES FILHO, A. ....                    | 557               | MUNOZ-VILLANUEVA, M.C. ....                                   | 26                         |
| MIGUEL-GALLARDO, C. ....                                                       | 633              | MORAES, A. ....                          | 642               | MURADE, S. ....                                               | 109                        |
| MIKAT, R. ....                                                                 | 74, 528          | MORALES, D. ....                         | 306               | MURAKAMI, K. ....                                             | 219, 433                   |
| MIKKILÄ, S. ....                                                               | 552              | MORALES, E. ....                         | 21, 355, 420, 424 | MURAMATSU, K. ....                                            | 325                        |
| MIKKOLA, J. ....                                                               | 103              | MORALES, E. ....                         | 425               | MURAMATSU, K. ....                                            | 538                        |
| MILANEZI, F.C. ....                                                            | 414              | MORALES, S. .... 105, 140, 141, 390, 392 |                   | MURAOKA, T. ....                                              | 416, 417                   |
| MILANO, G. ....                                                                | 359, 464         | MORALES-ÁLAMO, D. ....                   | 47, 161           | MURASE, N. ....                                               | 119                        |
| MILANO, G.E. ....                                                              | 359, 464         | MORATAL, C. ....                         | 344, 421          | MURASE, Y. ....                                               | 577                        |
| MILASIUS, K. ....                                                              | 180              | MOREIRA, A. .... 151, 399, 585, 637, 645 |                   | MURATA, H. ....                                               | 555, 556                   |
| MILEVA, K.N. ....                                                              | 594              | MOREIRA, C. ....                         | 136, 371          | MURATA, S. ....                                               | 218, 632                   |
| MILIA, R. ....                                                                 | 603              | MOREIRA, P. ....                         | 136               | MURATA, S. ....                                               | 135                        |
| MILLER, T. ....                                                                | 393              | MOREIRA, R.L.L. ....                     | 361               | MURAYAMA, M. ....                                             | 195                        |
| MILLET, G.P. ....                                                              | 76, 630          | MOREL, B. ....                           | 182, 517          | MURER, K. ....                                                | 470                        |
| MILLET, G.Y. ....                                                              | 33, 83, 104, 290 | MORELLI, A. ....                         | 614               | MURPHY, C. ....                                               | 187, 299                   |
| MILLET, G.Y. ....                                                              | 522              | MORENCO, E. ....                         | 235, 626          | MURRAY, M. ....                                               | 453                        |
| MILLET, G.Y., ..... 33, 104                                                    |                  | MORENILLA, L. ....                       | 151               | MUSTAFINA, L. ....                                            | 320, 357                   |
| MILLOR, N. ....                                                                | 157              | MORENO CATALÁ, M. ....                   | 498               | MUSTAFINA, L.J. ....                                          | 320                        |
| MINATO, K. ....                                                                | 311, 331, 377    | MORENO, F.J. ....                        | 82, 562, 633      | MUTANEN, N.E. ....                                            | 309                        |
|                                                                                |                  | MORENO, L.A. ....                        | 94                |                                                               |                            |
|                                                                                |                  | MORENO-VECINO, B. ....                   | 223               |                                                               |                            |



MYBURGH, K.H. .... 409, 510  
 MYERS, S.D. .... 529, 591  
 MYKLEBUST, G. .... 339, 499  
 MYKLEBUST, H. .... 241

**N**

NACY, G. .... 58  
 NADAL-GINARD, B. .... 24  
 NADAMOTO, M. .... 219, 433  
 NAFFAH-MAZZACORATTI, M.G. .... 494  
 NAGAHARA, R. .... 339  
 NAGAMATSU, T. .... 494, 607  
 NAGANO, Y. .... 118, 120  
 NAGATA, K. .... 101, 175  
 NAGATA, N. .... 564  
 NAGATOMI, R. .... 494  
 NAGELS, G. .... 117  
 NAGIRA, A. .... 307  
 NAITO, H. .... 109, 425  
 NAITO, Y. .... 336  
 NAKA, A. .... 179  
 NAKADA, T. .... 107  
 NAKAGAICHI, M. .... 223  
 NAKAGATA, T. .... 109  
 NAKAGAWA, N. .... 223, 391  
 NAKAGAWA, Y. .... 179  
 NAKAI, A. .... 159  
 NAKAJIMA, H. .... 407  
 NAKAJIMA, T. .... 454  
 NAKAMOTO, F. .... 308  
 NAKAMOTO, H. .... 193  
 NAKAMURA, C. .... 576, 577  
 NAKAMURA, F. .... 525, 614  
 NAKAMURA, M. .... 410, 628  
 NAKASE, M. .... 570  
 NAKATA, H. .... 417  
 NAKATANI, T. .... 219, 433  
 NAKAZAWA, K. .... 112, 491  
 NANJIAH, P. .... 214, 648  
 NANNI COSTA, A. .... 87  
 NAOKI, K. .... 224  
 NAOSHI, F. .... 254  
 NAPOLITANO, S. .... 296  
 NARICI, M.V. .... 466, 468  
 NART, A. .... 505  
 NASRI, K. .... 285, 286, 575  
 NASSIS, G.P. .... 178, 403  
 NAUL, R. .... 459  
 NAVALTA, J. .... 410  
 NAVARRO, D. .... 415  
 NAVARRO, E. .... 338, 414  
 NAYLOR, L. .... 52  
 NÉDÉLEC, M. .... 593  
 NEDIC, A. .... 440, 630  
 NEEDHAM, O. .... 402  
 NEGISHI, D. .... 430  
 NEGRO, F. .... 323  
 NEIL, R. .... 475  
 NEIVA, C. .... 139, 465, 535, 607  
 NEIVA, C.M. .... 139, 607  
 NEIVA, H. .... 110  
 NEIVA, J.F.O. .... 362, 363  
 NELSON, M.J. .... 512  
 NEMTSEV, O. .... 631  
 NESIC, M. .... 381  
 NEUBAUER, O. .... 254  
 NEUHOLD, B. .... 606  
 NEVES, L. .... 389, 535  
 NEVIANI, C. .... 323  
 NEWSHOLME, P. .... 187, 299

NEWTON, M. .... 162  
 NEWTON, R.U. .... 287, 288, 634  
 NEYROUD, D. .... 33  
 NICAISE, V. .... 387  
 NICASTRO, H. .... 637  
 NICOL, C. .... 159, 515  
 NICOL, C. .... 159  
 NICOLÒ, A. .... 552  
 NICOLUCCI, A. .... 319  
 NIELSEN, B.V. .... 181  
 NIELSEN, R.H. .... 282, 333  
 NIELSON, D. .... 484  
 NIEMEIJER, V. .... 502  
 NIES, R. .... 471  
 NIGORIKAWA, T. .... 372  
 NIIMI, M. .... 430  
 NIJHUIS-VAN DER SANDEN, M.W.G. 111,  
 258  
 NIJS, J. .... 87, 137  
 NIKANDER, R. .... 516  
 NIKOLAIDIS, G.M. .... 523  
 NIKOLAIDIS, M.G. .... 387  
 NIKOLAIDIS, P. .... 369, 530, 583, 597  
 NIKOLAIDIS, P.T. .... 530, 597  
 NIKSERESHT, M. .... 145  
 NILWIK, R. .... 90  
 NINDL, B. .... 554  
 NIO, A.Q.X. .... 172  
 NIRENGI, S. .... 525  
 NISHIMURA, K. .... 622, 623  
 NISHIMURA, L.S. .... 361  
 NISHIWAKI, M. .... 307  
 NISHIZAWA, T. .... 625  
 NIZNIKOWSKI, T. .... 418  
 NOAKES, T.D. .... 73, 74, 118, 409, 456,  
 520  
 NÓBREGA, O. .... 410  
 NOBUE, A. .... 515  
 NOEL, D. .... 273  
 NOGAMI, J. .... 433  
 NOGAMI, Y. .... 407  
 NOGUEIRA, F. .... 411  
 NOH, B. .... 211  
 NOLTE, H.W. .... 225  
 NOORKOIV, M. .... 152  
 NORDBY, P. .... 98  
 NORIHISA, M. .... 220  
 NORIKATU, K. .... 625  
 NOSAKA, K. 46, 152, 162, 245, 411, 458,  
 477, 645  
 NOSE, Y. .... 373  
 NOUTSOS, K. .... 208  
 NOVOTNY, M. .... 560  
 NOVOTNÝ, M. .... 560  
 NTOLOPOULOU, M. .... 117  
 NÜSSER, S. .... 613  
 NUMATA, T. .... 177  
 NUMAZAWA, H. .... 46  
 NUMMELA, A. .... 103  
 NUNES, J.E.D. .... 390  
 NUNES-LEITE, M.M.S. .... 188  
 NUNES-LEITE, M.M.S. .... 520  
 NUNES-SILVA, A. .... 188  
 NUNEZ, F. .... 375, 545, 619  
 NUNEZ, F.J. .... 619  
 NÚÑEZ, F.J. .... 641, 642  
 NUNOME, H. .... 341  
 NUUTILA, P. .... 233, 581  
 NYAKAS, C. .... 71, 453  
 NYBERG, K. .... 74, 528  
 NYBO, L. .... 75, 387  
 NYMAN, K. .... 103

