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PHYSICAL FITNESS AND PHYSICAL SELF-PERCEPTION OF CHILDREN IN RELATION TO BMI: AN OBSERVATIONAL STUDY IN SOUTHERN ITALY

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ABSTRACT. Introduction. Despite international literature has well recognized the rule of physical education in primary school for the promotion of children's educational process and the mediating effects on cognitive, emotional and social development, in many European countries sedentary lifestyles in children have increased involving all age groups and social classes. Moreover, in Italy the prevalence of children's overweight and obesity is linked to increased physical inactivity and reduced opportunities for physical activity expenditure. The present study aims to assess physical fitness and self-perception in children involved in SBAM Project in Apulia (Southern Italy), according to gender and BMI. The assessment involved four physical fitness tests (SLJ, MBT, 10x4 and 6mWT) and a self-report to assess physical self-perception. A 3x2 ANOVA was carried out to assess the main and interaction effect of gender and BMI on considered variables. **Results** showed (a) better motor performances and self-perception in normal weight children compared to overweight and obese peers, (b) male were stronger and faster than female, and (c) physical self-perception didn't change between obese male and female. Methodological interventions aimed at increasing time spent in motor activity and develop physical fitness are needed in primary school to promote health-oriented physical education.

***Keywords**: health promotion; motor development; physical education; children; self-perception.*

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INTRODUCTION

Each experience made by a child through motor activities contributes significantly to the child's educational process. Physical education has a mediating role for motor, cognitive and social development (Bailey, 2006). PA during childhood and adolescence is associated with numerous health benefits for children and adolescents, including the reduction of adiposity, the improvement of cardiovascular efficiency, the reduction of symptoms of depression and anxiety self-perception and improved academic performance (Strong et al., 2005; Eveland-Sayers et al., 2009). Numerous studies confirm that physical activity, in fact, has preventive and protective effects against non-communicable diseases, reduction of adiposity, improvement of cardiovascular efficiency, prevention of metabolic syndrome (Janssen & Le Blanc, 2010; Brambilla et al., 2011).

In many countries, curricular PE, motor activity and sport in childhood fall within the ambit of education policies for correct eating habits and for the fight against overweight and obesity, directing the birth of new organizational and teaching models of the school (Carson & Webstar, 2020; Bailey et al., 2023). Furthermore, reduced opportunities to practice structured daily motor activities and in free time reduce the individual motor repertoire and the preventive and protective effects on systems, organs and apparatuses (Faigenbaum et al., 2018).

Physical fitness is an important indicator of health for children and young people. Indeed: (1) levels of cardiorespiratory efficiency are predominantly associated with abdominal adiposity; (2) cardiorespiratory and muscle efficiency are associated with cardiovascular disease risks; (3) the improvement of muscle efficiency and speed has positive effects on skeletal development; (4) improved cardiorespiratory efficiency has positive effects on depression, anxiety, mood and self-esteem and is also associated with academic achievement (Ortega et al., 2008).

Promotion of children's health through physical education, physical activity and sport is an educational purpose that requires interinstitutional programs. Primary school is an ideal setting for multi-component interventions that contrast sedentary behaviour and promote learning of motor competencies.

According to Garrido-Miguel et al. (2019), in fact, the prevalence of overweight and obesity in European children aged 2 to 13 changed from 20.6% in the period 1999-2006, to 21.3% in the period 2011-2016. The highest prevalence is found in Italy (16.8%) and Malta (14.2%). In childhood, overweight and obesity are public health problems that affect motor development and psychological factors. In Puglia (southern Italy), regardless of gender differences, overweight children are 21.6% and obese people 15.1% (Okkio alla Salute, 2019).

