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Proposal for an enhanced physical education program in the primary school: evaluation of feasibility and effectiveness in improving physical skills and fitness

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Abstract

Background: A large proportion of children do not reach the recommended levels of physical activity for health. A quasi-experimental study with non-random assignment was performed to evaluate the effectiveness and feasibility of a school-based physical education intervention aimed at increasing the levels of moderate-to-vigorous physical activity (MVPA). **Methods:** Ten classes from four primary schools, including 241 children aged 8-10 years, were recruited. The experimental group (n=97) received 4 additional sessions/week of 60 minutes of MVPA for 8 months. The control group (n=135) continued their standard program (2 sessions of 50 minutes/week). Motor abilities (standing long jump, handgrip strength, Harre circuit, Sit&Reach), physical fitness (Yo-Yo Intermittent Recovery Level-1), anthropometric measures (BMI, Waist to Height Ratio) and self-efficacy (Perceived Physical Ability Scale for Children) were evaluated at baseline and after the intervention. **Results:** The experimental group significantly improved in the Harre circuit both in males ($p<0.001$) and females ($p<0.01$), while physical fitness test improved only in males ($p<0.001$). Males in the experimental group improved the perception of self-efficacy in coordinative abilities ($p=0.017$). **Conclusions:** The proposed school-based MVPA program showed effectiveness and feasibility. The differences observed by gender highlight the need to use different strategies to increase the involvement of all the participants.

Key words: youth, physical activity, exercise performance, body weight

Introduction

A growing number of studies report that regular physical activity (PA) during childhood is associated with physical, mental, emotional and social health benefits.^{1,2} A considerable amount of strong evidence-based data exists supporting the concept that PA in school-aged children improves fitness and musculoskeletal health, and reduces several risk factors of chronic diseases, especially in high-risk youngsters (e.g. overweight or obese).^{3,4} PA can thus contribute not only to current wellness but also to future health. A dose-response relationship between physical activity and health has been reported in several observational studies.⁴ For these reasons, the World Health Organization recommends that children and adolescents aged 5-17 should accumulate at least 60 minutes per day of moderate-to-vigorous intensity physical activity (MVPA) for 5 days a week, in order to avoid the risk of metabolic and cardiovascular diseases.⁵

In European countries the majority of national PA recommendations for young people are in line with those reported by the WHO.⁶ Despite this, the percentage of European children complying with these recommendations is generally low and differs considerably between sexes and countries, ranging from 2% in Cyprus to 14.7% in Sweden among girls, and from 9.5% in Italy to 34.1% in Belgium among boys.⁷ Moreover, the experience of physical activity in Italian children is frequently confined to participation in a few training sessions of sport alone, which is not enough to ensure the daily requirement.⁸⁻¹⁰

The school is widely recognized as an important institution for the promotion of PA and fitness in youth. However, systematic reviews and meta-analysis conducted to summarize the evidence of the effectiveness of school-based interventions in promoting PA, fitness and lifestyle in children and adolescents result in an inconclusive picture,¹¹⁻¹⁴ due to the heterogeneity of the interventions, the great variability in the duration, intensity and type of

physical activity used, and the likelihood of small study bias. Dobbins et al. also highlighted the generally poor quality of the studies included in the Cochrane Review and suggested that these results should be interpreted cautiously.¹⁵ The biases most frequently reported are the marked loss at follow-up, the self-reported or parent-reported outcome assessment and the not blinded school allocation. Nevertheless, the school is still considered the ideal setting to promote healthy behaviors, since it has the potential to reach the vast majority of children with the recommended amount of MVPA. Currently, to our knowledge, no recommendation is available for MVPA during school hours. In order to attenuate the epidemic of childhood obesity and physical inactivity currently afflicting European Countries, strong responses from policy makers are advocated, and schools can play a central role.¹⁶⁻¹⁷

In 2009 we undertook a multi-component health promotion intervention to increase PA and improve the dietary habits of primary school pupils (8-9 years) using integrated educational strategies involving schools, families, public bodies, sport associations and public health operators. After 2 school years, the percentages of overweight or obese children significantly decreased. We also found a significant improvement in dietary habits, whereas motor habits did not improve in the same way.¹⁸ We postulated that to achieve this aim, more targeted measures were necessary in the administration of MVPA, involving an effective control of the physical activity intensity and duration.