**O**

OANCEA, C. .... 362  
 OBERHOFFER, R. .... 258, 371, 472, 483,  
 508  
 OBERHOFFER, R. .... 258  
 OCHI, G. .... 103  
 OCHIAI, H. .... 228  
 ODA, T. .... 515  
 OFFRINGA, C. .... 320  
 OGATA, T. .... 430  
 OGAWA, K. .... 318, 344  
 OGITA, F. .... 193, 307  
 OGOH, S. .... 30  
 OH, H. .... 189  
 OHBU, T. .... 559  
 OHIWA, N. .... 597  
 OHKI, K. .... 223, 391  
 OHKUWA, T. .... 627  
 OHTA, A. .... 638  
 OHTA, M. .... 314, 608  
 OHTA, Y. .... 621  
 OIKONOMOU, D. .... 335, 381  
 OISHI, K. .... 372, 422  
 OISHI, L.M. .... 324  
 OJALA, A. .... 571  
 OKA, H. .... 340  
 OKABE, N. .... 337  
 OKADA, Y. .... 134  
 OKAZAKI, H. .... 337  
 OKAZAKI, K. .... 96  
 OKCU, M. .... 150  
 OKORO, T. .... 300, 325  
 OKSA, J. .... 594  
 OKSANEN, R. .... 348, 571  
 OKUNO, K. .... 632  
 OKURA, T. .... 191, 223  
 OKUSHIMA, Y. .... 312  
 OLADIPO, O. .... 358  
 OLBRECHTS, N. .... 326  
 OLEK, R.A. .... 378  
 OLIVAR, R. .... 649  
 OLIVARES, P.R. .... 138  
 OLIVEIRA, A. .... 58  
 OLIVEIRA, C. .... 312, 378  
 OLIVEIRA, C.A.M. .... 378  
 OLIVEIRA, E. .... 280  
 OLIVEIRA, F.B.D. .... 642  
 OLIVEIRA, G.G.A. .... 188, 520  
 OLIVEIRA, J.C. .... 563, 603  
 OLIVEIRA, J.C.F. .... 563  
 OLIVEIRA, M. .... 188, 299  
 OLIVEIRA, M.M. .... 188  
 OLIVEIRA, R. .... 151, 180, 521, 540, 557,  
 642  
 OLIVEIRA, R.S.F. .... 521  
 OLIVEIRA, W.G.A. .... 324  
 OLIVEIRA-TAVARES, A. .... 200  
 OLIVIER, N. .... 83  
 OLLER DO NASCIMENTO, C.M. .... 185  
 OLM, T. .... 327  
 OLMEDILLAS, H. .... 390, 392  
 OLSEN, A.B. .... 45, 163, 165  
 OLSTAD, B.H. .... 22, 463  
 OMAR, A.S. .... 525  
 OMMUNDSEN, Y. .... 146  
 ONDRACEK, J. .... 438  
 ONGARO, L. .... 391, 533  
 ONISHI, H. .... 227, 228, 345, 416  
 ONISHI, H. .... 227, 345  
 ONO, K. .... 312  
 ONODERA, S. .... 363

ONODERA, S. 363, 386, 570, 610, 623  
 OOMEN, J. 133  
 OOMEN, J.M. 133  
 OOSTERVELD, F.G.J. 111, 258  
 OOSTHUIZEN, C. 234  
 OOUE, A. 226, 523  
 OPATZ, O. 59, 529  
 OPDENACKER, J. 500  
 ORBÁN, K. 224, 333, 365  
 OREGÉ, A. 358  
 ORIZIO, C. 323, 542  
 ORME, D. 511, 604  
 ORTEGA, F. 94  
 ORTEGA, G.P. 427  
 ORTEGA-BECERRA, M.A. 518  
 OSADA, T. 119  
 OSAWA, Y. 538  
 OSBORN, G. 201, 351, 574  
 OSBORNE, M. 163, 215, 587  
 OSHIMA, S. 169  
 OSTAPIUK-KAROLCZUK, J. 336, 382, 582  
 OTADUY, M.C. 335  
 OTANI, H. 30  
 OTERO-ESQUINA, C. 328, 545  
 OTOMO, M. 576  
 OTSUKI, T. 410, 433  
 OTTER, T.A. 44  
 OUSSAIDENE, K. 60, 503  
 OUZZAHRA, Y. 164  
 OVERGAARD, M. 30  
 OVERTON, A.J. 102  
 OVIEDO, G.R. 386  
 OXBOROUGH, D. 261, 551  
 OXFORD, S. 206  
 OYAMA, L.M. 185  
 ÖZDEMİR, F. 474

**P**

PABLOS, A. 145, 344, 349  
 PABLOS, C. 202, 349  
 PABST, J. 438  
 PACELLI, F.Q. 168, 384  
 PACELLI, Q.F. 596  
 PACHECO, D.A.S. 188, 520  
 PADIAL, P. 436  
 PADULO, J. 150  
 PAGEAUX, B. 324  
 PAILLARD, T. 94, 446  
 PAIN, M.T.G. 31  
 PAIVA, A. 180, 580  
 PAIZIS, C. 467  
 PALADINI, P. 497  
 PALLARÉS, J.G. 617  
 PALMA, A. 198, 334, 346, 372, 389, 445, 534, 568  
 PALOMO, R. 331, 332  
 PALUMBO, C. 204  
 PANACKOVA, M. 447, 448  
 PANAYIOTOU, G. 387  
 PANTALEAO, L.C. 361  
 PANTELI, F. 124, 125  
 PANTIGA JR, G. 627  
 PAOLI, A. 168, 384, 485, 568, 596  
 PAPACOSTA, E. 178  
 PAPADOPOULOS, C. 160, 399  
 PAPADOPOULOS, S. 523  
 PAPAIOANNOU, A. 205, 355, 387, 496, 566  
 PAPAIOANNOU, M. 495

PAPAPARASKEVA, K. 70  
 PAPAXANTHIS, C. 32, 324  
 PAPOTI, M. 303, 447, 587, 619  
 PAPOULIAKOS, S. 418  
 PAPPOUS, A. 496  
 PARADISIS, G. 343  
 PAREJA-BLANCO, F. 328, 376, 545  
 PARISE, G. 38, 46, 97  
 PARISI, A. 98, 322  
 PARISI, Y. 391  
 PARKKARI, J. 348, 571  
 PASANEN, K. 348  
 PASCHALIS, V. 335, 387  
 PASCHOALIN, V. 360  
 PASIC, M. 466  
 PASQUERELLI, B.N. 435  
 PASTOR, D. 640  
 PATIKAS, D. 278, 431  
 PATRAS, K. 326  
 PATRIKSSON, G. 506  
 PATSIKA, G. 195  
 PATTI, A. 534  
 PATTYN, N. 18, 117, 282  
 PAUL, D. 403  
 PAUL, L. 87, 137  
 PAULA, A. 543  
 PAULA, F. 312  
 PAULISTA, H. 557, 642  
 PAULSEN, G. 91, 153, 187, 409, 547  
 PAULWEBER, B. 272  
 PAUNESCU, C. 429  
 PAUNESCU, M. 362  
 PAUWELS, L. 228  
 PAVEI, G. 42, 86  
 PAVLAKIS, K. 271  
 PAVLIK, G. 96  
 PAVLOVA, E. 551  
 PEAKE, J. 524  
 PEARSON, N. 353  
 PEARSON, T. 468  
 PEART, D. 172, 337  
 PEART, D.J. 172  
 PECCI, C. 524  
 PEDREIRO, S. 180, 580  
 PEDRERO, R. 138  
 PEDROSO, J.A.B. 361  
 PEELING, P. 164, 643, 648  
 PEERSMAN, W. 509  
 PEGREFFI, F. 497  
 PEIFFER, J.J. 245, 298  
 PEINADO, A.B. 139, 235, 373, 379, 464, 512, 538  
 PEINADO, S. 235  
 PEIXOTO, F. 188  
 PELARIGO, J.G. 301, 303  
 PELLEGRINI, A. 497  
 PELLEGRINI, B. 77, 510  
 PELSSEERS, J. 500  
 PELTONEN, J. 242, 309  
 PENAILILLO, L. 46  
 PENNEY, D. 296  
 PENNINGGS, B. 238  
 PENSINI, M. 396  
 PEPI, A. 568  
 PERALES, J.C. 35  
 PERCIVAL, M.E. 55  
 PEREIRA, A. 180, 199, 288  
 PEREIRA, B. 316, 409, 638  
 PEREIRA, C. 510  
 PEREIRA, G. 410  
 PEREIRA, M. 147, 206, 248  
 PEREIRA, M.J.B. 147, 206

PEREIRA, T. 356  
 PEREPJOLKINA, V. 226  
 PÉREZ VALERO, I. 147  
 PÉREZ, E. 202  
 PÉREZ, I. 306  
 PEREZ, P. 550  
 PEREZ, S. 219, 313, 390, 603  
 PEREZ, S. 312, 410  
 PEREZ, S.A. 603  
 PEREZ, S.E.A. 219, 390  
 PÉREZ-GÓMEZ, J. 27  
 PÉREZ-MEDINA, I. 533  
 PÉREZ-NAVERO, J.L. 26  
 PEREZ-SUAREZ, I. 47  
 PERIARD, J.D. 381  
 PERINI, R. 405, 549  
 PERISSIOU, M. 630  
 PERNG, W. 576  
 PÉROT, C. 492  
 PERREY, S. 290, 502  
 PERREY, S. 522  
 PERRIER, E. 264  
 PERRY, C.G.R. 300, 450  
 PERSIANI, M. 79  
 PESCE, C. 457  
 PESERICO, C.S. 588  
 PESOLA, A. 471  
 PESSOA FILHO, D. 607, 615  
 PESSOA-FILHO, D.M. 535  
 PETERS, C. 371  
 PETERS, S. 431  
 PETERS, T. 614  
 PETERSEN, M.B. 339, 499  
 PETIT, O. 264  
 PETRIDIS, L. 198  
 PETRISOR, L. 362  
 PETRON, D. 627  
 PETRONE, N. 485  
 PEYROT, N. 463  
 PEZARAT-CORREIA, P. 543  
 PFEFFER, I. 352  
 PFEIFER, K. 431, 452, 575  
 PFISTER, G. 514, 575  
 PFRIMER, K. 137  
 PHILLIPS, B. 47  
 PHILLIPS, S. 369, 486  
 PHILLIPS, S.M. 369  
 PIACENTINI, M.F. 183, 349  
 PIALOUX, V. 170, 259, 289, 470  
 PICERNO, P. 183, 457  
 PIEBER, K. 273  
 PIERONI, R.P. 603  
 PIHU, M. 481  
 PIIRAINEN, J.M. 193  
 PILGER, N. 90, 360  
 PILIPIV, V. 340, 561  
 PILLING, J. 47  
 PIMENTA, L.D. 465, 535  
 PIMENTA, R.A. 301, 303  
 PINAR, M.I. 35  
 PINHEIRO, V. 321  
 PINNINGTON, H. 164, 643  
 PINTENS, S. 196  
 PINTO, G. 564  
 PINTO, R.S. 214, 218  
 PINTO, S.S. 214, 218  
 PIRAS, A. 79  
 PIRES, P. 129  
 PISCIONE, J. 541  
 PISOT, R. 43, 69, 492  
 PITHON-CURI, T.C. 139  
 PIZZOLATO, F. 150

