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Validation in Young Soccer Players of the Modified Version of the Harre Circuit Test: The Petrucci Ability Test

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Abstract

The evaluation of soccer players' physical fitness from youth onward is important for monitoring performance and planning training. While health-related factors present valid and reliable tests, the skill-related component should be studied in depth. An interesting test to evaluate the skill-related factors is the Harre circuit test (HTC); unfortunately, this test includes the somersault, an element not present in soccer. The aim of the present study is the validation of the Petrucci ability test (PAT), a variation of the HTC without the somersault for young soccer players. Children and adolescents (age range 10–13 years old) soccer players concluded the 20-m, the HTC and the PAT. To establish the validity of the PAT, correlation analysis has been performed, which presented a $p < 0.0001$ between PAT and HTC; $p < 0.001$ between PAT and a 20-m test; and $p < 0.0001$ between HTC and the 20-m test. The results suggest that the PAT can be a valid substitute for the evaluation of the skills-related components of young soccer players and, consequently, also of athletes and schoolchildren.

Keywords: *skill-related evaluation, youth, physical fitness, football, protocol*

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Introduction

Soccer, or association football, is a widely practised activity in the world and performance is influenced by physical, biomechanical, technical, mental and tactical factors (Stolen, et al., 2005). It is important to monitor athletic performance and plan training (Svensson & Drust, 2005), and the aspects to be evaluated are sprints, jumps, turns, shots, and tackles (Hoff & Helgerud, 2004). Also, in children and adolescents, an appropriate evaluation to identify talents or to find the suitable role on the soccer team is necessary (Hammami et al., 2013; Lago-Penas, et al., 2014).

The evaluation of the soccer player's physical fitness (PF) performance can be accurately and objectively performed through laboratory and field tests (Hoff, 2005; Svensson & Drust, 2005; Tabacchi, 2019). While laboratory tests are usually more reliable, field tests, instead, are generally easier to administer, as well as being less costly and time-consuming (Heyward, 1991; O'Reilly & Wong, 2012; Svensson

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& Drust, 2005). Furthermore, field tests are more ecologically valid and suitable in population-based studies, such as in a school or college setting (Artero et al., 2011). Finally, field-based tests are more sport-specific and sensitive to seasonal changes (O'Reilly & Wong, 2012). Given that PF is composed of health-related (cardiorespiratory endurance, muscular strength, body composition and flexibility), and skill-related components (agility, balance, coordination, power, reaction time and speed) (Caspersen, et al., 1985), it is necessary to test these characteristics properly among soccer players.

Health-related PF components are tested by valid and reliable field-test protocols, such as the Cooper test (Cooper, 1968) for cardiorespiratory endurance, the 20 m Shuttle Run Test (Leger & Lambert, 1982) or the intermittent Yo-Yo test (Paul & Nassis, 2015) for muscular endurance, vertical jumps (Petrigna et al., 2019) for muscular power, and the sit-and-reach test (Wells, 1952) for flexibility. Also, some skill-related components are evaluated with valid and reliable tests, such as speed, assessed with sprints from 5 to 60 metres (Hoff, 2005; Paul & Nassis, 2015), agility and balance, evaluated with the T-test and the Flamingo balance test respectively (Pojskic et al., 2018; Tabacchi, 2019; Walaszek, et al., 2017). The reaction time can be tested through the athlete's responses to determined inputs, such as sounds or lights (Tabacchi, 2019) while for the evaluation of coordinative abilities the Körperkoordinationstest für Kinder (KTK) test could be adopted (Tabacchi, 2019), a valid test for gross motor coordination in school-aged children (Iivonen, et al., 2015; Iivonen & Laukkanen, 2014; Vandorpe et al., 2011). Other tests combine more skill-related components, such as the performance of sprints with changes of direction (speed and agility) (Iivonen & Laukkanen, 2015; Iivonen & Laukkanen, 2014; Vandorpe et al., 2011). The Harre circuit test (HTC) (Harre, 1982) evaluates dynamic motor coordination, coordinative abilities, and cognitive capabilities (reaction time and space perception) (Harre, 1982; Trecroci, et al., 2015; Zatsiorsky, 2006), also in children (Chiodera et al., 2008; Dallolio, et al., 2016). Due to the inclusion of different skill-related components with the HTC, which could limit the use of this test in those sports for which the somersault is not required (i.e., football, basketball, water polo), the objective of the present study is to evaluate if the HTC in a modified version (without the somersault), called the Petrucci ability test (PAT), is valid for young soccer players.

Methods

A total of sixty-nine children and adolescents (11.1 ± 1 years; 41.2 ± 7.7 kg; 148.3 ± 9.6 cm) of the U.S. Città di Palermo soccer school (Palermo, Italy) have been recruited for the study.