The purpose of this study was to examine the effect of a physical education intervention on motor abilities, physical fitness and anthropometric variables during school hours in children aged 8-10 years. The changes in the perception of physical self-efficacy were also evaluated. At the same time, the feasibility of the proposed MVPA program in a school setting was considered.

Methods

Participants

A quasi-experimental study with non-random assignment was carried out during the school year 2013-2014. We conducted an a priori power analysis based on a hypothesized difference in the change in at least one motor test between experimental and control means of 0.4 (Cohen's delta), corresponding to a small-to-moderate effect. The sample size needed was 99 experimental subjects and 99 control subjects, in order to reject the null hypothesis that the mean changes in the experimental and control groups are equal with 80% power and alpha (Type I error probability) of 0.05.

Ten classes from four primary schools in a Province of the Emilia Romagna Region (Italy) were recruited. The study included 241 children aged 8-10 years attending the third and fourth years (respectively 4 and 6 classes) of primary school. For each school, the enrolled classes were assigned either to an intervention or to a traditional physical education program, within the school setting. A total of 232 children (97 interventions, 4 classes; 135 controls, 6 classes) took part in the evaluation (overall response rate: 95.9%).

Anthropometric measurements, motor skills of the children, and their perception of self-efficacy were assessed in both groups at the beginning (pre-intervention) and the end (post-intervention) of the school year. The teachers of the classes that took part in the intervention were interviewed at the end of the study to highlight any problems that may have emerged and to assess the feasibility and repeatability of the program.

The study was approved by the Ethical Advisory Committee of Bologna University and the head teachers of the participating schools. For each participant, informed consent was obtained from both parents, in accordance with the Italian ethical guidelines and legal requirements.

Intervention

The intervention aimed to increase children's activity levels through PE lessons given by specialist PE teachers specifically trained for the purpose. The children of the intervention group followed four weekly sessions of MVPA of one hour each, held during the last hour of the school day in the facilities of the school, throughout the whole school year. This activity was carried out as an augmentation to the standard program of physical education, consisting of two lessons of around 50 minutes a week, taught by the ordinary classroom teacher. In accordance with WHO definition, moderate intensity was defined as activity allowing the

children to control their verbal language without becoming breathless (the child can talk, but not sing), and vigorous intensity as activity leading to sweating and heavy breathing (the child is not able to say more than a few words without pausing for breath).¹⁹

Table 1

describes the physical education sessions of the experimental group. The activities were alternated so as not to create learning paths that were too structured and all activities invariably involved team games and obstacle courses that challenged the children physiologically. The organization of the lesson was aimed at keeping the pupils' effort at a medium-high level, and to achieve a high quantity, intensity and density of work, with a balanced alternation between stimulus and recovery, that is to say: very short moments of rest

in low intensity activities (with almost constant activity); moments of complete rest lasting 2-3 minutes in activities of medium to high intensity.

The intervention started after the initial data collection at the beginning of the school year (September/October 2013) and continued for about 8 months until the follow-up examination (May/June 2014). The control classes continued with the standard program of physical education involving two lessons of around 50 minutes a week.

Assessment of motor abilities and physical fitness

A limited number of tests were selected, suitable for the age group, able to provide a representative spectrum of the children's physical capacity and easy to perform in the primary school settings.²⁰⁻²² The following tests were chosen:

The **Sit & Reach test** to assess the hip and low-back flexibility;²³ in a seated position with the knees extended and the feet placed firmly against a vertical support the pupil reaches forward along the measuring line as far as possible with the arms at the same level; the score is recorded to the nearest 0.1 cm as the distance reached by the hands, using the level of the feet as recording 100, so that any measure that did not reach the toes is <100 and any measure beyond the toes is >100.

