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Influence of a specific aquatic adapted physical activity in a child with Autism Spectrum Disorders: A case study

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Abstract

Aquatic environment offers an exciting and motivating place for children and aquatic exercise programs provide an appropriate setting for early educational interventions in individuals with autism spectrum disorders (ASD). The purpose of this study was to examine the effects of a specific Multi-systemic Aquatic Therapy (CI-MAT) on gross motor and adaptive skills in a child with ASD. The study was divided into three phases: baseline, 12-week CI-MAT program and Post-Test. Child was administered a battery of tests incorporating anthropometric

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measurements, gross motor development test (TGM test), Vineland Adaptive Behavior Scales (VABS) and Psychoeducational Profile (PEP-3) before and after a 12-week CI-MAT program.
The child improved locomotor and object control skills after CI-MAT program. Concerning social behaviors, the higher proportion of gains was observed in the sensitivity of other's presence and eye contact for the contact domain and in the comply turn for the domain relationship. Furthermore, after the CI-MAT program period, the child showed improvements in his social behaviors.
The results of this study showed that CI-MAT program was effective for the development of gross-motor and social skills in a child with ASD. Moreover, there is an urge to carry out a whole psychological assessment targeting both motor and adaptive development suitable to provide educational and vocational plans of exercises for people with ASD.

Keywords: Sport; Swimming; Autism Spectrum Disorders; Aquatic Therapy; Health.

1. Introduction

Physical exercise programs are recognized to play a crucial role to prevent diseases and to enhance physical and psychological well-being (Fragala-Pinkham, Haley, & O'Neil, 2011) and several studies have shown the positive effects of a structured physical activity (P.A.) on physical and mental health in people with (Alesi, Battaglia, Roccella, Testa, Palma, & Pepi, 2014; Battaglia, Agro, Cataldo, Palma, & Alesi, 2019) or without disability during the lifetime (Battaglia, Bellafiore, Bianco, Paoli, & Palma, 2010; Bellafiore, Battaglia, Bianco, Paoli, Farina, & Palma, 2011). Benefits of regular P.A. and sport in people with developmental disabilities have been addressed in several and specific research recently (Fong, Tsang, & Ng, 2012; Alesi *et al.*, 2014). In the past 30 years benefits from these interventions have been widely investigated in individuals with Autism Spectrum Disorders (ASD) because of poor psychomotor skills and behavioral diseases characterizing this population (Pitetti, Rendoff, Grover, & Beets, 2007; Gabriels, Agnew, Beresford, Morrow, Mesibov, & Wamboldt, 2012). Nevertheless, several studies on exercise training programs for subjects with autism have concentrated on cognitive and behavioral outcomes (Bass, Duchowny, & Llabre, 2009; Bahrami, Movahedi, Marandi, & Abedi, 2012). Only few studies have examined the physical outcomes of exercise programs in people with ASD (Yilmaz, Yanarda, Birkan, & Bumin, 2004; Fragala-Pinkham *et al.*, 2011). The literature suggests that exercise training may improve aerobic performance, body mass index (BMI) and muscle strength in children with moderate-to-severe forms of autism (Russell, Kern, Kristen, April, Whitney, & Whitney, 2010; Srinivasan, Pescatello, & Bhat, 2014). Almost all the reported exercise programs for children with ASD have underlined land-based exercise programs. Past studies demonstrate that swimming pool activities should emphasize psychomotor skills and physical expertise in children with ASD. Swimming pool, in particular, has been successful to improve subjects' adaptive behaviors with ASD to environmental stimuli (Bremer, Crozier, & Lloyd, 2016). Moreover, Mortimer and colleagues carried out a systematic review on the beneficial effects of hydrotherapy on social and behavioral aspects in children with ASD (Mortimer, Privopoulos, & Kumar, 2014). They demonstrated that evidence-based programs with structured aquatic activities not only improve motor performances, but also deliver opportunities for social interaction and lead to enable language development as well as self-confidence and mastery motivation to face challenging motor