Recently Faigenbaum, Rebullido and McDonald (2018) show that a high percentage of children and adolescents in the world do not reach 60 minutes of daily moderate to intense physical activity (MVPA-Moderate Vigorous Physical Activity), with a consequent reduction in levels of physical efficiency in the developmental age. The motor activity triad in children (Faigenbaum et al., 2018) identifies three distinct but closely related factors: exercise/motor activity deficit disorders, pediatric dynapenia, physical illiteracy. A dangerous circular process is thus generated: subjects with low levels of habitual physical activity will be less inclined to participate in motor activities, even free/unstructured ones, which lead to the achievement of a state of joy and fun; this determines a lower predisposition to motor or sports practice and a progressive reduction of the individual motor repertoire and the consequent levels of individual motor development (Peña et al., 2022).

The increase in overweight and obesity in childhood is a determining factor for the development of physical efficiency. Rauner, Mess and Woll (2013) analyzed the relationship between motor activity levels and overweight and between fitness and overweight, highlighting that obesity is inversely related to physical activity levels and motor performance. Numerous studies also reveal inverse relationships between physical efficiency and overweight and mediating effects in the interrelationship between body mass index (BMI), fitness, physical activity and related psychological factors. Excessive body weight would be the cause or effect of reduced daily physical activity and low levels of fitness. Cattuzzo et al. (2016) confirmed that: motor skill levels are inversely proportional to body weight (27 out of 33 studies), there is a positive association between motor skills and good cardiorespiratory efficiency (12 out of 12 studies) and between motor skills and muscle function -skeletal (7 out of 11 studies).

Fundamental motor skills, in fact, play a key role in the physical literacy curricular project, being functional to motor competencies (Edwards et al., 2017); the development of children's physical efficiency is an essential educational objective of educational interventions, as it solicits positive associations with the self-perception of personal motor skills and abilities (Barnett et al., 2018).

Positive motor experiences contribute to structuring of a positive self-image and to the development of self-perception of one's motor skills, a prerequisite for self-perception and beliefs of physical self-efficacy in different age groups (Feltz & Magyar, 2007; Stodden et al., 2008).

Perceived self-efficacy is linked to the perception of the body self and to the factors that constitute motor competence (Babic et al., 2014; Bardid et al., 2016) concerning the ability to mobilize one's own cognitive, motor, social resources to carry out a wide repertoire of motor skills, in different contexts and in every daily activity (Robinson et al., 2015).

The physical self-perception arises from the global self-perception, which is a hierarchical organization of personal beliefs of action to be performed, with different levels of concreteness and complexity; these beliefs profoundly influence learning and human and social development in different ages (Estevan & Barnett, 2018).

The construct of self-perception has been used in studies according to two meanings: self-efficacy referred to the perceived ability to perform a particular task; self-efficacy refers to the perceived ability to control, prevent or manage potential difficulties that could arise from the performance of a task (Bardid et al., 2016).

Self-perception derives from the experience lived in different contexts and from the way in which these experiences are lived by the individual (Kantzas & Venetsanou, 2020; Estevan & Barnett, 2018). Positive motor experiences in which children successfully experiment with a wide repertoire of activities and executive variants of motor tasks, enrich the individual body experience, i.e., the experiences concretely carried out through the body and movement.

Physical perception of oneself is linked to self-perception and to factors that constitute motor competence (Bardid et al., 2016) concerning ability to mobilize one's cognitive, motor, social resources to perform a wide repertoire of motor skills, in different contexts and in daily activity (Cairney et al., 2019; Robinson et al., 2015).

Recent studies (Khodaverdi et al., 2015; Dapp et al., 2019) highlight how self-perception arises from quality of teaching proposals and is a mediating factor capable of conditioning, accelerating or inhibiting the relationships between cognitive functions, motor, emotional and social and for continuation of motor activity in childhood.

In the light of these evidence, the present study aims to assess differences in physical fitness (strength and speed) and self-perception according to gender and BMI.

