



Motor Development in Children: The Triennial SBAM Regional Italian Program

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ABSTRACT

Objective: The aim of this study was to present the results of the triennial SBAM regional program aimed at monitoring 8- year old children in the Apulian region of Southern Italy from 2013 to 2016.

Materials and methods: The program included 17,102 children in the first year, 16,104 children in the second year and 14,847 children in the third year. SBAM was a multi-component program and included different integrated action plans: physical education, active transport (pedibus), and methods for developing healthy eating habits. For each year, four motor tests (long jump standing, shuttle run, 6 min walk test, and medicine ball throw), a motor coordination test and two self-reports for evaluating self-efficacy and enjoyment were proposed to all children.

Results: The results showed gender and group differences (normal-weight vs. overweight-obese) in both motor tests and self-reports ($p < 0.05$). The annual results of the motor tests were sorted in deciles in order to have a regional observation and monitoring database concerning the motor development skills among children and preadolescents.

Conclusion: Boys showed motor performance, perceived self-efficacy scores and enjoyment higher than females in three years. Growth influences the development of motor abilities; overweight and obese males and females showed a different development of motor performance that was lower than in children with a BMI in the norm. It is necessary to develop physical education in primary school, increasing opportunities and adapting them to the needs of all children. SBAM project highlighted the need to promote interdisciplinary and inter-institutional actions to promote child health and acquire physically active lifestyles.

Key words: Health promotion, motor development, physical self-efficacy, physical education, primary school.

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INTRODUCTION

Teaching physical education in primary school is a disciplinary area in which the motor skills learning and the interdisciplinary and transversal objectives related to correct eating habits and healthy lifestyles flow together. Numerous studies and good practices show the effects of motor activities for the prevention of various diseases in the developmental age (obesity, diabetes, heart disease) and the promotion of correct lifestyles, through multi-component and inter-institutional interventions at school,

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sport centres and local organizations (1). Physical education in primary school is the first structured setting for developing semantic and logical connections with other disciplines and learnings. Motor and physical activities can contribute significantly to the educational process of the person. Motor experience can provide quanti-qualitative opportunities to be physically active, in which the students are fully involved not only on the physical-motor level but also cognitive, emotional and social one (2,3). Recent studies conducted in the school setting, have investigated the relationships between specific organizational modalities of motor activities and cognitive development, with a special emphasis on cognitive functions (4), the relation among different types of motor and sport activities (such as dance, sports games, outdoor education), academic performance, the increase in levels of daily physical activity (according to quantity-duration, intensity, difficulty) and the learning of motor skills (5,6,7).

Sedentary habits during developmental age depend on various socio-cultural factors, responsible for the low levels of physical activity and the increase of overweight and obesity (8). The recommendation of the Council of European Union warns that the benefits of physical activity in the early age concern the decreased risk of cardiovascular diseases, some types of cancer, diabetes, the improvement of musculoskeletal efficiency and the control of body weight, as well as the benefits on cognitive processes (The Council of the European Union, Recommendations Council of 26 November 2013). The European Council Document (9) specifies that physical education at school is an unavoidable opportunity to raise HEPA awareness (health-enhancing physical activity) and implement prevention programs and health promotion.

The SBAM Program! took place in Puglia, in the South of Italy, from 2013 to 2016. SBAM! is a three-year, inter-institutional and multi-component program, composed of different and complementary measures, based on curricular physical education, correct eating habits and

active transport through *pedibus*. The program was structured to implement measures to reduce sedentary habits and prevent childhood overweight and obesity. The implementation of SBAM! was an important challenge for the teaching organization of the participating schools. Principals and teachers requested to integrate the presence of experts outside the school, even if in different periods and operating phases. The intervention components include teachers training and parent engagement. The program proposed to induce changes in children's behavior, promoting in the "school" setting, correct food choices and active lifestyle.

Main purposes: promoting correct eating habits and children's awareness of food choice and consumption; motor skills learning during curricular physical education lessons; developing active transport through *pedibus*; promoting recreative sport and socialization through fair play; promoting active lifestyles to reduce sedentary habits and support physical activity during leisure time; preparing safe routes for the home-school journey (10).