tasks. On the whole, the beneficial effect of aquatic activities in subjects with ASD appeared to be related to this therapeutic setting. It is known, indeed, that water is characterized by the properties of hydrostatic pressure and buoyancy, which can induce and facilitate improvements in sensory and social behaviors (e.g. maintaining eye contact and paying attention) and motor skills in individuals with ASD (Vonder Hulls, Walker, & Powell, 2006). Aquatic environment, moreover, offers an exciting and motivating place for children and provides physical resistance in order to increase muscle strength and aerobic capacity. Swimming is often a component of an aquatic exercise program and is believed to facilitate language development, self-concept and provide an appropriate setting for early educational interventions in individuals with ASD (Mortimer *et al.*, 2014; Bremer *et al.*, 2016). It is often suggested as an effective physical activity for people with ASD; however, very little studies, up to now, support these suggestions (Pan, 2010).

2. Aims and hypothesis

Recently, Caputo and colleagues (Caputo, Ippolito & Maietta, 2008; Caputo, Ippolito, Mazzotta, Sentenza, Muzio, Salzano *et al.*, 2018) developed the multi-systemic aquatic therapy (CI-MAT which corresponds to Italian Terapia Multisistemica in Acqua - TMA). It was designed to make use of water as an emotional and sensory activator in people with communication, cognitive and behavioral problems. The CI-MAT is a therapy, which uses the natural element (water) in a structured environment (the pool) in agreement with a multi-systemic theoretical model ranging from the cognitive-behavioral approach to the "theory of attachment" (Bowlby, 1969) through the "holding" model (Winnicott, 1973) and emotional attunement (Stern, Hofer, Haft, & Dore, 1987). It staged methodology in interdependence with the behavioral, cognitive, relational and sensory-motor techniques. The purpose of the CI-MAT is to decrease social, emotional, behavioral, relational and psychomotor deficits in people with ASD and promote a special relationship with the trainer and afterwards with the other participants. CI-MAT primarily aimed to:

1. The improvement of body posture and gestures;
2. The cooperation during games;
3. The recognition and representation of the emotive expressions (acknowledgement of anger, joy, shame, fear and happiness);

4. The limitation of problematic behavior (aggressive and self-aggressive);
5. The search and recognition of reference people;
6. The improvement of social mutuality (cooperation in social rules, group recognition);
7. The improvement of the imitative skills;
8. The knowledge of corporal scheme;
9. The improvement of personal autonomy;
10. The enhance of self-esteem;
11. The improvement of verbal and non-verbal communication;
12. The decrease of stereotypical behavior;
13. The stimulation of psychomotor skills.

The standard protocol requires the assessment of cognitive and adaptive functioning as important prognostic indicators for the efficacy of the CI-MAT (Caputo *et al.*, 2018). The purpose of this pilot study was to examine the effects of a CI-MAT program on gross motor and adaptive skills in a child with ASD.

3. Methods

3.1. Participant

The child was enrolled through autism support groups for families and children. He was called to meet the researchers and become familiar with the experimental procedures and the aims of the study. The following inclusion criteria were considered: (I) diagnosis of ASD, (II) availability to attend at least 70-80% of the multi-systemic therapy in water (III) medically able to participate in an aquatic exercise training and (IV) no anticipated medication or other intervention changes during the experimental period. Before starting the study, appropriate local ethics committee approval was obtained from the University of Palermo. A participant's caregiver provided signed informed consent. As shown in Table 1, subject was 4.2 years old and showed developmental age below the average with significant impairments in all the domains of adaptive behaviors. He was from medium socio-economic level, lived in an urban area and was familiarized with swimming conditions in the last year. He had been engaged in structured speech therapy and did not attend any additional exercise training in or out of school during the experimental period.