The **Standing long jump test** to assess the lower body and legs explosive strength;²⁴ the pupil is instructed to jump as far as possible from a standing start, with the feet slightly apart; the test is performed twice and scored to the nearest 0.1 cm; the longest jump is reported.

The **Harre circuit test** to assess the children's coordinative abilities, the perception of themselves in space and their dynamic total body coordination.²⁵ Children are instructed to complete the circuit described in Figure 1, at maximum speed. The test initially requires the execution of forward rolls (only once after the start) and then three consecutive passages above and underneath three obstacles. A technician measures the time and checks if the pupil makes a mistake (e.g. touching the obstacles or the cone placed in the middle of the circuit). The time employed to run the whole circuit is recorded to the nearest 0.1 seconds.

The **Yo-Yo Intermittent Recovery Level 1 Test (YYIRL1)** adapted test for children 6-10 years old)²⁶ to evaluate cardiovascular fitness. The pupil runs back and forth between the start and finish lines, at progressively increased speeds and with a five second period of recovery between runs. The rest periods, running periods, and the speed progression are

controlled by beep sounds from a CD player. The whole test is run in 3 minutes (3 min-YYIRL1 test), corresponding to 9 shuttles (each run: 2 x 16 m) and a total distance of 288 m. Heart rate (beats per minute, bpm) is measured at the end of the YYIRL1 test (maximal heart rate) and after 2 minutes of rest (recovery heart rate), using a cardio frequency meter (Polar SR100).

The **Handgrip strength test**, to measure the maximum isometric strength of the hand and forearm muscles.²⁷ The child stays in a standard bipedal position with the arms in complete extension holding the dynamometer (Lafayette instruments) in the hand to be tested (chosen by the pupil). Then, the pupil squeezes the dynamometer with maximum isometric effort, which is maintained for about 5 seconds. No other body movement is allowed. The test is scored to the nearest 0.1 Kg.

Anthropometric measurements

Trained personnel measured the children's height, weight, and waist circumference (WC) in accordance with standardized methods and using calibrated instruments. Standing height was measured using a portable stadiometer (SECA 217). Measurements were taken to the nearest 0.1 cm with shoes off, feet together, and head in the horizontal plane. The children were weighed on a portable scale (SECA 761) to the nearest 0.1 Kg, lightly dressed and without shoes. Waist circumference was measured to the nearest 0.1 cm using a non elastic tape applied at a midway level between the lower border of the rib cage and the iliac crest.

Body Mass Index (BMI) was calculated on the measured weight and height (Kg/m^2). Overweight and obesity were defined using the age- and gender-specific international cut-off points proposed by Cole et al.²⁸ Waist-to-height ratio (WHtR) was obtained dividing the WC

by height (cm/cm). WHtR values >0.5 were considered indicators of abdominal obesity, in accordance with the literature.²⁹⁻³⁰

Assessment of physical self-efficacy

In order to assess the children's perception of self efficacy the Perceived Physical Ability Scale for Children (PPAS-C) was used. The scale was proposed in the Italian version by Bortoli and Robazza³¹ and modified by Colella et al.³² to render it easily understandable by children. Six items representing strength, speed and coordinative abilities were identified. Each item is structured in a response scale with a score from 1 to 4, giving a total test score ranging from 6 to 24. High scores are assumed to indicate a high self-perception of physical ability, whereas low scores reflect a low self-perception. A detailed description of the PPAS-C is reported by Colella et al.³²

Data analyses

The results of the motor tests, the values of the anthropometric parameters and the answers given by children in the PPAS-C were summarized as mean \pm standard deviations. Comparisons of anthropometric variables and motor tests at baseline between control and intervention groups were carried out using χ^2 test or t-test as appropriate. Changes in the 6 motor tests and perceived physical ability scores from baseline to post-intervention were compared between the study groups using repeated-measures ANOVA. Gender and BMI status at baseline (categorized as underweight/normal weight and overweight/obese) were included in the ANOVA models to analyze their effects. Bonferroni correction was applied to the probability level to control for type-I error related to multiple testing.

