Forma fisica degli studenti italiani: efficacia di una formazione extracurriculare supervisionata della durata di 12 settimane

Alessandro Acella • Università degli Studi di Bari– alex.acella@live.it
Stefania Cataldi • Università degli Studi di Bari – stefania_cataldi@virgilio.it
Francesco Fischetti • Università degli Studi di Bari – francesco.fischetti@uniba.it
Gianpiero Greco • Università degli Studi di Bari – gianpiero.greco@uniba.it

Physical fitness of young Italian students: effectiveness of a 12-week supervised extracurricular training

Il sovrappeso minaccia la salute degli adolescenti. Questo studio ha esaminato gli effetti di un allenamento multilaterale extracurriculare (MT) della durata di 12 settimane rispetto a un programma di allenamento standard (ST) effettuato a scuola come da programma ministeriale sulle componenti del fitness fisico. 11 ragazzi e 9 ragazze (età 13,6 ± 0,5 anni) sono stati assegnati in modo casuale a un gruppo sperimentale (EG, n= 10) o di controllo (CG, n = 10). Sono stati valutati: indice di massa corporea (BMI), circonferenza vita (WC), test 505 di cambio di direzione rapido (CODS) e corsa 300 m. EG ha svolto MT (90 min, 2 volte a settimana) più ST, mentre CG ha svolto solo ST. Significative interazioni Tempo x Gruppo sono state rilevate a favore di EG per tutte le misurazioni (da –8,37 a –3,50%). Il protocollo MT è stato efficace nel migliorare l'efficienza fisica e ridurre il peso negli adolescenti dopo un periodo di 12 settimane.

Parole chiave: sovrappeso; obesità; adolescenza; allenamento multilaterale; educazione fisica; attività fisica

The overweight threatens the adolescents' health. This study investigated the effects of extracurricular multilateral training (MT) lasting for 12 weeks compared to a standard training (ST) program performed at school as required by the ministerial program, on health- and skill-related components of physical fitness. Eleven boys and nine girls (age 13.6 ± 0.5 years) were randomly assigned to an experimental group (EG, n = 10) or control group (CG, n = 10). At weeks 1 and 12, body mass index (BMI), waist circumference (WC), a 505 change of direction speed (CODS) and 300 m run test, were assessed. The EG underwent MT (90 min, 2 times a week) plus ST, while the CG underwent only ST. Significant Time x Group interactions were detected in favor of the EG for all measurements (from –8,37 to –3.50%). The extracurricular MT protocol was effective in improving physical efficiency and reducing weight in adolescents after a period of 12 weeks.

Keywords: overweight; obesity; adolescents; multilateral training; physical education; physical activity

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1. Introduction

Overweight and obesity represent a threat to the health of the young population in Italy. In fact, childhood obesity is associated with cardiovascular, endocrine, pulmonary, musculoskeletal and gastrointestinal complications and may also have psychosocial consequences (Ebbeling, Pawlak, Ludwig 2002). The prevalences of obesity and overweight among Italian schoolchildren 11-15 years old are high, particularly in the south and in boys (Lazzeri et al., 2014). Body weight in childhood is an important determinant of overweight in adulthood (Guo et al., 1995; Guo, Chumlea 1999). Those who at a young age were overweight or obese have a higher risk of developing metabolic and cardiovascular disease as adults (Janssen et al., 2005; Must et al., 1992). With reference to these findings, it seems plausible to argue that it is crucial to begin prevention at a young age. In fact, children and adolescents respond better to preventive treatment than do adults (Lau et al., 2007; Rees, 1990).

However, obesity is a multi-factorial disorder originating from the interaction between genetic background and environmental factors, such as sedentary lifestyle and unhealthy dietary habits (Janssen et al. 2004; Rankinen et al. 2002). Several studies have shown that insufficient physical activity is an important risk factor for obesity (Brock et al., 2009; Lau et al., 2007). In fact, in the Italian population, research has shown that 5.2% of 11-year-old children, 6.7% of 13-year-old children and 12.4% of 15-year-old children reported never doing any type of physical activity (Cavallo et al., 2013). Overweight and obesity prevention or reduction essentially involves lifestyle modification through behavioral changes at the individual and family level. Programs including individual and family-based behavioral modification, dietary modification, and exercise cause a greater decrease in weight and maintenance thereof and simultaneously eliminate the sedentary lifestyle and increase the energy expenditure (Epstein, 1993; Lau et al., 2007; Magrone, Jirillo 2015).