OBJECTIVES

In the light of these evidence, the present study aims to assess differences in physical fitness (strength and speed) and self-perception according to gender and BMI in a sample of primary schoolchildren. The attention of researchers has been particularly focused on the evolution (or involution) of physical fitness parameters in normal weight, overweight and obese children.

MATERIAL & METHODS

Participants

The sample involved 900 children (Male, age: 9.23±0.43; Female, age: 9.12±0.36) attending primary schools in Puglia (Italy) recruited by schools that joined the SBAM Project in Apulia (Southern Italy). The project provides four areas of intervention (physical education, active transport, correct eating habits) to promote health and prevent sedentary behavior in 4^{th} and 5^{th} grade primary school children. Sample recruitment was performed via a simple randomization procedure.

Measures

The sample was divided according to gender differences and into three groups according to BMI differences: normal weight (Nw), overweight (Ow) and obese (Ob) (Cole et al., 2000). Data concerning motor development and psychological factors related to motor experience (self-perception) were evaluated and compared. The following motor tests were proposed to all children (Council of Europe-Committee for the Development of Sport, 1988; Cooper Institute, 2004; Ruiz et al., 2011): standing long jump (SLJ) and 1 kg medicine ball throw (MBT 1Kg) to assess strength ability, 10 × 4 shuttle run (10x4), and 6 min walking test (6 min WT) to assess endurance.

Perceived self-efficacy was assessed through the PSP_C self-report (Children's Self-Efficacy Scale), (Colella et al., 2008). The questionnaire is made up of six items referring to the factors of strength, speed and motor coordination which provide a scale of values for the answers from 1 to 4 points. Children are asked to express a self-perception score, corresponding to when they play, participate in physical education or when they are involved in sports.

Data analysis

In addition to descriptive statistics (mean ± standard deviation) for all variables, a 2x3 Factorial ANOVA was performed to assess the main effect and possible interaction effect of gender (male and female) and BMI Cutoff (normal weight, overweight and obese) on physical fitness and self-perception. Post hoc analysis was also carried out using Tuckey HSD test to highlight significant differences according to gender and groups. All statistical analysis were conducted setting the significant index (p) < .05. "SPSS-Statistical Package for the Social Sciences" Software (IBM Corp. Released 2019, vers.26) was used to perform statistical analysis.

RESULTS

After collecting anthropometric data (**Table 1**), the sample was divided according to BMI Cutoff (Cole et al., 2000) in three subgroups: Normal weight (Male: 16.80±1.42; Female: 16.45±1.53), Overweight (Male: 21.01±1.22; Female: 20.72±1.25), and Obese children (Male: 25.59±2.28; Female: 25.49±2.91).

Table 1. Sample's Descriptive Profile
Anthropometric Characteristics

Gender	N	Group	Age	Height	Weight	BMI
Female	150	Nw	9.05 ± 0.27	1.36 ± 0.07	30.69 ± 4.48	16.45 ± 1.53
Female	150	Ow	9.21 ± 0.49	1.39 ± 0.06	39.88 ± 4.77	20.72 ± 1.25
Female	150	Ob	9.09 ± 0.31	1.41 ± 0.06	50.48 ± 7.49	25.49 ± 2.91
Male	150	Nw	9.14 ± 0.35	1.38 ± 0.06	31.94 ± 4.09	16.80 ± 1.42
Male	150	Ow	9.27 ± 0.46	1.40 ± 0.06	41.29 ± 5.29	21.01 ± 1.22
Male	150	Ob	9.29 ± 0.47	1.41 ± 0.07	50.90 ± 6.92	25.59 ± 2.28
Total	900	Overall	9.18 ± 0.39	1.39 ± 0.06	40.86 ± 5.51	21.01 ± 1.77

Sample's descriptive profile (mean ± standard deviation) has been reported in **Table 1** according to gender and BMI groups for age, weight, height, and BMI, while data obtained from physical fitness test and self-perception have been reported in **Table 2**.