In order to evaluate the relationships of perceived physical ability with the measured physical skills, Pearson's correlation coefficients (r) were calculated and stratified for gender

and group. Partial Eta Squared was used as a measure of the effect size. Cohen's recommended cut-offs for this measure are 0.099 (small), 0.059 (medium), 0.138 (large).³³

All statistical analyses were conducted using the IBM SPSS Statistics, Version 22 for Windows.

Results

Table 2 shows the descriptive statistics of the anthropometric variables and the motor tests at baseline in the overall sample and by gender. No significant differences between the study groups were found at baseline, although assignment to the intervention was not random.

Table 3 compares the pre-post differences in the motor tests between the experimental and the control group, adjusted for gender and BMI status at baseline. At post-intervention all the children (both control and experimental) improved their performance in the motor tests that measure strength, general coordination, dexterity and state of fitness, while the back flexibility (Sit&Reach) worsened. On average the improvement on motor tests was significantly greater in the experimental group for the Harre circuit ($p < 0.001$), and in the recovery heart rate after the YYIRL1 test ($p = 0.002$), with a medium effect size for both the tests. Table 4 shows that the intervention had a positive effect in both genders on the Harre circuit performance, while the benefit in terms of reduction of maximal heart rate and recovery heart rate was found only in males.

Compared with controls, children in the intervention group had a higher reduction in BMI, as shown by the larger proportion shifting to the lower BMI category (10.2% vs 5.5%, Fig. 2). However, this difference failed to reach statistical significance ($\chi^2 = 3.6$, $p = 0.164$). Similarly, a higher reduction in WHtR was observed in the experimental group compared

with the control group, but the difference between groups was not significant (ANOVA $F=2.94$, $p=0.088$).

Perceived physical ability (PPAS-C) total and sub-scale scores were significantly higher in males than in females in the overall sample ($p<0.01$). When changes (post-intervention vs baseline) were compared between the control and intervention groups, adjusted for gender and BMI status, a significant improvement was observed only in males of the experimental group for the coordinative sub-scale score ($p=0.017$; Table 5).

Table 6 shows the correlations between PPAS-C scores and the results obtained in some motor tests (objective measures of physical abilities) at the end of the study. Significant correlations were found almost exclusively in males, particularly in the standing long jump test (positive correlation) and Harre circuit test (negative correlation). The males appear to perceive the performances in these tests, which measure strength of lower limbs, speed, coordination and dexterity, as indicators of their physical capacity, more than the tests correlated to cardiovascular fitness (YYIRL1 test).

Table 7 summarizes the positive and negative aspects of the intervention on the basis of interviews with the teachers. The attitudes and behavior of the pupils and parents highlight important positive aspects, in particular the improvement in the relational dynamics among the children and their greater capacity for attention in the didactic activities proposed after the PE sessions. Also the positive judgment of the teachers on the feasibility, repeatability and utility of the intervention represents an important result of the study.

Discussion

The aim of the school-based MVPA program was twofold: 1) to put into practice the international indications for the administration of physical activity and assess their effects on

the children; 2) to demonstrate the concrete possibility of using the school environment and hours to increase daily physical activity in children.

With regard to the effectiveness of the intervention, the findings show that the MVPA program improved some physical abilities in the experimental group compared to the control group. After adjusting for gender and BMI status, the motor tests that yielded the greatest benefit were those involving speed, coordination and dexterity (Harre circuit), and aerobic fitness (recovery heart rate after the 3 min-YYIRL1). The improvement in fitness tests is an important result, as high aerobic fitness is shown to reduce the long-term cardiovascular disease risk in adult life.²⁶ The tests measuring the motor abilities such as strength of the lower limbs, strength of hand/forearm and back flexibility, the latter depending largely on the subject's anatomical constitution (i.e. length of legs with respect to the trunk), were little influenced by the proposed program of exercises, which focused mainly on cardiopulmonary performance and, to a lesser extent, on strength.