Motor development during the developmental age depends on and is influenced by the growth and organic maturation of the child and the interaction with the environment in which he grew up (11). The opportunities and environmental conditions interact with the biological substrates of growth and maturation and determine the child motor skills' repertoire. Motor development is a continuously changing process that involves various factors: 1) neuromuscular maturation; 2) physical growth and child's behavioral characteristics; 3) time of physical growth, biological maturation and behavioral development; 4) the effects of previous motor experiences; 5) new motor experiences (11). Several studies have showed inverse relationships between physical efficiency and overweight. Rauner et al (12) analyzing the relationship between physical activity, fitness and overweight/obesity, highlight that obesity was inversely related to physical activity. Mediation effects in the relationship between BMI, fitness and physical activity have been detected. Excessive body

weight would be the cause or effect of low levels of physical activity and low levels of fitness. According to Cattuzzo et al (13) the learning and development of motor skills can increase physical fitness levels, directly and indirectly, and promote long-term health in children and adolescents.

Objective

The aim of this study was to evaluate and compare motor abilities (strength, resistance, motor coordination) and the factors of perceived self-efficacy and enjoyment, according to gender and group differences (body mass index).

Participants and Setting

Sbam! (*Health Wellness Food Movement at school*) was a multi-component regional project aimed at primary schools in Apulia Region, in the south of Italy. The project has been promoted and financed by the Regional Administration and had provided for the collaboration of the University of Foggia, the CONI (Puglia regional committee) and local health authorities.

The three-year didactic interventions involved a sample of children from the third to the fifth class. The program included at launch 17,102 children in the first year, 16,104 children in the

second year and 14,847 children in the third year. The sample who completed the monitoring was less than the number of children recruited for organizational and didactic reasons (N=15231, N= 14147 and N=13362).

The schools (N = 207) responded to an invitation from the Regional Administration and involved all their the third year classes.

MATERIALS AND METHODS

The anthropometric data (height and weight) and those relating to motor development and psychological factors (physical self-efficacy and enjoyment) were carried out. The sample that carried out the tests of the monitoring was less than the number of children recruited for organizational and didactic reasons (Table 1). According to Cole et al., (2000) participants were divided by gender and group differences: normal-weight (Nw), overweight (Ow) and obese (Ob) children, (14). The following motor tests were assessed (15): long jump standing (SLJ) and medicine ball throw (MBT) to evaluate strength of the lower and upper limbs, shuttle run 10x4 (10x4) and 6 min walk test (6min WT) to evaluate resistance, while fundamental movement skills (rolling, running, jumping, throwing, grasping) were evaluated through the coordination tasks.

Table 1. Sample description

Gender	Sample		
	1°year (age 8±0)	2°year (age 9±0)	3°year (age 10±0)
Male (N=)	7901	7317	6427
Female (N=)	7330	6830	6935
Total	15231	14147	13362

The deciles were used for each test. In this way the distribution was divided for ten instead of 100 The minimum value is that value which has above 100% of the observed cases; the first decile is that value which has below 10% of the analyzed subjects and 90% above; the second decile is the value that has below 20% of the

observed subjects and above 80%, and so on. The tenth decile corresponds to the maximum and has 100% of the cases below.

Two self-reports were also utilized: the PSP_C (16) and the PACES (17) to measure enjoyment.

Enjoyment of PA was assessed using the Physical Activity Enjoyment Scale (PACES), (17).

The 16-item scale is scored on a 5-point Likert scales, with responses ranging from 1 (Disagree a lot) to 5 (Agree a lot). A high score on the positive scale (PACES_P) and a low score on the negative (PACES_N) indicate a high pleasure in physical activity. A total score can also be calculated, reversing the scores of the negative items and adding them to the positive ones, with this procedure the total score of the PACES can vary between 16 and 80 points.

The PSP_C (Physical Self Efficacy Scale for Children) utilizes six items representing strength, speed, and coordinative abilities. The items are structured in response scales having a 1- to 4-point format. Children are required to

think of themselves when playing, performing physical education exercises, or when involved in sporting activities. For each item, participants are asked to choose one of the four sentences best representing their personal feelings. Therefore, the total test score can range from 1 to 24. High scores would indicate a high self-perception of physical ability, whereas low scores would reflect a low self- perception.

Each group-class took between 20 and 30 hours of physical education with a specialist teacher (Expert) who supported the generalist teacher. The motor assessment protocol was proposed two months after the project started (April 2013).