PLACE, N. .... 32, 33, 291, 491, 495  
 PLANIC, N. .... 618  
 PLATEN, P. 84, 212, 215, 233, 272, 366,  
 411, 532, 539, 581  
 PLATTE, K. .... 539  
 PLATTNER, K. .... 229  
 PLAYER, D.J. .... 394  
 PLAZA-CARMONA, M. .... 138  
 PLEBANI, M. .... 596  
 PLENGE, U. .... 254  
 PLEVNIK, M. .... 43, 492  
 PLODER, M. .... 255  
 PLOUG, T. .... 98  
 PLUK, A. .... 244  
 PODLOG, L. .... 275, 276, 627  
 POEZE, M. .... 100  
 POGLIAGHI, S. .... 380  
 POHLENZ, B. .... 615  
 POLAT, C. .... 375  
 POMIDORI, L. .... 309, 587  
 PONCE, J. .... 306  
 PONCE-GONZALES, J.G. .... 176  
 PONCE-GONZALEZ, J.G. .... 47  
 PONCE-GONZÁLEZ, J.G. .... 161  
 PONSOT, E. .... 71, 245  
 POORTMANS, J. .... 359, 574  
 POOTZ, S. .... 167  
 POPE, C. .... 296  
 POPOV, D. .... 393  
 POPPENDIECK, W. .... 120  
 PORCAR, C. .... 358  
 PORCARI, J.P. .... 74, 105  
 PORCELLINI, G. .... 497  
 POROZOVA, D. .... 347  
 POROZOVS, J. .... 226, 347  
 PORRO, N. .... 514  
 PORTELLA, D.L. .... 442  
 PORTILLO YÁBAR, L. .... 375  
 POSKIPARTA, M. .... 316, 344  
 POSTHUMUS, M. .... 179  
 POULSEN, S.S. .... 432  
 POUTIAINEN, P. .... 242  
 PÓVOAS, S. .... 280, 437  
 PRAETORIUS, A. .... 581  
 PRATES, L. .... 107  
 PRATS, C. .... 98, 330, 432  
 PRAULITE, G. .... 226  
 PREDEL, H.G. .... 502  
 PRESSLER, A. .... 59  
 PRESTES, J. .... 410  
 PRINS, L.F. .... 105  
 PRIORESCHI, A. .... 87  
 PRISACARU, R. .... 429  
 PRITCHARD-PESCHEK, K. .... 163  
 PROIA, P. .... 198, 334, 336  
 PROSPERI, R. .... 203  
 PROSS, N. .... 264  
 PROTZEK, A.O. .... 378  
 PROTZNER, A. .... 321  
 PROVYN, S. .... 508  
 PRPIC, T. .... 578  
 PSIFOS, V. .... 381  
 PSYCHARAKIS, S. .... 194  
 PSYCHOUNTAKI, M. .... 208, 565  
 PUGGINA, E.F. .... 578  
 PUGH, C.J.A. .... 61, 171  
 PUGLIESE, G. .... 319  
 PUGLIESE, L. .... 432  
 PUKENAS, K. .... 431  
 PUKOWSKI, P. .... 371  
 PUMPA, K. .... 287  
 PURVIS, A. .... 513

PUTA, C. .... 544  
 PUTZE, F. .... 229  
 PUYPE, J. .... 175  
 PUZOVIC, V. .... 381, 400  
 PYNE, D.B. .... 88, 111, 181, 244

**Q**

QUARANTA, F. .... 98  
 QUEIROGA, M.R. .... 147, 206  
 QUERIDO, A. .... 143  
 QUESTED, E. .... 39, 114, 115, 481  
 QUIRK, F. .... 553

**R**

RAASTAD, T. .... 91, 153, 187, 278, 328,  
 409, 547  
 RABELO, F.N. .... 435  
 RACCUGLIA, M. .... 568  
 RACINAIS, S. .... 265, 267, 307, 396, 519  
 RADAELLI, R. .... 214, 218  
 RADAK, Z. .... 595  
 RADÁK, Z. .... 71  
 RADCHENKO, A.S. .... 308  
 RADIVOJEVIC, N. .... 89, 203, 370, 454,  
 585  
 RADMAN, I. .... 623  
 RADOMINSKI, R.B. .... 359, 464  
 RAE, D.E. .... 255  
 RAFFI, M. .... 79  
 RAHLF, A.L. .... 42  
 RAIOLA, G. .... 203, 204, 296  
 RAITAKARI, O.T. .... 270  
 RAJABI, H. .... 601  
 RAKOVAC, M. .... 621  
 RALEIGH, S.M. .... 179  
 RAMA, L. 178, 180, 474, 482, 540, 580,  
 622  
 RAMAEKERS, M. .... 52  
 RAMALHO, F. .... 252  
 RAMALHO, H. .... 564  
 RAMAZANOGLU, N. .... 559  
 RAMÍREZ-LECHUGA, J. .... 207, 270, 370,  
 371  
 RAMOS, G.P. .... 188, 520  
 RAMPININI, E. .... 150, 401, 524, 614  
 RANDELL, R.K. .... 63, 89  
 RAO, G. .... 41  
 RAPP, W. .... 515  
 RASMUSEN, H. .... 160, 432  
 RASMUSEN, H.K. .... 160  
 RASMUSSEN, P. .... 306  
 RASOHAMANANA, P. .... 60  
 RÄTSEPSOO, M. .... 338  
 RATTRAY, B. .... 287, 317  
 RAYA, J.F. .... 600  
 RAZAVI, S. .... 640  
 RAZMJOU, S. .... 601  
 REBOCHO, L. .... 510  
 REDORTIER, B. .... 163, 164  
 REER, R. .... 42, 376  
 REES, T. .... 115  
 REGGIANI, C. .... 168, 196, 384, 596  
 REGO, I. .... 540  
 REID, S. .... 419  
 REIHMANE, D. .... 45, 163, 165  
 REILLY, T. .... 55, 401, 402, 445, 448, 508  
 REILLY, T.P. .... 445  
 REINECKE, K. .... 494  
 REINER, N. .... 508

REINTS, A. .... 248, 249, 293, 351  
 REIS, J. .... 527, 629, 630  
 REITELSEDER, S. .... 282, 333  
 RELPH, N. .... 511, 604  
 RENFREE, A. .... 424, 469  
 RENNIE, M.J. .... 47  
 RES, P.T. .... 63, 238  
 REY, D. .... 574  
 REYES, A.C. .... 417  
 REYES-LÓPEZ, M.V. .... 507  
 REZENDE, L. .... 378, 609  
 REZENDE, L.F.M. .... 609  
 RHODE, B. .... 131  
 RIBEIRO, J. .... 302, 356, 614  
 RIBEIRO, J. .... 301  
 RIBEIRO, L.F.P. .... 547, 587, 619  
 RIBOT SERRANO, J. .... 611  
 RICE, A.J. .... 591  
 RICHARTZ, C. .... 493  
 RICHTER, K. .... 526  
 RICKERT, M. .... 630  
 RIDGERS, N.D. .... 92, 365  
 RIEGER, G. .... 51, 170  
 RIENHOFF, R. .... 81  
 RIES, F. .... 481, 496  
 RIETH, N. .... 636  
 RIGGIO, M. .... 524  
 RIIS, P. .... 99  
 RILEY, G.P. .... 277  
 RILOVA, N. .... 357, 636  
 RINGBÆK, T. .... 51  
 RING-DIMITRIOU, S. .... 272  
 RINTAMÄKI, H. .... 98, 263, 594  
 RIOS, J.G. .... 541, 542  
 RISSANEN, S. .... 594  
 RITTWEGER, J. .... 43, 69  
 RITZMANN, R. .... 325, 435  
 ROBERTO, S. .... 603  
 ROBERTS, J. .... 123, 155  
 ROBERTS, J.W. .... 155  
 ROBERTSON, C. .... 586  
 ROBEBY, E. .... 174  
 ROBIC, T. .... 439  
 ROBIJNS, A. .... 56  
 ROBLES GIL, M.C. .... 332  
 ROBLES, M.C. .... 331, 332  
 ROBSAHM, T.E. .... 143  
 ROCA, J. .... 207, 424  
 ROCCO, G.F. .... 236  
 ROCHA, L.A.O. .... 322  
 RODEN, L.C. .... 255  
 RODENAS, L. .... 638  
 RODIONOVA, Y.Y. .... 308  
 RODRIGUES, A.M. .... 361  
 RODRIGUES, L. .... 482, 483, 535  
 RODRIGUES, L.P. .... 482, 483  
 RODRIGUES, M. .... 219, 313, 410, 603  
 RODRIGUES, M. .... 312  
 RODRIGUES, M.F.C. .... 219, 313, 603  
 RODRIGUES, P. .... 417, 419  
 RODRIGUES, V. .... 354  
 RODRIGUES-KRAUSE, J. .... 187, 299  
 RODRIGUES-KRAUSE, J.C. .... 299  
 RODRIGUEZ DE LA CRUZ, C. .... 157, 273  
 RODRÍGUEZ ZAMORA, L. .... 113  
 RODRIGUEZ, F.A. .... 645  
 RODRÍGUEZ, F.A. .... 113, 533, 579  
 RODRIGUEZ, J. .... 138, 495  
 RODRÍGUEZ, J. .... 491  
 RODRIGUEZ, J.A. .... 138  
 RODRÍGUEZ, L. .... 306  
 RODRIGUEZ-GARCÍA, L. .... 176