The intervention proved to be more effective in males, while the BMI status at baseline did not affect the results. Boys have been shown to be generally more motivated towards participation in physical activity, spurred by their greater spirit of competition and the importance they give to self-fulfillment through physical performance. Girls, instead, are more oriented towards cooperation and learning, and show a lower involvement in physical activity.^{34,35} Moreover, Xiang et al. observed that girls start to lose their motivation for physical activity precisely around the age group (fourth year of primary school) considered in our study.³⁶

Differences between genders were also found in the perception the children have of their physical abilities. In the PPAS-C the males obtained scores that were on average higher than those of the females, in line with the literature.^{31,32,37,38} These contrasting models of self-assessment may explain the differences in the involvement in vigorous physical activity and

sport.^{35,36} It could be hypothesized, therefore, that the less evident improvements in motor tests obtained by the females can be attributed to their lower level of motivation to participate

to the best of their ability in the MVPA program, contrary to the males.

The PPAS-C was proposed to assess the effectiveness of physical activity programs on the perception of motor abilities such as strength, speed and coordination.^{32,39} In this study the scores obtained are correlated to the performances in the motor tests that measure the coordinative capacities, but only in the boys, who significantly increase the self-perception of these physical abilities in the post-intervention, thus confirming the differences in gender

found in the motor test improvements. These results underline the importance, when implementing physical education programs, of a careful analysis of the population participating in the intervention and of the variables that might influence the involvement of

all groups, for example in terms of gender.

With regards to the feasibility of the proposed MVPA program, our study showed that, within the current organization of the Italian primary school, it is possible to implement such a program in a structured fashion, without negatively affecting the curriculum programs of the other subjects. If the program were to be extended to all classes of the primary school, the intervention would need to be re-planned depending on the age of the children and the availability of spaces.

Some limitations of this study should be considered. The first concerns the non randomization of the sample due to problems of a logistic and organizational nature. We tried to overcome this limitation by recruiting the control classes and the experimental classes from the same schools, so that the socio-economic and cultural variables would not influence the results. Moreover, the sample size did not allow us to test hypotheses concerning the effects of the intervention on the BMI status and WHtR, which are considered good predictors of cardiovascular risk factors both in adults and youths.⁴⁰⁻⁴²

The strengths of the study include the high level of participation in a program that required the constant involvement of ordinary classroom teachers and great effort on the part of the children in the vigorous physical activities which, though tiring, were well received as they were presented in the form of a game. An innovative element is to have studied the relationship between objective measures of physical performance (motor test measurements) and the subjective perception of physical efficacy (PPAS-C), an aspect that, to our knowledge, has been scarcely investigated in the literature.³⁹

The findings deriving from this trial highlight the importance of instituting a new approach to teaching PE in the Italian primary school. In particular, an effort should be made to introduce a teacher with a specific curriculum in physical education. Such a figure is

currently not foreseen in the Italian primary school system, but the presence of a qualified PE instructor would be indispensable for the implementation of programs similar to the one proposed here and would help to ensure the persistence of positive results. Such a teacher would assume a fundamental role in coordinating and monitoring the physical activity in the school environment, making use of the spaces and sports facilities already present in most schools. This additional resource would represent a fundamental investment that would be well compensated in terms of public health.

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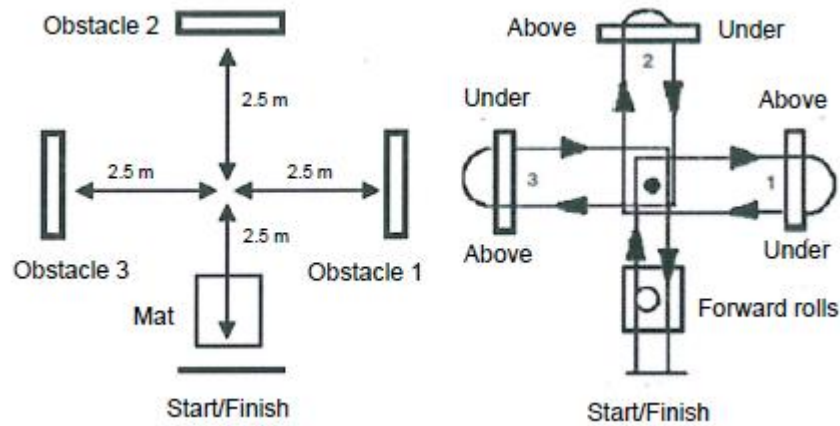