Table 2. Results of Motor Assessment

Gender	N	Group	SLJ	10x4	MBT 1kg	6mWT	PSP
Female	150	Nw	1.26 ± 0.17	13.36 ± 1.36	4.25 ± 0.81	757.83 ± 124.72	18,97 ± 2.20
Female	150	Ow	1.11 ± 0.22	14.10 ± 1.79	4.39 ± 0.95	631.54 ± 91.63	18,13 ± 3.43
Female	150	Ob	1.00 ± 0.23	14.66 ± 2.43	4.33 ± 1.11	584.43 ± 122.29	17,57 ± 3.02
Male	150	Nw	1.49 ± 0.17	12.50 ± 0.89	5.19 ± 0.97	755.71 ± 132.23	20,35 ± 2.10
Male	150	Ow	1.24 ± 0.21	13.63 ± 1.47	5.33 ± 1.06	682.71 ± 94.72	19,50 ± 2.92
Male	150	Ob	1.09 ± 0.22	14.49 ± 2.52	5.13 ± 1.18	601.45 ± 105.52	17,94 ± 4.42

Table 3 showed the effect of gender, BMI Cutoff and interaction Gender*BMI Cutoff reporting F value and partial eta squared value (ηp^2). Results showed that F value for gender and BMI Cutoff groups were all significant with a significant index *p* less than 0.05 (excepted for MBT), while the interaction effect was significant only for SLJ (F= 10.472, *p* = .000), 10x4 (F= 3.153, *p* =.043) and 6mWT (F= 4.288, p = .014). Therefore, post hoc analyses were performed to analyze significant main effects of gender and BMI Cutoff.

Table 3. Main and Interaction Effect Between Subjects

	Gender			BMI Cutoff			Gender*BMI Cutoff		
	F	***p***	**ηp^2**	**F**	***p***	**ηp^2**	**F**	***p***	**ηp^2**
SLJ	126.652	.000	.124	200.592	.000	.310	10.472	.000	.023
MBT	166.557	.000	.157	.910	.403	.002	.147	.863	.000
10x4	16.633	.000	.018	71.707	.000	.138	3.153	.043	.007
6mWT	8.557	.004	.009	160.353	.000	.264	4.288	.014	.010
PSP	24.995	.000	.027	28.139	.000	.059	2.613	.074	.006

Post-hoc analysis has been reported in **Table 4** and **5** according to BMI Cutoff and Gender, respectively. The results (**Table 4**) showed, in both male and female, significant better performance of Normal weight group for SLJ, 10x4 and 6mWT compared to overweight and obese peers. Moreover, physical self-perception differed significantly in favors of normal weight group in female, while obese male showed lower levels of physical self-perception compared to normal weight (p = .000), and overweight peers (p = .000).

Table 4. Tuckey HSD Post Hoc Test according to BMI Cutoff

			Female				Male			
Measure	**Cutoff**		**Mean diff.**	**p**	**LLCI**	**ULCI**	**Mean diff.**	**p**	**LLCI**	**ULCI**
SLJ										
	Nw	*Ow*	.15	.000	.09	.20	.26	.000	.20	.31
		Ob	.25	.000	.19	.30	.39	.000	.34	.45
	Ow	*Nw*	-.15	.000	-.20	-.09	-.26	.000	-.31	-.20
		Ob	.10	.000	.04	.15	.13	.000	.08	.19
	Ob	*Nw*	-.25	.000	-.30	-.19	-.39	.000	-.45	-.34
		Ow	-.10	.000	-.15	-.04	-.13	.000	-.19	-.08
MBT										
	Nw	*Ow*	-.12	.512	-.37	.13	-.04	.944	-.33	.25
		Ob	-.01	.995	-.26	.24	.06	.862	-.22	.35
	Ow	*Nw*	.12	.512	-.13	.37	.04	.944	-.25	.33
		Ob	.11	.572	-.14	.36	.10	.677	-.18	.39
	Ob	*Nw*	.01	.995	-.24	.26	-.06	.862	-.35	.22
		Ow	-.11	.572	-.36	.14	-.10	.677	-.39	.18
10X4										
	Nw	*Ow*	-.79	.001	-1.30	-.28	-1.18	.000	-1.64	-.71
		Ob	-1.37	.000	-1.88	-.86	-2.10	.000	-2.57	-1.64
	Ow	*Nw*	.79	.001	.28	1.30	1.18	.000	.71	1.64
		Ob	-.58	.020	-1.09	-.07	-.92	.000	-1.39	-.46
	Ob	*Nw*	1.37	.000	.86	1.88	2.10	.000	1.64	2.57
		Ow	.58	.020	.07	1.09	.92	.000	.46	1.39