RODRIGUEZ-GARCÍA, L. .... 47  
 RODRÍGUEZ-GARCÍA, L. .... 161  
 RODRIGUEZ-ROSELL, D. .... 328, 376  
 RODRÍGUEZ-ROSELL, D. .... 376, 545  
 RODRÍGUEZ-ZAMORA, L. .... 533, 579  
 RODRIQUEZ-MARROYO, J. .... 528  
 ROELANDS, B. .... 61, 298, 594  
 ROELEVELD, K. .... 291  
 ROETTGER, K. .... 385, 487  
 ROGELJ, I. .... 439  
 ROGERO, M.M. .... 361  
 ROGERS, D.K. .... 512  
 ROGISTER, B. .... 188, 394  
 ROGOWSKI, I. .... 517  
 ROI, G.S. .... 87  
 ROIVAINEN, E. .... 269  
 ROJAS, S. .... 398  
 ROJO-TIRADO, M.A. 235, 373, 379, 512, 538  
 ROMAGNOLI, M. .... 186, 522, 550, 622  
 ROMAN DE METTELINGE, T. .... 472  
 ROMANN, M. .... 124  
 ROMBAUT, L. .... 234, 472  
 ROMERO, B. .... 139, 235  
 ROMERO-ARENAS, S. .... 27, 184  
 RONKAINEN, N. .... 192  
 RØNNESTAD, B.R. .... 187  
 RONQUE, E. .... 540  
 ROOS, L. .... 215, 605  
 ROOSEN, P. .... 509  
 ROSA, F. .... 137, 367, 475  
 ROSA, F.O. .... 475  
 ROSA, F.T. .... 137  
 ROSA, M.J. .... 200  
 ROSADO, F. .... 180, 482  
 ROSCHEL, H. .... 45, 112, 367  
 ROSCHEL ..... 398  
 ROSENBERG, M. .... 208, 239  
 ROSENBERGER, A. .... 43, 289  
 ROSENHAGEN, A. .... 211, 629  
 ROSENKILDE, M. .... 160  
 ROSIER, N. .... 248, 249  
 ROSS, F. .... 402  
 ROSS, M.L. .... 108, 599  
 ROSS, M.L.R. .... 599  
 ROSSER, T. .... 441  
 ROTA, S. .... 517  
 ROTH, R. .... 271, 329  
 ROTHWELL, J.C. .... 416  
 ROUFFET, D. .... 182  
 ROUSSOS, T. .... 124  
 ROUX, M. .... 251  
 ROWLEY, C. .... 423  
 ROZAND, V. .... 324  
 ROZMAN, S. .... 489  
 RROJI, O. .... 228  
 RUBIO-ARIAS, J.A. .... 136, 356  
 RUEGGE, A. .... 271  
 RUELL, P. .... 162, 300, 381, 513  
 RUELL, P.A. .... 381  
 RÜTTIMANN, J. .... 33  
 RUIZ, J. .... 35, 94  
 RUIZ, J.R. .... 35  
 RUMBOLD, P.L. .... 238  
 RUPCIC, T. .... 440  
 RUPP, T. .... 290, 522  
 RUSSELL, F.D. .... 88, 261  
 RUZIC, L. .... 578, 623  
 RYBA, T.V. .... 192  
 RYNKIEWICZ, M. .... 382, 582, 649  
 RYNKIEWICZ, T. .... 382, 582, 649  
 RYOKO, K. .... 625

RYU, J.Y. .... 647  
 RYUSHI, T. .... 378

**S**

SA YUP, K. .... 409  
 SÄÄKSLAHTI, A. .... 239, 316, 344, 471  
 SABAPATHY, S. .... 254  
 SABBAGHIAN RAD, L. .... 364  
 SABBE, B. .... 190  
 SABOUL, D. .... 170  
 SACCHETTI, M. .... 552  
 SADAMOTO, T. .... 226, 523  
 SADOWSKI, J. .... 418  
 SÄFVENBOM, R. .... 478  
 SAGAYAMA, H. .... 526  
 SAGGINI, R. .... 251, 428  
 SAGHAZADEH, M. .... 191  
 SAHO, Y. .... 577, 632  
 SAITO, K. .... 386, 610  
 SAITO, M. .... 406  
 SAITO, T. .... 373  
 SAITO, T. .... 363, 386, 610, 623  
 SAITO, Y. .... 410  
 SAITOU, K. .... 543  
 SAKAGUCHI, M. .... 577, 632  
 SAKAI, K. .... 638  
 SAKAI, S. .... 632  
 SAKAI, T. .... 121  
 SAKAMAKI, F. .... 407  
 SAKAMOTO, A. .... 119  
 SAKAMOTO, S. .... 177, 314  
 SAKAMOTO, Y. .... 96  
 SAKELLARIOU, G. .... 468  
 SALGADO, M. .... 550  
 SALGAU, S. .... 362  
 SALVADORI, A. .... 174  
 SALVATI, A. .... 432  
 SAMANI, A. .... 259  
 SAMOZINO, P. .... 461, 463  
 SAMPAIO, I.H. .... 176  
 SAN, J. .... 142  
 SANABRIA, D. .... 355, 420, 423, 424  
 SANCHES, P.L. .... 408  
 SANCHEZ, X. .... 66, 496  
 SANCHEZ-DELGADO, G. .... 35  
 SÁNCHEZ-OTERO, T. .... 44, 545  
 SÁNCHEZ-SÁNCHEZ, E. .... 589  
 SANDBAKK, Ø. 77, 143, 241, 246, 288, 635  
 SANDERS, R. .... 107, 462, 564  
 SANDERS, R.H. .... 107  
 SANDERSON, M.F. .... 369  
 SANDNER, H. .... 219  
 SANDOR, I. .... 566  
 SANO, F. .... 580  
 SANO, K. .... 515  
 SANOMURA, M. .... 577, 632  
 SANOMURA, M. .... 525  
 SANTA-CLARA, H. .... 383  
 SANTANA, A. .... 176  
 SANTANA, C.S. .... 206  
 SANTANA, M.G. .... 391  
 SANTANA, P. .... 353  
 SANTHIAGO, V. .... 303  
 SANTIAGO, B.M. .... 335  
 SANTIAGO, P.R.P. .... 158  
 SANTOS, A. .... 180, 286, 346, 350, 351, 456, 570  
 SANTOS, A.M. .... 350, 456  
 SANTOS, A.M.C. .... 456

SANTOS, B.S. .... 362, 363  
 SANTOS, G.J. .... 378  
 SANTOS, L.C. .... 362, 363  
 SANTOS, P. .... 136, 371, 557  
 SANTOS, P.C. .... 136, 371  
 SANTOS, R. .... 136, 185, 200, 308, 316, 371, 538, 645  
 SANTOS, R.O. .... 645  
 SANTOS, R.V.T. .... 185, 308  
 SANTOS, S.A. .... 185, 308  
 SANTOS, T. .... 297, 557, 642  
 SANTOS, T.M. .... 297  
 SANTOS, V.C. .... 139  
 SANTOS-CONCEJERO, J. .... 167, 413  
 SANTOS-MAGALHAES, A. .... 622  
 SANTOS-ROCHA, R. .... 252  
 SARABIA, J.M. .... 444, 589, 640  
 SARABON, N. .... 131, 384  
 SARDINHA, L. .... 383  
 SAREMI, A. .... 327, 409, 437  
 SARMENTO, H. 197, 199, 330, 347, 506  
 SARMENTO, J. .... 230  
 SARPIRA, M. .... 126  
 SARRAZIN, P. .... 115  
 SARRAZIN, S. .... 395  
 SARRE, S. .... 225  
 SARTOR, F. .... 465  
 SASAKI, K. .... 96  
 SASSO, J.P. .... 475  
 SASSOON, D. .... 24  
 SATO, D. .... 227, 345, 416  
 SATO, K. .... 30, 72, 226, 523  
 SATO, T. .... 391, 595  
 SATTLER, F. .... 59, 529  
 SAUCEDO, C.M. .... 56  
 SAUGY, J. .... 291  
 SAUNDERS, J. .... 488  
 SAUNDERS, P.U. .... 88, 624  
 SAVOLAINEN, A. .... 173, 233, 581  
 SAYLI, O. .... 559  
 SCAFOGLIERI, A. .... 508  
 SCARIOT, P. .... 302, 554  
 SCARIOT, P.P.M. .... 554  
 SCARPA, S. .... 505  
 SCHAAL, K. .... 264  
 SCHAENZER, W. .... 90, 237, 360  
 SCHAFFERT, N. .... 216  
 SCHAILLÉE, H. .... 285  
 SCHEER, V. .... 474  
 SCHEERDER, J. .... 230  
 SCHEGA, L. .... 83, 429  
 SCHEIBER, P. .... 158, 633  
 SCHELLDORFER, S. .... 454, 561  
 SCHENA, F. .... 477, 510  
 SCHINZ, F. .... 562  
 SCHINZEL, M. .... 483  
 SCHIPILOW, J. .... 68  
 SCHIPPER VAN VELDHOFEN, N. .... 190  
 SCHIRM, J. .... 349  
 SCHJERLING, P. .... 62, 272, 274  
 SCHLEGEL-ZAWADZKA, M. .... 370  
 SCHLICHT, K. .... 303  
 SCHMIDT, A. .... 613  
 SCHMIDT, C. .... 166, 210  
 SCHMIDT, K. .... 455  
 SCHMIEDER, PH. .... 398  
 SCHMITZ, G. .... 57, 209  
 SCHNEIDER, R. .... 128  
 SCHNEIDER, S. .... 18, 35, 146, 267  
 SCHNELL, D. .... 212  
 SCHÖLLAUF, V. .... 341  
 SCHORER, J. .... 81, 438