Table 1 - *Characteristics of subject*

Chronological Age		CA	4.2 yrs
Mental Age		MA	4.3 yrs
Height		h	1.10 m
Weight		W	19.9 kg
Body Mass Index		BMI	16.45
PEP-3	Communication Composite Index	CC	29.3
	Motor Composite index	MC	26
	Maladaptive Behavior	MB	Sev
	Subtest	CVP	38
		EL	25
		RL	25
		FM	31
		GM	20
		VMI	27
		AE	Mod
		SR	Mod
		CMB	Mod
		CVB	Mod
VABS	Composite Scale Index	CS	2.7 yrs
	Subtest	C	3.6 yrs
		DLS	2.6 yrs
		S	2.7 yrs
		MS	2.0 yrs

Legend: Chronological age (CA); Mental age (MA) measured trough C.F.V.; Height (h); Weight (W); Body mass index (BMI); Cognitive Verbal/Preverbal (CVP); Expressive Language (EL); Receptive Language (RL); Fine motor (FM); Gross motor (GM); Visual motor imitation (VMI); Affective expression (AE); Social Reciprocity (SR); Characteristic Motor Behavior (CMB); Characteristic Verbal Behavior (CVB); Communication composite (CC); Motor composite (MC); Maladaptive Behavior (MB); Communication (C); Daily Living Skills, (DLS); Socialization, (S); Motor Skills, (MS); Composite Scale (CS); years (yrs); months (mo.); mod = moderate; ave = average; sev = severe. Notes: Developmental age, percentile ranks and developmental level, measured through PEP-3, Age-Equivalent Scores and Adaptive Functioning Level measured through VABS, on Communication, Daily Skills, Socialization, Motor Skills and Composite Scale.

3.2. Procedure

The research design involved a multi-method approach for the assessment: 1. tests to measure participant's developmental age (at baseline only), anthropometric characteristics and gross motor abilities (at both baseline and post-test); 2. parent ratings of participant's adaptive behavior (at baseline only); 3. Videos/tapes of participant's behavior in swimming pool (at both baseline and post-test). The method of case study was used because of its documented employ to measure the individual response to CI-MAT program (Rosenthal-Malek & Mitchell, 1997). The study was divided

into three phases: baseline (bl), 12-week CI-MAT program and Post-Test (pt). At the Pre-Test phase an assessment was carried out over six sessions of an hour each in order to detect the baseline. The anthropometric/gross-motor, adaptive and cognitive profile of participant was investigated. As for the anthropometric/motor profile, subject was administered a battery of tests incorporating anthropometric measurements and the gross motor development test (Ulrich, 2003).

As for the adaptive and psychoeducational profile, VABS (Vineland Adaptive Behavior Scales, Sparrow, Balla, & Cicchetti, 1984) and PEP-3 (Psychoeducational Profile - Third Edition, Schopler, Lansing, Reichler, & Marcus, 2005) were used in agreement with CI-MAT protocol (Caputo *et al.*, 2018). Moreover, child was videotaped and observed by a psychologist to measure his social behaviors. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from child's parents included in the study.

3.2.1. Assessment of Mental Age

The Correspondences and Functions Evaluation (in Italy MS CFV – Corrispondenze e Funzioni: Valutazione, Vianello, 2003) test was administered to the participant in order to determine their mental age. It consists of 42 items, subdivided into five areas of logical operations: qualitative correspondences, direct quantitative correspondences, indirect quantitative correspondences, direct functions and indirect functions. For each item, evaluation is binary, with a mark of 1 being attributed to each correct item and 0 to incorrect items. The raw data thus obtained were then transformed into a measure of mental age (range 3 - 14 yrs) on the basis of appropriate conversion tables.

3.2.2. Assessment of Adaptive Behavior

The VABS (Sparrow *et al.*, 1984) was administered to participant's mother in order to determine his child adaptive development. It's a semi-structured interview with the primary caregiver to assess adaptive behaviors necessary for everyday independent life from birth to 90 years old. It is composed of 365 items structured in four areas: Communication (receptive, expressive and written language), Daily Living Skills (skills to take care of oneself, household and community skills), Socialization (social relationship,

emotional and behavioral regulation, leisure activities) and Motor Skills (fine and gross motor skills). Raw scores were transformed in Age-Equivalent Scores Adjusted for Age and Level of Adaptive Functioning