Height and weight were measured by trained investigators following a standardized protocol. Height was measured to the nearest 0.1 cm with a stadiometer (SECA, Hamburg, Germany) with feet together. Weight was also evaluated to the nearest 0.1 cm with a balance SECA (Hamburg, Germany). Body mass index (BMI) (kg/m^2) and Body surface area (m^2) were calculated.

Children and adolescents' parents were informed about the purpose of the study and the risks of the research project. Furthermore, informed consent forms were provided by parents or legal guardians.

The study has been approved by the local Bioethics Committee of the Università degli Studi di Palermo and was in accordance with the Helsinki Declarations revised in 2013.

Study design

The testing session took one day, and the tests were proposed at the beginning of the sports season. During the session, participants were screened against the eligibility criteria, following which the 20-m, the HTC and the modified version of the Harre circuit test, named PAT, were proposed.

The test was performed after a generalized warm-up that consisted of 6 minutes of a low-intensity run (about 7 km/h), two series of high running skips for eight metres, and two series of back running kicks with a recovery time of thirty seconds between series. The three tests were proposed in random order with a recovery time between tests of five minutes.

The 20-metre test required participants to run 20 metres at their maximum speed. The time was measured using a Garmin stopwatch (USA). Participants started the test from a pre-established standing position; after the start signal, they had to run 20 metres. The time was measured in seconds.

The Harre circuit test followed the procedure was followed (Harre, 1982). After the start from an upright position, the participants perform a somersault on a mattress, followed by three passages above and below of three obstacles (50 cm high). Before the obstacles, participants have to move to their right and touch an indicative ball/cone. The test was stopped when the athletes passed the finish line. The test was also stopped if an obstacle was touched or the execution was not the correct one.

The Petrucci ability test protocol was adapted previously (Alesi et al., 2014) and, differently from the HCT, the PAT consisted of running directly to the ball/cone without the somersault. Furthermore, the athletes should not touch the ball/cone when they turn around it. The second part of the test followed the same procedure as the test HTC. In this case, the time to complete the test was evaluated, and the test was also stopped if an obstacle was touched or the execution was not the correct one.

Statistical analysis

Statistical analysis was performed with the GraphPad Prism (Vers. 5.0) software. The Shapiro-Wilk test to evaluate data distribution was performed, and normality was set with alpha at 0.05. Data are presented as mean and standard deviations. The parametric Pearson test has been performed to evaluate the correlation between the PAT and: (i) the 20-m test; (ii) HTC; and (iii) age. The statistical significant has been set with $p < 0.05$.

Results

All participants completed the testing session. The results for age, PAT, HTC, and 20-m sprint test are normally distributed. The Pearson test showed an r-value of 0.51 ($p < 0.0001$) between the PAT and the 20-m test (Figure 1), while a 0.83 ($p < 0.001$) between the PAT and the HTC (Figure 2). An r-value of 0.50 ($p < 0.0001$) was between the 20-m test and the HTC (Figure 3). Mean data and standard deviation for the PAT, the HTC and the 20-m tests according to the age group are presented in Table 1.

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Table 1. Data related to the physical tests carried out on the four groups (mean ± standard deviation)

	20-m run (sec)	Harre test (sec)	Petrucci ability test (sec)
10-year-olds group	4.0 ± 0.2	16.4 ± 2.2	15.1 ± 1.8
11-year-olds group	3.7 ± 0.2	15.1 ± 1.4	14.4 ± 1.2

Note. A correlation analysis between age and: (i) PAT presented and r of -0.40 ($p < 0.001$); (ii) with the 20-m test of -0.62 ($p < 0.001$) and with HTC of -0.36 ($p < 0.01$).

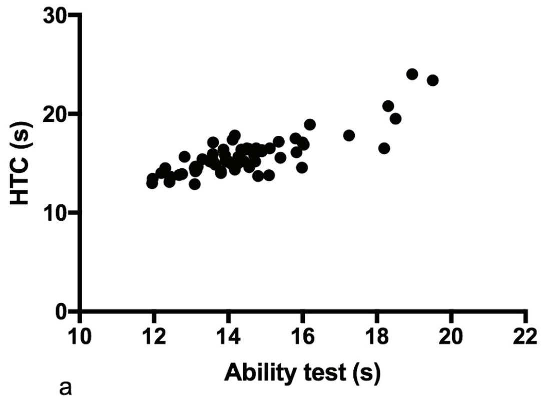

FIGURE 1. Correlation analysis between PAT and HTC (p<0.0001). All data are in seconds.