|                       |                    |                      |                                   |                        |                      |
|-----------------------|--------------------|----------------------|-----------------------------------|------------------------|----------------------|
| SCHRADER, Y.          | 272                | SHIGEMATSU, R.       | 223                               | SINGH, N.B.            | 83                   |
| SCHRAUWEN, P.         | 179                | SHIGUEMOTO, G.E.     | 313                               | SIQUEIRA, L.O.C.       | 607                  |
| SCHUBERT, M.          | 473, 494           | SHIH, T.F.           | 508                               | SIVA FILHO, F.         | 125                  |
| SCHÜTZ, T.C.B.        | 627                | SHIMAMOTO, H.        | 548                               | SIVIERI, A.            | 405                  |
| SCHULTE, S.           | 627                | SHIMANO, H.          | 179                               | SJØGAARD, G.           | 453                  |
| SCHULTZ, T.           | 229                | SHIMIZU, K.          | 177, 649                          | SJÖKVIST, J.           | 288                  |
| SCHULZ, A.            | 220                | SHIMIZU, Y.          | 209                               | SJÖSTRÖM, M. ET AL     | 94                   |
| SCHULZ, D.            | 212                | SHIMMURA, Y.         | 584, 628                          | SKALSKA, M.            | 537                  |
| SCHULZ, T.            | 258, 371           | SHIMODA, M.          | 119                               | SKAUGEN, M.            | 168                  |
| SCHUMANN, M.          | 103                | SHIMOYAMA, Y.        | 345                               | SKENDERI, D.H.         | 342, 437             |
| SCHWERTFEGER, R.      | 234                | SHIMURA, Y.          | 222                               | SKINNER, T.            | 587                  |
| SCHWINDLING, S.       | 110                | SHIN, J.M.           | 556, 560                          | SKORSKI, S.            | 297                  |
| SCORZA, F.A.          | 494                | SHIN, K.             | 572, 602                          | SKOURA, D.             | 418                  |
| SCOTTO DI PALUMBO, A. | 552                | SHIN, K.O.           | 602                               | SKOVERENG, K.          | 143, 246, 406        |
| SCREEN, H.R.C.        | 277                | SHIN, M.             | 220                               | SKURVYDAS, A.          | 431                  |
| SCULLEY, D.V.         | 519                | SHING, C.M.          | 524                               | SLATER, G.             | 108, 163             |
| SCULTHORPE, N.        | 551, 646           | SHINTANI, K.         | 372                               | SLATTERY, K.           | 92                   |
| SCURATI, R.           | 304, 383, 436, 616 | SHINYA, M.           | 112, 117, 491                     | SLINGERLAND, M.        | 204                  |
| SCURR, J.             | 414                | SHIODA, K.           | 558, 597                          | SLOWINSKA-LISOWSKA, M. | 582, 649             |
| SEABRA, A.            | 280                | SHIODA, S.           | 378                               | SMEETS, J.S.J.         | 97                   |
| SEBASTIANI, E.M.      | 345                | SHIRAIISHI, A.       | 219                               | SMIRNIOTOU, A.         | 124, 125, 343, 603   |
| SECHER, N.            | 30                 | SHIROYA, Y.          | 311, 331, 377                     | SMIT, A.               | 356, 614             |
| SEDLACEK, J.          | 438, 439           | SHKLYARENKO, A.      | 364                               | SMITH, D.J.            | 475                  |
| SEELAENDER, M.        | 367, 475           | SHLYAKHTOV, V.       | 533                               | SMITH, J.              | 262                  |
| SEGADO SEGADO, F.     | 81, 199            | SHUMPEI, F.          | 625                               | SMITH, K.              | 23, 47, 236          |
| SEGUI, R.             | 259                | SIARAVAS, S.         | 326                               | SMITH, M.              | 116, 518             |
| SEIFERT, J.G.         | 158, 583, 633      | SIBILIO, M.          | 203, 204                          | SMITH, N.              | 114                  |
| SEIFERT, T.           | 30                 | SIDDALL, A.          | 108, 598                          | SMITH, T.              | 296                  |
| SEIL, R.              | 213                | SIDEQUERSKY, F.V.    | 158                               | SMITS, T.              | 249                  |
| SEIXAS, M.T.          | 473, 474           | SIEBENMANN, C.       | 306                               | SNIJDERS, T.           | 46, 71, 97, 100, 174 |
| SELBY, A.             | 236                | SIEBERT, T.          | 544                               | SOARES, A.             | 248                  |
| SELENCIA, R.          | 131                | SIEGLER, J.          | 337                               | SOARES, J.             | 188, 280, 437, 600   |
| SELIMI, M.            | 144                | SIEGLER, K.          | 629                               | SOARES, J.P.           | 188                  |
| SEMINATI, E.          | 79                 | SIERRA, A.           | 235, 440, 581                     | SØDEM, A.              | 389                  |
| SENDEN, J.M.          | 174, 238           | SIGEAKI, A.          | 318                               | SØDEM, P.              | 389                  |
| SENDEN, J.M.G.        | 238                | SILALERTDETKUL, S.   | 535                               | SOGAARD, K.            | 259                  |
| SENN, A.              | 629                | SILAMI-GARCIA, E.    | 188, 520                          | SØGAARD, K.            | 102                  |
| SENSUI, H.            | 494, 607           | SILJEG, K.           | 304                               | SOHRABAIN, A.          | 531                  |
| SENTIJA, D.           | 556, 621           | SILLERO QUINTANA, M. | 182, 611                          | SOINI, A.              | 316                  |
| SEO, Y.               | 407                | SILVA JUNIOR, A.     | 410                               | SOKK, J.               | 338                  |
| SEONG BIN, P.         | 409                | SILVA NETO, A.       | 128                               | SOLANA-TRAMUNT, M.     | 142                  |
| SEREJO, O.            | 350                | SILVA, A.            | 180, 219, 288, 303, 321, 412, 619 | SOLEIMANI, M.          | 281                  |
| SÉRGIO, J.S.          | 107                | SILVA, A.C.          | 412                               | SOLER TORROJA, M.      | 147                  |
| SERPIELLO, F.R.       | 322                | SILVA, A.P.          | 321                               | SOLER, S.              | 285, 286, 575        |
| SERRESSE, O.          | 503                | SILVA, A.S.R.        | 303                               | SOLLERHED, A.C.        | 488                  |
| SESMA ARNAIZ, R.      | 147                | SILVA, E.            | 185, 308, 362, 363, 564           | SOMAUROO, J.           | 212                  |
| SETUAIN, I.           | 27, 157            | SILVA, E.T.          | 185, 308                          | SOMLEV, P.             | 550, 551             |
| SEVIL, G.             | 474                | SILVA, I.            | 538                               | SONDEREGGER, K.        | 401                  |
| SEYNNES, O.           | 45, 153, 276, 466  | SILVA, J.            | 360                               | SONNTAG, A.            | 514                  |
| SEYNNES, O.R.         | 45, 153, 276, 466  | SILVA, L.            | 543, 547                          | SOOS, I.               | 566                  |
| SFORZA, C.            | 158                | SILVA, L.H.          | 547                               | SOÓS, I.               | 572                  |
| SHABKHIZ, F.          | 142, 281           | SILVA, M.            | 149, 540, 557, 642                | SORIC, M.              | 95                   |
| SHALAJ, I.            | 136, 144           | SILVA, P.            | 58, 437                           | SORIMACHI, M.          | 383                  |
| SHANNON, C.E.         | 90                 | SILVA, P.B.          | 58                                | SØRSTRØM, A.           | 409                  |
| SHARIFNEZHAD, A.      | 278                | SILVA, T.A.          | 563                               | SORSTROM, A.N.         | 187                  |
| SHARPE, K.            | 624                | SILVA, T.C.A.        | 303                               | SOTIRIADOU, P.         | 48                   |
| SHARPLES, A.P.        | 394                | SILVA, T.D.          | 362, 363                          | SOULIOU, S.            | 381                  |
| SHAVANDI, N.          | 327, 437           | SILVA, W.L.          | 327                               | SOUSA, A.              | 302                  |
| SHAVE, R.             | 172, 260, 261      | SILVEIRA, L.R.       | 176                               | SOUSA, A.C.            | 301                  |
| SHAVE, R.E.           | 261                | SIMAR, D.            | 300, 381                          | SOUSA, F.              | 339, 587, 619, 633   |
| SHAW, C.S.            | 47, 97, 171, 504   | SIMI, H.             | 606, 613                          | SOUSA, F.A.B.          | 587, 619             |
| SHAW, D.              | 247                | SIMIKIC, I.          | 314                               | SOUSA, M.              | 600                  |
| SHAW, G.              | 88                 | SIMOES, F.           | 540                               | SOUSA, N.              | 219, 410, 603        |
| SHEARMAN, J.          | 500                | SIMÕES, P.S.R.       | 494                               | SOUSA, N.M.F.          | 219, 603             |
| SHEEL, A.W.           | 306                | SIMONEAU, E.M.       | 466                               | SOUZA, A.C.B.          | 563                  |
| SHEPHERD, S.          | 97, 171            | SIMONEK, J.          | 566                               | SOUZA, D.              | 312                  |
| SHEPHERD, S.O.        | 97                 | SIMONI, P.           | 273                               | SOUZA, H.              | 550, 551             |
| SHIANG, T.Y.          | 578                | SIMPSON, B.          | 44, 434                           | SOUZA, M.              | 410                  |
| SHIBANO, K.           | 193                | SIMPSON, B.M.        | 434                               | SOUZA, N.              | 410                  |
| SHIBATA, M.           | 548                | SIMUMIC, B.          | 69                                | SOUZA, T.              | 411, 561             |
| SHIBLI, S.            | 48, 49, 125        | SINDBY, A.K.R.       | 62                                | SOUZA, V.              | 410                  |
| SHIELD, J.P.H.        | 319                |                      |                                   | SOUZA-JUNIOR, T.P.     | 638                  |