Unfortunately, Italian schools institute only 2 hours per week of physical education, which is not sufficient to prevent overweight and obesity in students. In addition, overweight and obese children have postural control difficulties and worse fine motor skill performance (D'Hondt et al., 2008). Therefore, it becomes very important to recommend extracurricular physical activities (Crouter, Salas,, Wiecha, 2016; Li et al., 2014). To this end, we recommend a multilateral training (MT) program that aims to develop basic motor skills and motor qualities such as strength, speed, endurance, agility and flexibility. This multilateral approach respects the physiologic age and psychological maturation of youth and is a means to improve fitness and conditioning (Bompa, 1999).

Despite numerous publications on physical activity in students, there are few studies available that have assessed objectively, and with a rigorous design, extracurricular physical activity interventions (Mears, Jago 2016). Consequently, we focused our research on filling the gaps identified in the literature, such as the lack of studies of adolescents and interventions performed outside of the school setting (van Sluijs, McMinn, Griffin, 2007). Thus, the purpose of this study was to investigate the effects of an extracurricular MT program lasting 12 weeks compared to the standard training (ST) program at school as required by the ministerial program, on health- and skill-related components of physical fitness in adolescents. Based on the findings of the previously mentioned studies, we hypothesized that participants who underwent extracurricular MT compared to only ST would show a decrease in body mass index (BMI) and waist circumference (WC) and larger improvements in physical fitness tests (i.e., agility, speed and anaerobic power).

2. Methods

2.1 *Experimental approach to the problem*

To test our hypothesis, adaptations following extracurricular MT compared to only ST were assessed using a randomized controlled study design that included pre- and post-testing at weeks 1 and 12, respectively. This research was designed to obtain baseline data of some health-related (i.e., body composition) and skill-related (i.e., agility, speed, power) components of physical fitness (Caspersen, Powell, Christenson, 1985) in young students, in order to evaluate whether a supervised 12-week MT program can produce improvements. This outcome was defined as statistically significant improvements in anthropometric values (i.e., BMI and WC) and physical fitness tests (i.e., a 505 change of direction speed (CODS) test, 10 m speed test and 300 meter run test)

2.2 *Subjects*

Twenty healthy subjects between 13 and 14 years of age (11 boys and 9 girls, age 13.6 ± 0.5 years, body height 166 ± 4.7 cm, body mass 73.8 ± 4.3 kg, mean ± SD) volunteered to participate in this study. An a priori power analysis (Faul et al. 2007) with an assumed type I error of 0.05 and a type II error rate of 0.20 (80% statistical power) was calculated for measures of physical fitness and revealed that 8 participants per group would be sufficient to observe medium 'Time x Group' interaction effects.

The subjects were recruited from a junior high school in Puglia (Italy) between January and February 2016. The characteristics of the study population are described in Table 1. The exclusion criteria were (a) children with a chronic pediatric disease, (b) children with an orthopedic limitation, and (c) children older than 14 years of age. All volunteers were accepted for participation.

Characteristic	CG (n = 10)		EG (n = 10)		
	M	SD	M	SD	*p*-value
Age (years)	13.6	0.5	13.7	0.5	0.660
Body height (cm)	165.1	4.4	166.5	5.1	0.519
Body mass (kg)	72.9	3.5	74.8	4.9	0.333
Sex (m/f)	5/5		6/4		

Note: m = male; f = female; M = mean; SD = standard deviation; CG = control group; EG = experimental group.

Table 1. Characteristics of the study participants

The subjects were randomly assigned to two groups: an experimental group (EG), which underwent extracurricular MT, and a control group (CG), which underwent only ST during school. For randomization, we used the method of randomly permuted blocks using Research Randomizer, a program published on a publicly accessible official website (www.randomizer.org).