6mWT										
	Nw	*Ow*	126.29	.000	95.37	157.22	72.99	.000	42.60	103.39
		Ob	173.40	.000	142.48	204.32	154.26	.000	123.86	184.66
	Ow	*Nw*	-126.29	.000	-157.22	-95.37	-72.99	.000	-103.39	-42.60
		Ob	47.11	.001	16.18	78.03	81.27	.000	50.87	111.66
	Ob	*Nw*	-173.40	.000	-204.32	-142.48	-154.26	.000	-184.66	-123.86
		Ow	-47.11	.001	-78.03	-16.18	-81.27	.000	-111.66	-50.87
PSP										
	Nw	*Ow*	.85	.034	.05	1.64	.85	.067	-.05	1.74
		Ob	1.40	.000	.60	2.20	2.41	.000	1.51	3.30
	Ow	*Nw*	-.85	.034	-1.64	-.05	-.85	.067	-1.74	.05
		Ob	.55	.232	-.24	1.35	1.56	.000	.67	2.45
	Ob	*Nw*	-1.40	.000	-2.20	-.60	-2.41	.000	-3.30	-1.51
		Ow	-.55	.232	-1.35	.24	-1.56	.000	-2.45	-.67

The results of Tuckey's HSD Post Hoc test have been reported in Table 5. As regards the normal weigh and overweight groups, male showed better motor performances than female in all physical fitness test and physical self-perception, except for 6mWT in normal weight sample. However, these differences are less evident in obese children. In fact, male showed higher strength level than female in SLJ and MBT ($p < 0.01$).

Table 5. Tuckey HSD Post Hoc Test according to Gender

		Normal Weight			**Overweight**			**Obese**		
		Mean	**SD**	***p***	**Mean**	**SD**	***p***	**Mean**	**SD**	***p***
SLJ										
	Female	1.25	.17	.000	1.10	.21	.000	1.00	.22	.000
	Male	1.49	.16		1.23	.20		1.09	.21	
MBT										
	Female	4.24	.80	.000	4.37	.93	.000	4.26	1.07	.000
	Male	5.17	.97		5.21	1.12		5.11	1.14	
10x4										
	Female	13.36	1.36	.000	14.15	1.78	.013	14.74	2.33	.643
	Male	12.50	.87		13.68	1.47		14.61	2.39	
6mWT										
	Female	757.83	124.72	.886	631.54	91.62	.000	584.43	122.29	.198
	Male	755.71	132.23		682.71	94.71		601.45	105.52	
SEE										
	Female	18.97	2.20	.000	18.13	3.42	.000	17.57	3.02	.402
	Male	20.35	2.10		19.50	2.91		17.94	4.41	

DISCUSSION

The present study is in continuity with previous studies (Deforche et al., 2003; D'Hondt et al., 2009; Yuksel et al., 2020) which evaluated different factors of motor development and PA of children in relation to BMI. Obese children had lower motor performance in all tests requiring horizontal or vertical movements of body mass (stand long jump, sit-up, shuttle run) than their normal weight peers; conversely, obese children showed greater strength performance. Also, in the study conducted by Carvalho Dumith et al. (2010) on a sample of 519 students (from 7 to 15 years), males perform better than females in all tests (sit-and-reach, stand long jump, pull-up, medicine ball throw, 20m speed).