Table 2. Motor test measures divided by BMI, cutoff and years

BMI cut off		1st year - 2013/2014									
		SLJ		MBT		10x4		6wt		Motor coordination (s)	
		M	SD	M	SD	M	SD	M	SD	M	SD
Nw		1,16	0,2	3,6	0,92	14,5	2,1	566,32	154,56	25,59	6,51
			4	3		3	4				
Ow		1,09	0,2	3,8	0,93	14,8	2,1	554,67	147,88	26,12	6,03
			2	3		4	9				
Ob		1,02	0,2	4,0	1,21	15,3	2,1	546,48	149,46	27,01	6,24
			2	1		1	4				
BMI cut off		2nd year - 2014/2015									
		SLJ		MBT		10x4		6wt		Motor coordination (s)	
		M	SD	M	SD	M	SD	M	SD	M	SD
Nw		1,25	0,2	4,2	1,10	13,5	2,0	635,22	156,48	23,39	5,54
			5	7		5	1				
Ow		1,17	0,2	4,6	1,13	14,0	2,2	627,07	118,27	24,32	5,35
			4	5		4	2				
Ob		1,08	0,2	4,8	1,19	14,7	2,4	604,38	120,37	25,44	7,30
			3	3		1	8				
BMI cut off		3rd year - 2015/2016									
		SLJ		MBT		10x4		6wt		Motor coordination (s)	
		M	SD	M	SD	M	SD	M	SD	M	SD
Nw		1,30	0,3	5,0	1,27	13,2	1,6	657,98	141,03	21,25	4,27
			4	2		3	8				
Ow		1,21	0,3	5,2	1,29	13,6	1,7	664,66	128,67	22,05	4,32
			3	6		3	4				
Ob		1,12	0,2	5,3	1,36	14,2	2,1	643,03	125,92	23,49	5,01
			8	2		6	4				

Note: Nw refers to normal weight, Ow to overweight and Ob to obese children. SLJ stands for Standing Long Jump, MBT for Medicine Ball Throw, 10x4 for Shuttle Run Test, 6wt for 6 Minutes Walking Test.

RESULTS

In addition to the descriptive statistics ($M \pm SD$), analysis of the variance ANOVA 3 (group, normal-weight vs overweight vs obese) x 2 (gender) was performed, to highlight significant differences in relation to the dependent variables considered. The significance index was set at $p < 0.05$. In relation to BMI and gender difference. Results showed significant values (Table 2) for motor tests (long jump standing, shuttle run, 6 min walk test and medicine ball throw) and the coordination tasks ($p < 0.05$).

However, the following results can be highlighted: a. BMI values have not improved over the three-year period, regardless of gender and age differences; b. the motor performances of males and females, in conditions of overweight and obesity, are always lower than the group of both sexes normal-weight; c. females have lower motor performance than males; d. BMI influences psychological factors (perceived self-efficacy and enjoyment); e. the results of the motor test highlight an evolution of the performances during the three-years period (Tables 3 & 4).

Table 3. 2015/2016 years measures distribution- female

Deciles	Deciles - Female				
	SLJ	MBT	10x4 (s)	wt6 (m)	Motor coordination (s)
MIN	0,30	1,00	0,65	0,00	10,30
1 decile	0,94	3,50	12,00	510,00	17,61
2 decile	1,00	3,91	12,60	572,00	19,00
3 decile	1,00	4,00	13,00	600,00	20,00
4 decile	1,05	4,20	13,30	632,00	21,00
5 decile	1,20	4,68	13,60	659,00	21,87
6 decile	1,25	5,00	14,00	685,00	22,70
7 decile	1,30	5,34	14,30	710,00	23,82
8 decile	1,39	5,80	14,84	750,00	25,20
9 decile	1,50	6,30	15,60	805,00	27,25
MAX	1,70	6,50	52,40	1440,00	83,00