Figure 1. Scheme of the Harre circuit

		Post intervention						Post intervention											
		Control				Intervention													
Baseline		under/normal weight	overweight	obese	total	Baseline	under/normal weight	overweight	obese	total	changes								
under/normal weight		78	5	1	84	under/normal weight	59	1	0	60	negative	6	4.7%	none	114	89.8%	positive	7	5.5%
overweight		4	32	0	36	overweight	5	15	0	20	negative	1	1.1%	none	78	88.6%	positive	9	10.2%
obese		0	3	4	7	obese	0	4	4	8									
total		82	40	5	127	total	64	20	4	88									
		changes				changes													
		negative	none	positive		negative	none	positive											
		6	4.7%	114	89.8%	7	5.5%												

Figure 2. Shift table presenting the BMI-status of children at baseline and post-intervention

Table 1. Sessions of MVPA proposed to the intervention group

Organization of the sessions	Examples of exercises/games	Time
Warm-up	Slow running combined with arm exercises (pushing, raising, circling, etc.) Pre-athletic activities combined with arm exercises (side gallop, skipping, hopping, etc.) Movement games with low physical effort (passing games, prison ball, etc.)	10 min
Body of lesson	Team relays (4-5 children per team) organized to stimulate medium-high intensity physical effort and based on transporting: balls, cards with letters, cards with numbers, puzzles, etc.) Traditional movement games with high physical effort: Chase-catch (tag) Clear the court (game with balls and net) Dodgeball Passing games Sport games (sports oriented games): "Palla al re" (basketball preparation)* Scoutball (rugby preparation) "Palla a terra" (volleyball preparation)* "Palla in porta" (handball preparation)*	40 min
Cool-down	Exercises of breath control Exercises of muscle relaxation Exercises of simple muscle stretching Circle time (comments on the lesson)	10 min

* Games conceived by the Italian National Olympic Committee (CONI) to orient children towards the sports shown in brackets

Table 2. Anthropometric variables and motor tests at baseline, by group and gender

Anthropometric variables and motor tests	Males		Females		Males + Females		Control vs Intervention p
	Control	Intervention	Control	Intervention	Control	Intervention	
	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	
Age (years)	9.6 ± 0.5	9.5 ± 0.6	9.6 ± 0.6	9.4 ± 0.6	9.6 ± 0.5	9.5 ± 0.5	ns
BMI (Kg/m ²)	18.1 ± 2.7	18.1 ± 2.8	17.8 ± 2.5	18.0 ± 2.8	18.0 ± 2.6	18.1 ± 2.8	ns
under/normal weight (%)	66.2	68.0	68.2	68.9	67.2	68.4	ns
overweight/obese (%)	33.8	32.0	31.8	31.1	32.8	31.6	
Waist circumference (cm)	61.6 ± 6.7	62.2 ± 6.9	59.6 ± 5.8	60.3 ± 6.4	60.6 ± 6.3	61.3 ± 6.7	ns
Standing long jump (cm)	133.5 ± 21.6	138.7 ± 20.1	128.3 ± 16.6	119.8 ± 19.0	130.9 ± 19.4	129.6 ± 21.7	ns
Handgrip strength (Kg)	17.9 ± 3.1	18.5 ± 3.1	16.5 ± 3.1	16.0 ± 3.0	17.2 ± 3.2	17.3 ± 3.3	ns
Harre circuit (sec)	15.7 ± 2.8	15.9 ± 2.7	16.6 ± 2.4	17.9 ± 3.0	16.2 ± 2.6	16.8 ± 3.1	ns
Sit and Reach (cm)	99.8 ± 6.7	100.3 ± 6.6	104.6 ± 6.7	103.4 ± 6.4	102.2 ± 7.1	101.8 ± 6.7	ns
Maximal Heart Rate (measured after 3 min-YYIRL1 test) (bpm)	183.7 ± 12.7	184.9 ± 11.3	188.6 ± 10.2	189.2 ± 12.8	186.2 ± 11.7	186.7 ± 12.1	ns
Recovery Heart Rate (measured after 3 min-YYIRL1 test and 2 min of rest) (bpm)	123.3 ± 10.3	132.0 ± 14.7	132.7 ± 11.8	132.6 ± 20.1	128.3 ± 12.0	132.3 ± 17.1	ns