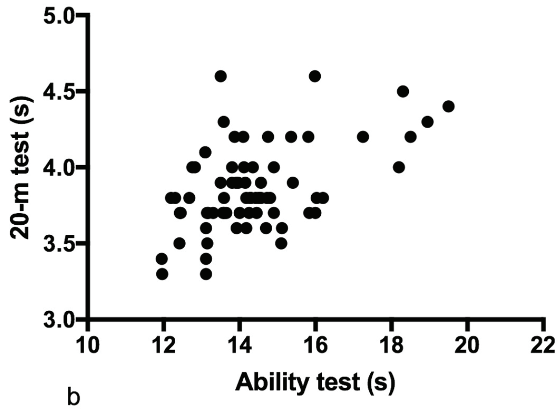

FIGURE 2. Correlation analysis between PAT and 20-m test (p<0.001). All data are in seconds.

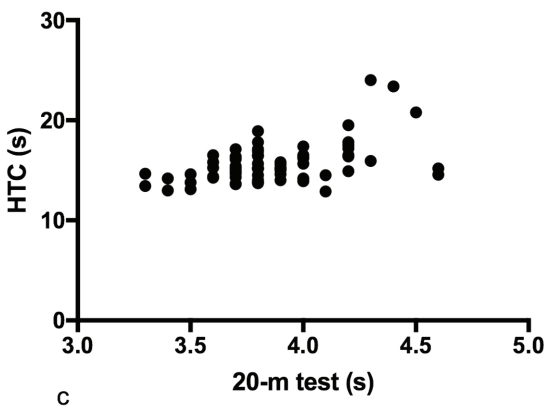

FIGURE 3. Correlation analysis between HTC and 20-m test (p<0.0001). All data are in seconds.

Discussion

The present study suggests that the PAT is equally reliable as the HCT; it is a simple, rapid and non-invasive motor skills evaluation method for young soccer players. The PAT, simplifying the HCT, allows several advantages such as the use of less equipment, the possibility of application to wider sports areas, elimination of an element (the somersault), and consequently extending the test to a wider audience.

The evaluation of lower limbs dexterity is important to guarantee to the soccer athletes the ability to perform sudden deceleration and change of direction, and this can be performed with agility tests (Lyle, et al., 2015) and the results of the present study, in which PAT and 20-m sprint test are positively correlated (r = 0.51), confirm that coordination tests are also useful.

The PAT was strongly positively associated with the HTC (r= 0.83); this is an important result for the study confirming the assumption that the two tests are interchangeable. The PAT can be used to replace the HTC; the former test measures coordination, reaction time and space perception (Harre, 1982; Trecroci et al., 2015; Zatsiorsky, 2006) with the only difference being that the ability in performance a somersault is not required. Not doing a somersault reduces the equipment needed to perform the test by making the protocol test inexpensive and feasible in a larger population, such as in schools or children to evaluate and monitor skill-related components. Evaluation and monitor of motor skill but also of PF, in general, is important because it is a marker of health status (Catley & Tomkinson, 2013), it is correlated with cardiovascular disease risk factors and skeletal health (Ortega, et al., 2008), and it presents a positive association with cognition and academic achievement (Donnelly et al., 2016). Considering the rapid rise of overweight children (Dollman, et al., 2005) with a consequent increase of cardiovascular and metabolic risk factors (Gong et al., 2013), it is vital to evaluate all PF components. Furthermore, the identification of low-level PF children should start in the schools in order to propose timely intervention (Ortega et al., 2008); consequently, other populations must be involved to confirm the feasibility of the present study.

Negative correlations exist between age and PAT (r = -0.40), meaning that the older the sample is, the faster they are; negative results were also found between age and HTC (r= -0.36) and age and 20-m sprint test (r =-0.62). These confirm the necessity of evaluating coordination constantly in youth since general and specific coordination, strongly related to speed, agility, and leg power, improve with age and during sport-specific skills acquisition (Kamandulis et al., 2013). One consideration is that, as different physical characteristics influence the test results in the T-test (agility test) (Pauole, 2000), the PAT is also influenced by multiple factors, such as lower limb strength, agility, sprint and psychological aspects, such as motivation; consequently, the interpretation of results have been made carefully.

Gender and age present differences in the PF of soccer players (Mujika, et al., 2009). Furthermore, as has been previously observed (Kaplan, et al., 2009), speed and agility performance differs between professional and amateur soccer players. Therefore, one limit of the study is the sample involved and, consequently, it is interesting to evaluate if coordination and, consequently, the time to complete the PAT is different according to the gender, age, and level of the athletes. Furthermore, a validation study is required. The strength of the present study is to present a new test to evaluate motor skills to the scientific world, as well as to teachers and coaches.

Conclusion

The PAT, simplifying the HCT, enables evaluating skill-related components in different age and physical activity level groups. The necessity of a few inexpensive pieces of equipment and the reduction of the injury risk due to the elimination of the somersault makes the PAT ideal for evaluating motor skills.

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