Table 4. 2015/2016 years measures distribution- male

Deciles	Deciles - Male				
	SLJ	MBT	10x4 (s)	wt6 (m)	Motor coordination (s)
MIN	0,20	0,00	1,00	0,00	0,90
1 decile	1,00	3,98	11,50	512,00	16,70
2 decile	1,00	4,01	12,00	580,00	18,00
3 decile	1,20	4,70	12,40	619,00	19,00
4 decile	1,25	5,05	12,70	650,00	19,80
5 decile	1,30	5,42	13,00	680,00	20,76
6 decile	1,38	5,80	13,40	702,00	21,60
7 decile	1,44	6,06	13,80	735,00	22,60
8 decile	1,51	6,50	14,20	780,00	24,00
9 decile	1,63	7,12	15,10	840,90	26,30
Max	1,83	7,30	56,70	1565,00	83,60

Table 5. *Self-efficacy and Enjoyment, (Paces_p e Paces_n) for BMI cut off and year*

BMI cut off	1st year - 2013/2014					
	PSP_C		Paces_P		Paces_N	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Nw	17,33	2,91	37,54	5,19	12,11	4,33
Ow	17,24	2,81	37,57	5,15	12,39	4,41
Ob	16,80	2,82	37,26	5,2	12,79	4,32
BMI cut off	2nd year - 2014/2015					
	PSP_C		Paces_P		Paces_N	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Nw	19,26	3,28	39,94	6,43	9,06	3,73
Ow	18,97	3,36	39,83	6,78	9,08	3,69
Ob	18,35	3,18	39,53	6,67	9,18	3,84
BMI cut off	3rd year - 2015/2016					
	PSP_C		Paces_P		Paces_N	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Nw	18,81	3,63	38,37	7,79	8,86	3,84
Ow	18,42	3,39	38,38	7,40	8,97	3,72
Ob	17,73	3,55	38,07	8,10	9,18	4,15

The results of the PSP_C (physical self-efficacy) questionnaire showed differences according to the school year factor: the results of the second year were better than those of the first but lower than those of the third. Likewise, data relating to the PACES self-report (enjoyment) evidence significant differences in the three school years (Table 5): the values of the negative scale indicate a gradual reduction in the three-year period. Males in normal weight always showed higher scores ($p < 0.05$) both in perceived self-efficacy and in positive emotions (Positive scale of the PACES questionnaire).

CONCLUSION

The monitoring of the SBAM program has confirmed previous studies highlighting that obese and overweight children have lower motor performance than normal-weight peers, especially in motor tasks required the horizontal and vertical displacement of the body (18,19). Furthermore, perceived self-efficacy and enjoyment are related to motor development and the motor experience opportunity at school.

Lopes (20), proposed a model of negative correlations between BMI and gross motor

coordination level considering the different ages; D'Hondt et al. (21) studied the longitudinal evolution of gross motor coordination (in two years) highlighting a strong relation with BMI. As stated by previous studies, Cattuzzo et al. (13) in a review shows that the levels of mastery of motor skills are inversely proportional to body weight (27 studies out of 33). The perceived self-efficacy and enjoyment are related to motor development and BMI, as factors of mediation to promote motor activities even after school hours (22). These factors determine the times and methods of learning motor skills and are conditioned by the choice of teaching styles. A recent study (23) has shown that children with higher levels of motor competence and self-perception show greater physical activity. Children who perceive their motor skills more accurately show higher levels of physical activity at different ages.

The study indicates that an accurate self-perception of motor competence can promote future physical activity. Therefore, the promotion of effective motor skills should be linked to the related development of perceived self-efficacy. Physical education at school offers all children various fun opportunities to

increase daily and weekly physical activity levels, regular opportunities for motor learning and development, and social interactions. Some research priorities emerge: to develop effective and sustainable interventions to increase the physical activity of children in the medium to long term; implement policies aimed at determining environmental changes to influence children's habits; implement longitudinal and transversal studies on motor activities performed by children and sedentary habits.

Physical activity, physical education and sport are areas of intervention that guide measures to promote public health; it is essential to analyze data related to the evolution and changes in motor skills and abilities and related factors.

Future development of the study

The monitoring results stimulate systematic and multi-component teaching interventions, curricular and extra-curricular, in collaboration with the family and other educational agencies of the territory.

The monitoring of motor abilities and related factors is a modality of study of the training process carried out and, through data analysis, a modality of implementation of the regional observatory on motor development of the child. The results are a first data bank for the realization of the regional observatory that will allow, subsequently, to study and compare the processes and the results of the interventions carried out on the territory. The data will be systematically analyzed and further enriched to become quality indicators of subsequent programs and actions.

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