SD: Standard Deviation

ns: not significant

Table 3. Post-pre estimated differences in motor tests in control and intervention groups, adjusted by gender and BMI status

Motor tests		Differences (post -pre)		p	Effect size ^a
		mean	95% CI		
Standing long jump (cm)	Control	3.7	1.0; 6.5	0.021	0.027
	Intervention	8.8	5.5; 12.1		
Handgrip strength (Kg)	Control	0.5	0.2; 0.9	0.939	0.000
	Intervention	0.6	0.1; 1.0		
Harre circuit (sec)	Control	-1.0	-1.3; -0.7	<0.001*	0.100
	Intervention	-2.2	-2.5; -1.8		
Sit & Reach (cm)	Control	-1.6	-2.4; -0.9	0.595	0.001
	Intervention	-1.9	-2.8; -1.1		
Maximal Heart Rate (measured after 3 min-YYIRL1 test) (bpm)	Control	-1.9	-4.6; 0.9	0.011	0.046
	Intervention	-7.1	-9.9; -4.2		
Recovery Heart Rate (measured after 3 min-YYIRL1 test and 2 min of rest) (bpm)	Control	-1.6	-5.6; 2.4	0.002*	0.079
	Intervention	-10.9	-14.9; -6.82		

* significant at Bonferroni corrected significance level ($p < 0.008$)

^aPartial Eta squared: values of 0.099 are considered small, 0.059 medium, and 0.138 large

Table 4. Post-pre estimated differences in motor tests, by group and gender, adjusted for BMI status

Motor tests		Males		p	Effect size ^a	Females		p	Effect size ^a
		Differences (post -pre) mean	95% CI			Differences (post-pre) mean	95% CI		
Standing long jump (cm)	Control	4.8	1.0; 8.6	0.380	0.008	2.7	-1.4; 6.8	0.016	0.060
	Intervention	7.6	3.0; 12.1			10.1	5.4; 14.8		
Handgrip strength (Kg)	Control	0.7	0.2; 1.2	0.959	0.000	0.4	-0.2; 0.9	0.916	0.000
	Intervention	0.7	0.1; 1.3			0.4	-0.2; 1.1		
Harre circuit (sec)	Control	-1.0	-1.4; -0.6	0.001*	0.101	-1.0	-1.5; -0.5	0.002*	0.100
	Intervention	-2.0	-2.5; -1.5			-2.3	-2.9; -1.8		
Sit & Reach (cm)	Control	-2.3	-3.3; -1.2	0.222	0.015	-1.0	-2.1; -0.1	0.338	0.006
	Intervention	-3.4	-4.6; -2.2			-0.5	-1.8; -0.8		
Maximal Heart Rate (measured after 3 min-YYIRL1 test) (bpm)	Control	-0.9	-4.8; 2.9	<0.001*	0.166	-2.8	-6.7; 1.1	0.746	0.002
	Intervention	-10.3	-14.2; -6.5			-3.8	-8.0; 0.4		
Recovery Heart Rate (measured after 3 min-YYIRL1 test and 2 min of rest) (bpm)	Control	-0.4	-6.1; 5.2	<0.001*	0.180	-2.8	-8.4; 2.8	0.359	0.015
	Intervention	-14.9	-20.2; -9.7			-6.8	-12.9; -0.7		

SD: Standard Deviation

* significant at Bonferroni corrected significance level (p<0.008)

^a Partial Eta squared: values of 0.099 are considered small, 0.059 medium, and 0.138 large

Table 5. Perceived Physical Ability scores at baseline and post-pre estimated differences, by group and gender, adjusted for BMI status