Higher values of body mass index, therefore, were associated with decreased levels of physical efficiency, regardless of age. The results of the study by Joshi et al. (2012) on a sample of 7230 students (aged between 5 and 17 years), confirm previous studies regarding motor performance and levels of physical activity in relation to BMI. In general, participants of normal weight have the highest *Health Fitness Zone* (HFZ) levels, followed by overweight and obese subjects.

Utesch et al. (2018) examined children's physical self-perception as a predictor of their future physical activity. The analysis revealed that children with high self-perception show greater future physical activity, and the effect is greater for underweight and overweight/obese children than for children of normal weight. Controlled instructional interventions on motor activity are associated with increased self-perception and self-confidence in children and adolescents. Compared to other contexts and environments, intervention at school and in the gym is strongly associated with an increase in self-perception (Liu, Wu & Ming, 2015). In fact, Fu et al. (2019) studied the relationships between physical activity, sedentary behavior, and motivation during a 12-week classroom active video game program, highlighting a significant negative trend regarding sedentary behavior, a significant increase in physical activity levels, number of steps and enjoyment.

A breakthrough is underway. Motor activities in primary schools, through different curricular organizational methods and aimed at implementation and development of educational interventions aimed at prevention of the main pathologies, are among the priority public health measures (Ainsworth & Macera, 2018).

To implement the purposes of motor activities, measures are urgently needed that proceed in the following directions:

a) training and higher university education of teachers;

b) implementation of an integrated territorial training system, aimed at implementing methodological synergies between various socio-educational partners;

c) dissemination of results of good teaching practices, aimed at civil society;

d) multi-year projects and in educational continuity (order of schools that precedes-follows).

An inescapable condition is evidence-based teaching at school and in other contexts. The results of programs and institutional actions, oriented towards health promotion, are visible only in the medium or long term and their evaluation is difficult and complex.

CONCLUSIONS

Therefore, PE assumes a central role, allowing both learning of motor alphabet (individual repertoire of motor skills), and the reciprocal relationships and the integration of main learning of other disciplines (for example mathematics, geography, English, history, science, etc.), generating and structuring strong links between the different curricular fields and generating continuity and significance between learning.

From the study carried out, methodological indications emerge which are necessary for quality of didactic intervention. The data show that overweight and obesity negatively influence motor learning process, the execution of executive variants of motor task, necessary for coordination and conditional development and have an impact on the perceived self-efficacy. Furthermore, they are limiting factors for success in activities that require horizontal and vertical movement of body; these tasks are often associated with the perception of fatigue which leads to the avoidance or renunciation of any motor activity. It is therefore necessary to adapt the activities to motor abilities of children with a high BMI, in the parameters of executive difficulty, duration and intensity, to help increase the quantitative and qualitative levels of PA, promoting success and motivation to continue.

It is necessary to intervene on two levels, didactic and organizational, different and complementary.

The proposal of motor tasks, modulating and adapting the executive variants (spatial, temporal, quantitative and qualitative and reciprocal relationships), is essential to allow overweight and obese children to participate in activities successfully. Furthermore, proposing motor activities through production styles (Mosston & Ashworth, 2008), in particular guided discovery and problem solving and through reproduction styles, inclusion, practice and self-check, are crucial in order to adapt load parameters to needs of each child, promote self-perception (task performed successfully; Was I good? How can I do to improve?) and enjoyment (emotional impact; When do we play again?) through autonomous and mediated discovery by teacher, of executive variants of motor task. The variation of teaching styles and the modulation of duration, intensity and executive difficulty are essential to encourage the personalization of motor activity, personal success and the continuation of motor and sports experiences outside of school.

CONFLICTS OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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