- SOYA, H. .... 34, 103, 108  
 SOYLU, A.R. .... 397  
 SOYLU, R. .... 624  
 SPANÓ, N.V. .... 158  
 SPARKS, M. .... 456  
 SPARKS, S.A. .... 599, 604  
 SPEE, R.F. .... 502  
 SPENCE, A. .... 52  
 SPENCER, M. .... 328, 470  
 SPENGOS, K. .... 160, 399  
 SPERLICH, B. .... 330, 526, 590, 649  
 SPERLING, W. .... 303  
 SPIEGEL, S. .... 605  
 SPINA, S. .... 568  
 SPINOSO, D.H. .... 414  
 SPINOZZI, M. .... 367  
 SPITTLE, M. .... 281  
 SPÖRRI, J. .... 243, 479  
 SPRAY, C. 114, 353, 354, 355, 565, 567  
 SPRAY, C.M. .... 114, 353, 355, 565, 567  
 SPRIET, L. .... 300, 450  
 SPRIET, L.L. .... 300  
 SPROULE, J. .... 369  
 SPRUNG, V.S. .... 61, 171  
 SPRY, N. .... 287  
 SPUNDE, A. .... 226  
 SQUATRITO, S. .... 79, 380  
 SRBECKÝ, I. .... 147  
 ST CLAIR GIBSON, A. .... 424, 469  
 STABOLITIS, C. .... 604  
 STAES, F. .... 508, 575, 577  
 STAHN, A. .... 18, 59, 229, 529  
 STAMATOPOLOUS, C. .... 58  
 STAMM, M. .... 130  
 STAMM, R. .... 130  
 STANGANELLI, L.C.R. .... 435  
 STANGL, J. .... 272  
 STANKOVIC, V. .... 569, 570  
 STAPELFELDT, B. .... 60, 593  
 STASINAKI, A. .... 160, 399  
 STASIULE, L. .... 334  
 STASIULIS, A. .... 334  
 STATHAM, A. .... 76  
 STATHI, S. .... 496  
 STATHIS, C. .... 256  
 STAVROU, N.A. .... 208, 565  
 STEBBINGS, J. .... 114  
 STECKLOW, M.V. .... 563  
 STEENBERGEN, B. .... 506  
 STEENE-JOHNANESSEN, J. .... 143  
 STEFANOVIC, B. .... 88, 261  
 STEGE, J. .... 357  
 STEGEN, C. .... 454, 561  
 STEIB, S. .... 575  
 STEIN, D. .... 376  
 STEINACH, M. .... 59, 529  
 STEINACKER, J.M. .... 95, 315, 481  
 STEINBACHER, P. .... 272  
 STEINER, T. .... 288  
 STELLINGWERFF, T. .... 56  
 STEMBRIDGE, M. .... 172, 442  
 STENING, J. .... 250  
 STEPHENS, B. .... 599  
 STEPHENS, F.B. .... 90  
 STEPHENS, J. .... 263, 476, 612  
 STEPHENSON, K.J. .... 255  
 STEPTO, N.K. .... 322, 377  
 STEVENS, C. .... 519  
 STEVENSON, E.J. .... 238  
 STEVERINK, N. .... 222  
 STEWARD, C. .... 322  
 STEWART, A. .... 264  
 STEWART, C. .... 300, 325, 394  
 STEWART, C.E. .... 325, 394  
 STICH, V. .... 310, 314  
 STÖCKER, F. .... 258  
 STODDEN, D.F. .... 344, 482  
 STÖGGL, T. .... 54, 77, 460, 562  
 STÖGGL, T., ..... 54  
 STOHR, E. .... 261  
 STÖHR, E. .... 172, 260  
 STÖHR, E.J. .... 172  
 STOKES, K. .... 108, 598  
 STOKES, R. .... 89, 585  
 STOLK, R.P. .... 84  
 STOPFORTH, M. .... 501  
 STORNILO, F. .... 346  
 STOSIC, J. .... 42  
 STOTER, I.K. .... 167  
 STOTZER, U. .... 312  
 STOTZER, U.S. .... 313  
 STOYLEN, A. .... 473  
 STRAGIER, S. .... 359  
 STRATTON, G. .... 25, 92, 94, 239, 437  
 STRAUB, B. .... 438  
 STRAUSS, B. .... 81  
 STRECKMANN, F. .... 33  
 STREJCOVA, B. .... 447, 448, 596  
 STRIDE, N. .... 330  
 STRÜDER, H.K. ... 35, 82, 182, 267, 398,  
 493  
 STUBBE, J. .... 357  
 STUDER, H. .... 253  
 STÜCKLER, M. .... 609  
 SU, M.Y. .... 382  
 SU, S.C. .... 578  
 SUAREZ MORENO ARRONES, L. .... 374  
 SUÁREZ, G. .... 641, 642  
 SUAREZ-ARRONES, L. .... 374, 375, 642  
 SUÁREZ-ARRONES, L. .... 375, 545, 619,  
 641  
 SUCHOMEL, T. .... 77  
 SUDO, M. .... 337  
 SUEN, V.M.M. .... 137  
 SUEPTITZ, F. .... 493  
 SUGAWARA, M. .... 599  
 SUGINO, M. .... 513  
 SUGIURA, H. .... 405  
 SUGURU, T. .... 579  
 SUHARA, Y. .... 595  
 SUITO, H. .... 341  
 SUKHOV, S. .... 368, 548  
 SUKRESKI, M. .... 402  
 SULLIVAN, C. .... 374  
 SULLIVAN, P. .... 567  
 SUM, K. .... 574  
 SUMITOMO, J. .... 558  
 SUNG, E. .... 411, 532  
 SUPEJ, M. .... 241  
 SUSTA, D. .... 299  
 SUTA, L. .... 362  
 SUTA, V.E.N. .... 362  
 SUWABE, K. .... 108  
 SUZOVIC, D. .... 466, 618  
 SUZUKI, H. .... 625  
 SUZUKI, I. .... 638  
 SUZUKI, K. .... 96, 222, 346  
 SUZUKI, S. .... 177  
 SUZUKI, Y. .... 337, 597  
 SWAINE, I. .... 262, 457  
 SWARÉN, M. .... 602  
 SWINNEN, S. .... 29  
 SZABLICS, P. .... 224, 333, 365  
 SZABÓ, S. .... 365  
 SZENDREI, B. .... 626  
 SZEWCZYK, N.J. .... 23  
 SZILÁGYI, N. .... 224  
 SZMODIS, M. .... 321, 588, 608  
 SZOTS, G. .... 588, 608  
 SZYGULA, Z. .... 370, 405  
 SZYMURA, J. .... 405
- ## T
- TAAFFE, D. .... 163  
 TABACCHI, G. .... 534  
 TABATA, I. .... 177, 556  
 TABERNER, M. .... 402  
 TAEYMANS, J. .... 534, 574  
 TAGOUGUI, S. .... 60  
 TAGUCHI, M. .... 169, 555, 556  
 TAHERI, A. .... 145  
 TAHMASBI, W. .... 531  
 TAI, Y.J. .... 306  
 TAI, Y.J. .... 305  
 TAIPALE, R.S. .... 103  
 TAKAGI, H. .... 577, 632, 634  
 TAKAGI, S. .... 119  
 TAKAGI, Y. .... 373  
 TAKAGI, Y. .... 363, 386, 570, 610, 623  
 TAKAHARA, T. .... 363, 373  
 TAKAHARA, T. .... 610, 623  
 TAKAHASHI, H. .... 410  
 TAKAHASHI, K. .... 72, 118, 120, 621  
 TAKAHASHI, M. .... 125, 586  
 TAKAHASHI, S. .... 96, 222  
 TAKAHASHI, Y. .... 337  
 TAKAHIKO, S. .... 318  
 TAKAHIRA, N. .... 586  
 TAKATA-ISHIKAWA, K. .... 555  
 TAKATSU, S. .... 225, 226  
 TAKEDA, F. .... 191  
 TAKEDA, K. .... 228  
 TAKEDA, M. .... 595  
 TAKEDA, T. .... 632  
 TAKEDA, Y. .... 311, 647  
 TAKEHIRO, N. .... 433  
 TAKEI, K. .... 218, 632  
 TAKEMATA, T. .... 410  
 TAKENOYA, F. .... 378  
 TAM, E. .... 380  
 TAM, N. .... 229, 413  
 TAMAKI, H. .... 193, 307  
 TAMMELIN, T. .... 270, 316, 344  
 TANABE, H. .... 157  
 TANABE, Y. .... 177  
 TANAKA, H. .... 225, 337, 526  
 TANAKA, K. .... 222  
 TANAKA, S. .... 221, 337, 441, 443, 608,  
 615  
 TANAKA, T. .... 307  
 TANHA, T. .... 169  
 TANIDA, K. .... 548  
 TANIMURA, Y. .... 336, 649  
 TANNER, A.V. .... 181  
 TANSKANEN, M. .... 554, 585  
 TARASOVA, O. .... 407  
 TARNOPOLSKY, M.A. .... 55  
 TARO, S. .... 532  
 TASHIRO, M. .... 494  
 TATAR, Y. .... 559  
 TATARU, T. .... 429  
 TATSUYA, U. .... 185  
 TAUBE, W. .... 57, 80, 325, 473  
 TAUDORF, L. .... 62