3.2.3. Assessment of psychoeducational profile

The PEP-3 (Schopler *et al.*, 2005) was administered to measure the participant's developmental age. The task performance was measured by 10 Performance Subtests: Cognitive Verbal/Preverbal (CVP), Expressive Language (EL), Receptive Language (RL), Fine Motor (FM), Gross Motor (GM), Visual-Motor Imitation (VMI), Affective Expression (AE), Social Reciprocity (SR), Characteristic Motor Behaviors (CMB) and Characteristic Verbal Behaviors (CVB). Moreover 3 composite scores were obtained: Communication score (C) derived by the combination of CVP, EL and RL and RL; Motor score (M) derived by the combination of FM, GM and VMI; Maladaptive Behaviors score (MB) derived by the combination of AE, SR, CMB and CVB. By using tables reported in the Examiner's Manual, raw scores were transformed into developmental ages (months) and percentile ranks.

3.2.4. Assessment of social behaviors

An observation schedule was derived and adapted by Venuti (2001) to provide measures of interaction and contact. In detail, 8 behaviors were observed: 4 behaviors for the interaction such as joint attention, joint play, searching others' presence, comply ones turn and 4 items for contact, such as sensitivity to other's presence, loneliness, eye contact, observation of other's behaviors (Venuti, 2001)

The child was videotaped by a trained operator for 50 minutes during the CI-MAT session delivered by his coach in the pool and for an additional 15 minutes during preliminary actions in locker room.

These videos were independently rated by 2 observers using the above observation schedule with scores ranging from 0 (never) to 4 (always) and measuring the rate of presence of the child's behavior of interest. Higher scores were indicative of socially oriented behaviors except for the loneliness.

3.2.5. Anthropometric measurements

Anthropometric measurements were recorded according to the evaluation procedures as reported in several studies (Bianco, Bellafiore, Battaglia, Paoli, Caramazza, Farina *et al.*, 2010; Battaglia, Paoli, Bellafiore, Bianco, &

Palma, 2014). Body weight was assessed using a Seca electronic scale (maximum weight recordable 300 kg; resolution 100 g) (Seca; Hamburg, Germany) for the subjects wearing only their underwear. Height was measured by a standard stadiometer (maximum height recordable 220 cm; resolution 1 mm) with the barefoot subject and standing upright. Body mass index (BMI) was estimated as bodyweight divided by squared height (kg/m^2).

3.2.6. Assessment of Gross Motor Abilities

The subject was assessed for locomotor ability and object control skills using the TGM Test, a gross motor development test (Ulrich, 2003). This test measures two different aspects of gross motor development, i.e., object control (requiring subjects to catch a ball with a tennis racket, bounce off the ball, catch a ball, kick the ball running, and throw a ball with the hand) and locomotion (requiring subjects to run as fast as possible for 15 meters, gallop for ten meters, hop on one leg for five meters, jump forward, do a long jump, and take little jumps forward and laterally). Performance of child was videotaped with a digital video camera that allowed to analyze movement sequences separately and to assign scores. To obtain a higher validity, according to the handbook, the participant was required to repeat the trial three times and a score of 1 was assigned if the subject performed well twice or 0 if the subject was not able to perform the test at all. The sum of raw scores obtained for each criterion (maximum total score 48) was recorded and used to analysis. The Cronbach's alpha coefficient was .81 and the correlation coefficient for the test-retest was .86

3.2.7. Multi-systemic aquatic therapy (CI-MAT) program

In agreement with Caputo and colleagues (2018), the used CI-MAT program worked in the sense of attenuating the symptoms determining significant changes in communication and social interaction in subject with ASD. In particular, the CI-MAT program includes three phases. The first phase is "Emotional Adaptation", as it is centered on building a functional attachment relationship between the certificated expert and the child with ASD. In this phase, for example, the child moves from and comes back to the expert playing in the water (throwing a ball away and retrieving it, blowing bubbles or straddling on the aquatic noodle). The second phase is called "Swimming Adaptation", because of its principal goal is teaching swimming skills (floating supine and prone unassisted, and gliding from the

side to side of pool with bent leg kick and basic arm movements independently) under the supervision of the certified CI-MAT expert.