All participants and their parents received a complete explanation in advance about the purpose of the experiment, its contents, and safety issues based on the Declaration of Helsinki; all subjects provided their informed consent. The study was conducted from February to May 2016.

2.3 *Procedures*

Anthropometric measurements and physical fitness testing were performed at weeks 1 (baseline) and 12 (end of the study). All subjects participated in an introductory training session before the testing procedures. Prior to pre- and post-testing, all participants underwent a standardized 10-minute warm-up that consisted of low-to-moderate intensity aerobic exercise (gradually from 60 to 80 %HRmax) and stretching. After the testing procedures, the subjects performed approximately 5 minutes of stretching exercises that consisted of achilles' tendon/calf stretches, skier's stretches, quadriceps stretches, hurdler's stretches, straddle stretches, groin stretches, back stretches, and archers. The anthropometric measurements were conducted indoors in the school gym, and the physical fitness testing was performed on an outdoor track near the school. The students were tested at the same time of day (3 pm – 6 pm) after school for three days.

The order of tests went from non-fatiguing (weight and height for measuring BMI and WC) to speed and change of direction (505 CODS) and ended with an anaerobic power test (300 meter run). All measurements for testing were performed by the same operator, and the test procedures were supervised by a physical education graduate. All trials were performed using standardized test protocols, observing the same conditions. Upon completion of testing, the subjects were assigned randomly to groups. The reliability of the dependent measures was calculated using the intraclass correlation coefficient (ICC).

2.3.1 Anthropometric measurements

Body mass index (BMI). BMI represents the most complete indicator of body fat composition and, at the same time, is the easiest to use. In particular, it is known that in children and adolescents, body fat is better correlated with BMI than with other indicators (Dietz and Robinson 1998). BMI was calculated as body weight divided by the square of body height. Body height (in cm to the nearest 0.1 cm) was measured using a SECA®stadiometer (Hamburg, Germany) and body weight (in kg to the nearest 0.1 kg) using a Tanita® digital scale (Tokio, Japan); the students were barefoot and wore light clothing (WHO, 1995). Height and weight were measured twice without delay between the measurements, and for both, the mean value of the two measurements was taken. Next, the BMI was calculated from these averaged values. The test-retest reliability reported a high reliability for BMI (ICC = 0.99) (Vincent, 2005).

Waist circumference (WC). WC provides a simple measure of central adiposity, which might be more predictive of adverse outcomes such as lipid profile. This measure also shows positive associations with cardiometabolic risk factors due to the relationship between waist measurements and visceral adiposity (Savva et al. 2000). WC (cm) was measured twice to the nearest 0.1 cm at the midpoint between the lower border of the last rib and the iliac crest, at the end of a normal expiration, using a non-elastic tape measure (WHO 1995). Next, the two measurements were averaged. The two measurements were taken consecutively, without delay. The test-retest reliability reported a high reliability for WC (ICC = 0.97) (Vincent 2005).

2.3.2 Physical fitness testing

505 change of direction speed (CODS) test. This test was used to measure a component of agility, which is defined as including perceptual and reactive decision-making factors, and the change of direction speed. CODS is determined by technical factors such as stride adjustments and by physical elements such as straight sprinting speed and leg muscle qualities, which include strength, power and reactive strength (Sheppard, Young, 2006; Young, Farrow 2006). In this study, the 505 CODS test involved a high-velocity 180° directional change, which was executed during the test. The subjects began by standing behind a set of timing gates (Microgate, Bolzano, Italy), then sprinted 10 m through a second set of timing gates, then sprinted a further 5 m, at which point they passed with both feet through a photocells system, turned 180°, and completed the test by sprinting 5 m back through the timing gates (Figure 1). The subjects completed 2 trials, planting and changing direction with their preferred leg only. Limb dominance or the 'preferred limb' was defined as the limb that a subject chooses and relies on to carry out a variety of functional activities. Each participant performed 2 trials (best time recorded to the nearest 0.01 s) with 3 minutes of rest in between. The 505 COD time(s) and approach speed(s) across the first 10 m were used as dependent variables. The test-retest reliability reported a moderate reliability for the 505 COD time (ICC = 0.84) and a high reliability for the 10 m speed test (ICC = 0.90) (Vincent 2005).