**V**

|                             |                                                 |
|-----------------------------|-------------------------------------------------|
| VAAG, A.                    | 23                                              |
| VAGO, P.                    | 348, 571                                        |
| VAISBERG, M.                | 483                                             |
| VAISBERG, T.M.J.A.          | 354                                             |
| VAJAGIC, B.                 | 203                                             |
| VALANTINIENE, I.            | 201                                             |
| VALE, S.                    | 136, 371                                        |
| VALENTE-DOS-SANTOS, J.      | 540                                             |
| VALENZA, G.                 | 507                                             |
| VALERO, E.                  | 474                                             |
| VALKOVIC, L.                | 147                                             |
| VALLE, C.                   | 310                                             |
| VAMBERGUE, A.               | 60                                              |
| VAN T HUL, A.J.             | 133                                             |
| VAN ACKER, R.               | 256                                             |
| VAN ARK, M.                 | 105                                             |
| VAN BALLEGOUIJEN, M.        | 141                                             |
| VAN BEEKVELT, M.            | 406                                             |
| VAN BEEKVELT, M.C.P.        | 644                                             |
| VAN BEIJSTERVELDT, C.E.M.   | 566                                             |
| VAN BERKEL, S.              | 134                                             |
| VAN BOTTENBURG, M.          | 20, 49, 125, 128                                |
| VAN DE REST, O.             | 643                                             |
| VAN DE VOORDE, J.           | 310                                             |
| VAN DEN AKKER-SCHEEK, I.    | 105, 490                                        |
| VAN DEN AKKER-SCHEEK, I.    | 211                                             |
| VAN DEN BERG, P.H.          | 233                                             |
| VAN DEN EEDE, F.            | 190                                             |
| VAN DER DOES, H.T.D.        | 109                                             |
| VAN DER HELM, F.            | 240                                             |
| VAN DER HOEVEN, L.          | 90                                              |
| VAN DER SCHANS, C.P.        | 84, 222                                         |
| VAN DER WAL, M.H.L.         | 84                                              |
| VAN DER WORP, H.            | 211                                             |
| VAN DER WOUDE, L.           | 141                                             |
| VAN DER WOUDE, L.H.V.       | 106                                             |
| VAN DER ZWALUW, N.          | 643                                             |
| VAN DIEËN, J.               | 294                                             |
| VAN DIJK, J.                | 62                                              |
| VAN GEFFEN, M.              | 85                                              |
| VAN GINCKEL, A.             | 509                                             |
| VAN HALEWYCK, F.            | 80                                              |
| VAN HEERDE, L.              | 85                                              |
| VAN HOECKE, A.S.            | 93                                              |
| VAN HOECKE, J.              | 249                                             |
| VAN HOOMISSEN, J.           | 352                                             |
| VAN HOYE, A.                | 115, 387                                        |
| VAN KRANENBURG, J.          | 90                                              |
| VAN LEEUWEN, D.M.           | 221                                             |
| VAN LOO, M.                 | 87                                              |
| VAN LOON, L.                | 46, 62, 63, 71, 90, 97, 100, 174, 502, 605, 643 |
| VAN LOON, L.J.C.            | 46, 63, 90, 97, 100, 174, 502, 643              |
| VAN MECHELEN, W.            | 28                                              |
| VAN MECHELEN, W.            | 357                                             |
| VAN MIL, E.                 | 465                                             |
| VAN OOSTERWIJCK, J.         | 87, 137                                         |
| VAN OS, J.A.                | 73                                              |
| VAN PAEPEGEM, W.            | 183                                             |
| VAN RANST HESSELINK, M.K.C. | 133                                             |
| VAN REMOORTELT, H.          | 428                                             |
| VAN ROIE, E.                | 500                                             |
| VAN ROSENDAL, S.            | 587                                             |
| VAN SINT JAN, S.            | 240                                             |
| VAN STRALEN, M.M.           | 146                                             |
| VAN T HOF, A.J.W.           | 134                                             |
| VAN THIENEN, R.             | 23, 52                                          |
| VAN WESSEL, T.              | 320                                             |
| VANBESLAERE, N.             | 116, 451                                        |
| VANDAELE, B.                | 56                                              |
| VANDE BROEK, G.             | 116, 122, 123, 451                              |
| VANDENBERGH, D.             | 234                                             |
| VANDEBOGAERDE, T.J.         | 190, 191                                        |
| VANDENBROECK, C.            | 234                                             |
| VANDERTHOMMEN, M.           | 591                                             |
| VANDEVELDE, A.              | 234                                             |
| VANGRUNDERBEEK, H.          | 231                                             |
| VANGSGAARD, S.              | 102, 259                                        |
| VANNINEN, E.                | 602                                             |
| VANPARIJS, J.               | 282                                             |
| VANRENTERGHEM, J.           | 575                                             |
| VANWALLEGHEM, J.            | 183                                             |
| VARADHAN, K.                | 47                                              |
| VARALDA, C.                 | 183                                             |
| VARELA, V.                  | 539, 611                                        |
| VARGA, C.                   | 224, 333                                        |
| VARGA, CS.                  | 365                                             |
| VÁRI, B.                    | 224                                             |
| VARLEY, M.C.                | 297                                             |
| VARRAY, A.                  | 495                                             |
| VASCONCELOS, O.             | 417, 419                                        |
| VASILAKI, A.                | 468                                             |
| VASTOLA, R.                 | 203                                             |
| VAYA, A.                    | 186, 522                                        |
| VAZ, J.                     | 543                                             |
| VAZ, L.                     | 129, 149                                        |
| VAZ, M.A.                   | 218                                             |
| VÁZQUEZ, J.                 | 533                                             |
| VECHIN, F.                  | 411                                             |
| VEGTER, W.H.                | 134                                             |
| VELIGEKAS, P.               | 360, 604                                        |
| VELTHUIS, M.                | 516                                             |
| VELTMEIJER, M.              | 85                                              |
| VENANCIO, C.                | 287                                             |
| VENEMA, M.                  | 62                                              |
| VENIAMAKIS, E.              | 369, 530, 583, 597                              |
| VENIAMAKIS, E.E.            | 530, 583, 597                                   |
| VENTER, R.                  | 450, 467                                        |
| VERA-GARCIA, F.J.           | 635                                             |
| VERARDI, C.E.L.             | 465, 607                                        |
| VERBOVEN, K.                | 132                                             |
| VERDIJK, L.                 | 38, 46, 71, 90, 97, 100, 174, 643               |
| VERDIJK, L.B.               | 38, 46, 90, 97, 100, 174, 643                   |
| VERDIJK, P.W.L.             | 601                                             |
| VERDOT, C.                  | 427                                             |
| VERECKEN, C.                | 139                                             |
| VERGES, S.                  | 290                                             |
| VERGES, S.                  | 522                                             |
| VERHAGEN, E.                | 27, 357, 497                                    |
| VERHEGGEN, R.H.M.           | 598                                             |
| VERHEUL, M.                 | 107                                             |
| VERSCHUEREN, J.             | 443                                             |
| VERSCHUEREN, S.             | 508, 575, 577                                   |
| VERSICS, A.                 | 572                                             |
| VERTOMMEN, T.               | 190                                             |
| VERTONGHEN, J.              | 190                                             |
| VERZOLA, R.M.M.             | 390                                             |
| VESTERGARD, J.              | 272                                             |
| VIANA, B.                   | 297                                             |
| VIANA, V.A.R.               | 391                                             |
| VICENTE, A.                 | 295, 426                                        |
| VICENTE-RODRIGUEZ, G.       | 138                                             |
| VICENTE-RODRÍGUEZ, G.       | 105, 140, 141, 390, 392                         |
| VICENZINO, B.               | 274                                             |
| VICIAN, M.                  | 147                                             |
| VICTOR, K.                  | 164                                             |
| VIDAL, S.                   | 642                                             |
| VIEILLEVOYE, S.             | 154, 359                                        |
| VIEIRA, D.                  | 97, 128                                         |
| VIKARI, J.S.A.              | 270                                             |
| VILALVA, R.                 | 638                                             |
| VILA-MALDONADO, S.          | 223                                             |
| VILAS-BOAS, J.P.            | 143, 302                                        |
| VILIM, M.                   | 438                                             |
| VILLA, J.G.                 | 138                                             |
| VILLAR, J.                  | 550, 622                                        |
| VILLAS-BOAS, J.P.           | 339, 633                                        |
| VILLBERG, J.                | 116, 316, 344                                   |
| VILMAN, T.                  | 590                                             |
| VILMEN, C.                  | 292                                             |
| VIMESHKUMAR, J.             | 265                                             |
| VINCE, R.                   | 172, 337                                        |
| VINCE, R.V.                 | 172                                             |
| VINCENT, G.E.               | 553                                             |
| VINCENT, P.J.               | 553                                             |
| VINCENT, S.                 | 313                                             |
| VINE, S.J.                  | 39, 189                                         |
| VINOGRADOVA, O.             | 393, 407                                        |
| VIRÁG, A.                   | 447                                             |
| VIRTANEN, K.                | 173, 233, 581                                   |
| VIRTANEN, K.A.              | 173                                             |
| VISNES, H.                  | 153, 154                                        |
| VISSERS, D.                 | 196                                             |
| VITÓRIO, R.                 | 303                                             |
| VITTORI, L.                 | 161, 497                                        |
| VITTORI, L.N.               | 161                                             |
| VIVES HERNÁNDEZ, J.J.       | 318                                             |
| VLECK, V.                   | 527, 629, 630                                   |
| VOELCKER, T.                | 164                                             |
| VOGEL, H.                   | 452                                             |
| VOGEL, J.                   | 51, 170                                         |
| VOGT, L.                    | 211, 455, 500, 629                              |
| VOGT, M.                    | 441                                             |
| VOGT, T.                    | 35, 267                                         |
| VOIGT, H.F.                 | 84                                              |
| VOITA, D.                   | 226                                             |
| VOLÁK, A.                   | 572                                             |
| VOLKWEIN-CAPLAN, K.         | 284                                             |
| VOLLMER-CONNA, U.           | 291                                             |
| VOLSKI, V.                  | 206                                             |
| VON DUVILLARD, S.P.         | 308, 460                                        |
| VOORN, E.                   | 32                                              |
| VORGERD, M.                 | 411, 532                                        |
| VOSS, S.                    | 519                                             |
| VOYSEY, V.                  | 214, 648                                        |
| VRABAS, S.I.                | 523                                             |
| VRANCKX, P.                 | 174                                             |
| VUCETIC, V.                 | 402, 556                                        |
| VUKASINOVIC VESIC, M.       | 203                                             |
| VUKASINOVIC-VESIC, M.       | 89, 370, 454, 585                               |
| VULETIC, M.                 | 381                                             |