The third phase of CI-MAT model is called "Social Integration", because the child participates in small group-swimming (from 4-to-6 children) activities with child's peers with a typical or atypical development in order to facilitate group integration, cooperation and social interaction (noodle kicking, jumping and floating, and hula-hoop swimming). Only after the child showed swimming skills, he could have access to the CI-MAT "Social Integration" phase. In this phase the expert-to-child ratio is one-to three instead of one-to-one as in the previous two CI-MAT phases. Child performed CI-MAT program for 12 weeks from 1 (the first two phases) to 2 (the third phase) times a week and each session lasts 45 min for all the three phases. The program increased the intensity of activities exercises mainly at a moderate-to-vigorous range.

4. Results

Child did not show any relevant differences in body weight, height and BMI (bl: 16.45 vs. pt: 15.66 kg/m^2) after the multi-systemic aquatic therapy program.

Table 2 - *Evaluation of locomotor and object control skills after the aquatic adapted physical activity program*

	Items	Time	
Locomotor skills	1. Run	Baseline	4
		Post-test	4
	2. Gallop	Baseline	0
		Post-test	0
	3. Hop on one leg	Baseline	0
		Post-test	3
	4. Leap	Baseline	0
		Post-test	0
	5. Horizontal jump	Baseline	0
		Post-test	2
	6. Skip	Baseline	0
		Post-test	0
	7. Slip	Baseline	0
		Post-test	3
	Score	Baseline	4
		Post-test	12

Object control skills	8. Catch a ball with a tennis racket	Baseline	0
		Post-test	0
	9. Stationary bounce	Baseline	0
		Post-test	2
	10. Catch	Baseline	0
		Post-test	3
	11. Kick	Baseline	1
		Post-test	3
	12. Overhand Throw	Baseline	1
		Post-test	2
	Score	Baseline	2
		Post-test	10
Total Score		Baseline	6
		Post-test	22

As regards gross motor abilities, based on raw scores, child increased his gross motor abilities from baseline to post-test (Tab. 2). After the CI-MAT program, the child improved *hop on one leg* (3-item), *horizontal jump* (5-item), *slip* (7-item), *stationary bounce* (9-item), *catch* (10-item), *kick* (11-item) *and overhand throw* (12-item) abilities.

As shown in Table 3, concerning social behaviors, the higher proportion of gains was observed in the sensitivity of other's presence and eye contact for the contact domain and in the comply turn for the domain relationship. Furthermore, after the CI-MAT program phase the child showed improvements in his social behaviors. In particular, he improved the frequency of behaviors of sensitivity to other's presence (bl: 2 vs. pt: 3), eye contact (bl: 0 vs. pt: 1), observation of other's behavior (bl: 1 vs. pt: 2), joint play (bl: 2 vs. pt: 3), searching other's presence (bl: 0 vs. pt: 1) and comply one's turn (bl: 1 vs. pt: 2).

Table 3 - *Frequencies of social behaviors targeting contact and interaction before and after the aquatic adapted physical activity program*

	Items	Times	
Contact	1. Sensitivity to other's presence	Baseline	2
		Post-test	3
	2. Loneliness *	Baseline	0
		Post-test	0
	3. Eye contact	Baseline	0
		Post-test	1
	4. Observation of other's behaviors	Baseline	1
		Post-test	2

Interaction	5. Joint attention	Baseline	2
		Post-test	2
	6. Joint play	Baseline	2
		Post-test	3
	7. Searching others' presence	Baseline	0
		Post-test	1
	8. Comply ones turn	Baseline	1
		Post-test	2

Note: 0: never; 1: rarely; 2: sometimes; 3: often; 4: always.
* Only for 2. Loneliness 0: always; 1: often; 2: sometimes; 3: rarely; 4: never