PPAS-C scores		Males			Females			Males + Females		
		Baseline	Differences (post-pre)	p	Baseline	Differences (post-pre)	p	Baseline	Differences (post-pre)	p
		mean ± SD	mean ± SD		mean ± SD	mean ± SD		mean ± SD	mean ± SD	
Total score	Control	19.1 ± 3.0	-0.8 ± 0.3	0.068	17.8 ± 2.1	0.1 ± 0.3	0.896	18.4 ± 2.6	-0.3 ± 0.2	0.604
	Intervention	19.9 ± 2.5	0.1 ± 0.4		18.9 ± 2.4	-0.4 ± 0.4		19.5 ± 2.5	-0.2 ± 0.3	
Coordinative items	Control	9.7 ± 1.5	-0.5 ± 0.2	0.017*	8.9 ± 1.2	-0.0 ± 0.2	0.998	9.3 ± 1.4	-0.3 ± 0.1	0.118
	Intervention	9.9 ± 1.5	0.2 ± 0.2		9.4 ± 1.2	-0.0 ± 0.3		9.7 ± 1.4	0.1 ± 0.2	
Conditional items	Control	9.4 ± 1.7	-0.3 ± 0.2	0.508	8.8 ± 1.2	0.1 ± 0.2	0.102	9.1 ± 1.5	-0.1 ± 0.1	0.453
	Intervention	10.0 ± 1.3	-0.1 ± 0.2		9.5 ± 1.4	-0.4 ± 0.2		9.8 ± 1.3	-0.2 ± 0.2	

SD: Standard Deviation

* significant at Bonferroni corrected significance level ($p < 0.025$)

Table 6. Correlations between Perceived Physical Ability scores and motor tests at the end of the study, by group and gender

PPAS-C	Groups	Gender	Standing long jump	Harre circuit	YYIRL1 (max heart rate)	YYIRL1 (recovery heart rate)
			r value	r value	r value	r value
Total score	Control	males	0.29*	-0.38**	-0.10	-0.11
		females	0.07	-0.22	0.04	0.09
	Intervention	males	0.37**	-0.44**	-0.20	-0.11
		females	0.28	-0.17	-0.16	-0.35
Coordinative items	Control	males	0.32**	-0.46***	-0.01	-0.11
		females	0.1	-0.25	0.06	0.13
	Intervention	males	0.24	-0.29*	-0.14	-0.12
		females	0.21	-0.13	-0.10	-0.18
Conditional items	Control	males	0.17	-0.19	-0.22	-0.10
		females	0.02	-0.16	0.01	0.04
	Intervention	males	0.41**	-0.47***	-0.21	-0.13
		females	0.27	-0.17	-0.18	-0.44*

* p<0.05; ** p<0.01; *** p<0.001

Table 7. Positive and negative aspects of the PE program in the opinion of the teachers

Positive aspects	Negative aspects
Equipment and logistic aspects	
Proposed activity requires minimum equipment and can be made in the open if no gym is available	If the program is extended to all classes, re-planning is needed depending on the availability of spaces
Behavior of pupils	
Enthusiastic participation	Some children complain of physical tiredness after the PE sessions, especially those with a sedentary lifestyle
Improvement in relational dynamics: less aggressive behavior, increased socialization and unity of the group	In some cases the high level of competitiveness among the children and the inhomogeneity of their motor capacities made it necessary to re-plan the proposed activities
Children more attentive during didactic activities proposed after PE lessons	
More positive attitude and greater interest towards sports activities	
Reaction of parents	
Favorable response to the project and request from some parents to continue the program in the following years	Resistance from parents of children who do competitive sports activities due to fear of injury or excessive fatigue
Less anxiety in children on days when PE lessons are scheduled	Parents not directly involved in the activity
Teachers' point of view	
Positive judgment on feasibility, repeatability and utility of the program	Need for staff specifically trained for PE, not foreseen in the current structure of the primary school in Italy
No interference with the regular execution of curriculum programs of other subjects	If the program is extended to all classes, some activities need to be re-planned for the children of the first and second years on account of their lower degree of autonomy
No objections from managers and colleagues	