**W**

|                     |                    |
|---------------------|--------------------|
| WADA, T.            | 363                |
| WAGENMAKERS, A.J.M. | 47, 97, 171        |
| WAGNER, H.          | 460, 562           |
| WAGNER, K.H.        | 254                |
| WAGNER, P.          | 386, 387, 464, 610 |
| WAHL, P.            | 61, 531, 590, 644  |
| WAHLIN-LARSSON, B.  | 245                |
| WAKAHARA, T.        | 154, 175           |
| WALDRON, M.         | 113, 298           |
| WALDRON, S.         | 24                 |
| WALKER, P.J.        | 88, 261            |
| WALL, B.            | 71, 174            |
| WALL, B.T.          | 174                |
| WALLACE, E.S.       | 461                |



WALLACE, J.A. .... 65  
 WALLACE, L. .... 92  
 WALLIS, G.A. .... 238  
 WALLMAN, K. .... 64, 92, 165, 527, 530  
 WALLMAN, K.E. .... 64, 92, 527  
 WALLMANN, B. .... 649  
 WALLNER, D. .... 606, 613  
 WANG, F. .... 188, 394  
 WANG, H.K. .... 508, 578  
 WANG, H.S. .... 97  
 WANG, W.Y. .... 487  
 WARBURTON, G.L. .... 92, 94  
 WARNOTTE, J. .... 388  
 WARREN, L.A. .... 277  
 WARRINGTON, G. .... 557  
 WATANABE, H. .... 121, 586, 638  
 WATANABE, K. .... 119  
 WATANABE, M. .... 569  
 WATERHOUSE, J. .... 586  
 WATERMAN, J. .... 178  
 WATSON, G. .... 165, 404  
 WATSON, P. .... 30, 227  
 WAUGH, C.M. .... 68  
 WEATHERALL, L. .... 214, 648  
 WEBB, O.J. .... 40  
 WEGMANN, M. .... 120  
 WEHRLE, A. .... 487  
 WEHRLIN, J.P. .... 288  
 WEI-CHIN, T. .... 457  
 WEIB, M. .... 494  
 WEISSENSTEINER, J. .... 159  
 WELDE, B. .... 143, 246, 552, 635  
 WELIN, L. .... 71  
 WELLMANN, K. .... 376  
 WELMAN, K. .... 57, 450  
 WELMAN, K.E. .... 57  
 WELTIN, E. .... 78  
 WENDEROTH, N. .... 56, 82, 228  
 WENS, I. .... 132  
 WERKER, W.A.N. .... 601  
 WERNER, A. .... 59, 529  
 WERNER, A.D. .... 59  
 WERNER, N. .... 61  
 WESSELS, B. .... 502  
 WESSNER, B. .... 255  
 WEST, J.S. .... 64  
 WEST, N. .... 263, 366, 476, 612  
 WEST, N.P. .... 263, 366  
 WESTERBEEK, H. .... 49  
 WESTERBLAD, H. .... 32, 246  
 WESTERTERP, K.R. .... 585  
 WESTON, K. .... 85  
 WHEATON, B. .... 478  
 WHITELEY, R. .... 403  
 WHYTE, G. .... 549  
 WIECEK, M. .... 405  
 WIECHA, S. .... 405  
 WIESINGER, H.P. .... 45  
 WIIG, H. .... 328  
 WIJN, P.F.F. .... 502  
 WIJTVLIET, P.E.J.P. .... 84  
 WILDMAN-TOBRINER, B. .... 484  
 WILES, J. .... 262  
 WILLE, M. .... 580, 636  
 WILLEMS, M.E.T. .... 263, 529, 591  
 WILLEMSEN, G. .... 40  
 WILLIAMS, J.P. .... 47  
 WILLIAMS, K. .... 123, 549  
 WILLIAMS, M. .... 163, 402, 488  
 WILLIS, S. .... 288  
 WILSON, C. .... 402, 488  
 WILSON, M.R. .... 39, 189

WINZEN, M. .... 84, 233  
 WISKEMANN, J. .... 234, 471  
 WISLOFF, U. .... 59, 150, 376, 403  
 WITARD, O. .... 236  
 WITVROUW, E. .... 509  
 WOITALLA, D. .... 498  
 WOLF, D. .... 547  
 WOLKORTE, R. .... 86  
 WOLLMER, P. .... 169  
 WOLNY, R. .... 336  
 WOLTERS, P.C.M. .... 105  
 WONG, D.P. .... 111, 456  
 WONG, H.S. .... 286  
 WOOLLEY, D.G. .... 82  
 WOORAM, B. .... 623  
 WORSFOLD, P. .... 113  
 WRIGHT, D.C. .... 300  
 WRIGHT, D.J. .... 261  
 WRIGHT, G. .... 74, 528  
 WU, C.M. .... 306  
 WU, C.M. .... 305  
 WU, S. .... 245, 576  
 WU, S.S.X. .... 245  
 WÜBBENHORST, K. .... 542  
 WULFF, H. .... 386  
 WULFF, J. .... 219  
 WUNDERLIN, S. .... 605  
 WUYAM, B. .... 290  
 WUYAM, B. .... 522  
 WYCKELSMAN, V.L. .... 322  
 WYLLEMAN, P. .... 20, 248, 249, 293  
 WYSS, T. .... 215, 605

X

XENOFONDOS, A. .... 103  
 XINYAN, Z. .... 34  
 XIROUCHAKI, C. .... 630

Y

YAHATA, N. .... 628  
 YAMADA, A. .... 610  
 YAMADA, K. .... 631  
 YAMADA, N. .... 179  
 YAMADA, Y. .... 526  
 YAMAGUCHI, H. .... 363, 373, 623  
 YAMAGUCHI, Y. .... 595  
 YAMAMOTO, M. .... 407, 608  
 YAMAMOTO, N. .... 378  
 YAMAMOTO, T. .... 125, 571  
 YAMASHIRO, K. .... 227, 345, 416  
 YAMASHITA, D. .... 117, 155  
 YAMAUCHI, H. .... 311, 331, 377  
 YAMAUCHI, J. .... 408, 557, 628  
 YAMAZAKI, S. .... 223, 391  
 YAMAZAKI, Y. .... 627  
 YANAGISAWA, O. .... 525  
 YANAGITA, S. .... 228  
 YANAI, T. .... 69, 102, 152, 175  
 YANAKA, S. .... 407  
 YANG, X. .... 270  
 YANO, M. .... 422  
 YASUKAWA, M. .... 372  
 YASUMATSU, M. .... 383, 388  
 YE, C.C. .... 305  
 YEE, N.B. .... 58  
 YEO, J. .... 569  
 YEO, Y.Y.W. .... 225  
 YIN, N.H. .... 578  
 YODA, T. .... 383

YOKOHATA, E. .... 449  
 YOON, J. .... 191, 425  
 YOON, J.H. .... 425  
 YOON, J.Y. .... 191  
 YOSHIDA, T. .... 345, 416  
 YOSHIDA, Y. .... 449  
 YOSHIIHARA, S. .... 125, 571  
 YOSHII, H. .... 155, 175  
 YOSHIKAWA, T. .... 336  
 YOSHIMURA, F.E. .... 224  
 YOSHIOKA, A. .... 373  
 YOSHIOKA, A. .... 610, 623  
 YOSHIOKA, S. .... 117  
 YOSHIZAWA, K. .... 570  
 YOTANI, K. .... 193  
 YUKAKO, I. .... 579  
 YUKI, A. .... 193  
 YUKI, A. .... 625  
 YUKO, G. .... 625  
 YUMI, S. .... 318  
 YUMIGETA, R. .... 536

Z

ZABALA, M. .... 207, 270, 355, 370, 371, 372, 420  
 ZABALA, M., .... 355  
 ZABALA-LILI, J. .... 167  
 ZABRZESKA, M. .... 56  
 ZACHARAKIS, E. .... 124, 196  
 ZACHAROGIANNIS, E. .... 343  
 ZAFEIRIDIS, A. .... 523  
 ZAFFARI, P. .... 214  
 ZAGALAZ-SÁNCHEZ, M.L. .... 127, 401  
 ZAGO, A.S. .... 224  
 ZAHN, P. .... 575  
 ZAHNER, L. .... 271, 329  
 ZAIA, J.E. .... 465, 535  
 ZALAVRAS, A. .... 335  
 ZAMFIR, V. .... 429  
 ZAMPARO, P. .... 634  
 ZANGE, J. .... 43, 289  
 ZANUSO, S. .... 319  
 ZAPICO, A.G. .... 139, 464  
 ZARAGOZA, J. .... 94  
 ZARAS, N. .... 160, 399  
 ZAWADZKI, P. .... 207, 424  
 ZEBIS, M.K. .... 339, 499  
 ZECH, A. .... 42, 575  
 ZEMBRON-LACNY, A. .... 336, 382, 582, 649  
 ZEMKOVÁ, E. .... 147, 590  
 ZHANG, W. .... 627  
 ZHANG, X. .... 56, 184  
 ZHAO, Y. .... 184  
 ZHURAVLEV, P. .... 127  
 ZIEMANN, E. .... 378  
 ZIJDEWIND, I. .... 70, 86, 167  
 ZIMMERMAN, D. .... 105  
 ZINNER, C. .... 22, 90, 360, 463, 526, 531, 590, 644  
 ZITO, V. .... 439  
 ZIV, G. .... 150, 448, 530  
 ZIVKOVIC, V. .... 381  
 ZOPPI, C. .... 312, 378  
 ZORANIC, J. .... 616  
 ZORKO, M. .... 489  
 ZOUABI, A. .... 83  
 ZOUHAL, H. .... 167  
 ZOURBANOS, N. .... 205, 355, 381, 387, 566

ZSCHORLICH, V. .... 220, 542  
ZSIDEGH, M. .... 447  
ZUIDEMA, M.J. .... 601

ZUPET, P. .... 489  
ZUREK, P. .... 336, 382  
ZUSHI, K. .... 339

ZWERVER, J. .... 105, 211, 490  
ZYCH, K. .... 139