5. Discussion

The results of this study showed that CI-MAT program was effective for the development of object control and locomotor skills in studied subject with ASD. These findings are corroborated by studies showing how exercise in water improves several aspects of gross motor area in subjects with typical and atypical development (Lochbaum & Crews, 2003; Fragala-Pinkham *et al.*, 2011) such as conditional (aerobic capacity, muscle strength, speed) and coordination skills. In particular, researchers reported that exercise training in water might improve aerobic capacity and muscle strength in children with autism syndrome. This is because water offers resistance during the physical activity, which may be used to increase physical fitness in enjoyable way contributing to motor development of subjects with autism. Furthermore, several studies showed that swimming could be used as a major component of an adapted physical activity program in ASD children. Best and Jones (1972) reported that over a period of 15 week swimming the ASD children improved body awareness, confidence and the aquatic orientation. Moreover in CI-MAT program, the water was a social activator, which encouraged the child to look for a first interaction with the CI-MAT therapist (Caputo *et al.*, 2008). Following the training, with regards to social behaviors, the studied subject seem to have enhanced his skills from baseline to post-test. Specifically, he improved both contact and interaction. This result needs to be related to mental age and developmental profile. The child had a low gap between chronological age (4.2 yrs) and mental age (4.3 yrs). Moreover, he showed a developmental profile characterized by moderate level in many areas, such as CVP, EL, RL, FM, VMI, AE, SR, CMB, CVB. On the whole, his development in the composite ability of communication was mild (20.3 months) and this strength could have affected positively his relationship with the

coach/therapist. Moreover, taking together results concerning motor and social skills, we found that child again improved his performance on locomotor and object control skill significantly by 200% and 400% respectively. These results are consistent with the hypothesis that the efficacy of motor programs would be influenced by the level of mental age and, conversely, by the severity of intellectual disability. It is known, indeed, that individuals with higher mental age would improve more than those with a severe level of ID after specific motor trainings. So, the impaired intellectual and adaptive functioning of people with mild ID seems to be connected to their reduced physical performance (Bartlo & Klein, 2011).

Furthermore, we showed that the use of CI-MAT program according to Caputo's guidelines (2018) acted on various functional systems, such as the motivational, cognitive, affective, behavioral, psychomotor ones. The socialization was a key element of CI-MAT program in children with ASD. In particular the program promoted a special connection of the child with the certificated expert and afterwards with the other children through CI-MAT activities based on the eye contact, waiting times, cooperation during games and paying attention. In particular, the CI-MAT therapist evaluated the measures of interaction with the subject, observing his interaction with the environment and with other people (i.e. people's looks) and his posture. The good sensory and social behaviors are very important in subjects with ASD (Montalbano & Roccella, 2009; Parisi, Di Filippo, & Roccella, 2015). The Interagency Autism Coordinating Committee and the National Institute of Mental Health have identified as a high priority the planning of interventions to address social impairment in subjects with ASD. For this reason, the CI-MAT program was performed in public swimming pools in order to promote the socializing of studied subjects with their peer. The use of public structured environments, according to a reference theoretical model and the use of cognitive, behavioral, relational and sensory-motor techniques have realized a positive therapeutic setting during the experimental period. Training session stimulated the subject's participation to CI-MAT as almost the child attended at least 90% of the CI-MAT program.

6. Conclusion

On the whole, the present study brings additional evidence to the effectiveness of beneficial effects of aquatic activities on motor, social and behavioral competences. The strength of this study lies in supporting the

hypothesis that motor and intellectual domains are highly interrelated in individuals with atypical development. Consequently, a whole psychological assessment targeting both motor and adaptive development should be carried out so to provide educational and vocational exercise plans for people with ASD. However, our findings are limited by the breath of age reinforced by the great intra-domain scatter in developmental functioning of participant with ASD. This pilot study, however, provides preliminary information about the hypothesis that motor and intellectual domains are highly interrelated in individual with atypical development. Additional research is needed to examine the effects of the aquatic adapted physical activity with larger sample size and a randomized controlled trial.

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