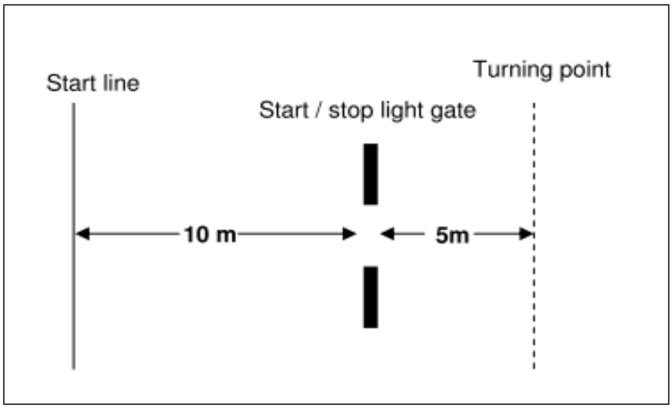

Figure 1. Diagram of the 505 change of direction speed test. Participants perform the test as fast as possible from the start line to the stop light gate (10 m speed test) and from the start to the turning point and back to the stop light gate (505 COD time).

300 meter run test. This test assesses lower extremity anaerobic power via sprinting (Tharp et al. 1985). The students were instructed to run as fast as possible and to complete two trials separated by a 5-minute rest period. Two pairs of cones were used to delineate the 300 meters in the outdoor track. Upon completion, each participant's' time was recorded to the nearest 0.01 s on a hand-held stopwatch (Reiman and Manske 2009). The minimum time (s) recorded in the trials was taken as a dependent variable. The test-retest reliability reported a moderate reliability for the 300 meter run test (ICC = 0.83) (Vincent 2005).

2.3.3 Multilateral training (MT) protocol

The subjects allocated to the EG underwent an MT program for a period of 90 minutes, two days a week, with a total of 24 training sessions. The entire intervention program was implemented in 12 weeks from the beginning of February until the end of May 2016. The MT program was supervised and conducted by 2 experienced instructors who are graduates in physical education. Each training sessions started with a brief dynamic warm-up program mainly consisting of calisthenic-type exercises for 10 minutes and ended with a 10-minute cool-down program consisting of static stretching exercises. The targeted components of the MT program included cardiovascular endurance, agility, dynamic strength, flexibility, and team-building activities.

Warm up	Cardiovascular endurance	Resistance training	Flexibility	Team building	Cool down
Arm swings Trunk twisting High marching Stride jumping High knees Side bending Side stretching Skipping leg swings Backward sprinting Lateral shuffles	Running Walking Circuits Sprint intervals Agility (i.e., the ladder exercise)	Jump squats Lunges Push-ups Pull-ups Curl-ups Half squats Long jumps Planks Medicine ball tosses	Trained using both dynamic and static stretches, typically as is done in the warm-up or cool-down phase of each training session.	Volleyball Basketball Handball Soccer Modified forms of the previous team games	Static stretching: Achilles' tendon/calf stretches Skier's stretches Quadriceps stretches Hurdler's stretches Straddle stretches Groin stretches Back stretches Archers.
Guidelines Duration: 10 minutes. Perform each exercise for 60 s, 1 sets	Guidelines Duration: gradually from 20 to 30 minutes; Intensity: 60 to 90 %HRmax; Progression: increase duration before intensity	Guidelines Duration: 10-20 minutes. 1-2 set of 8–15 repetitions with 45 sec of slow walking between each exercise		Guidelines Duration: about 20 minutes. Performed at the end of the session, before the cool-down	Guidelines Total duration: 10 minutes. Overload: stretch beyond resting length but not beyond pain-free ROM; Duration: 10-30 sec/stretch; Repetitions: 2-4; accumulate 60 sec per exercise; Progression: gradual increase in stretch duration or repetitions.

Table 2. Sample Multilateral Training protocol performed for 90 minutes, two days a week

The dynamic warm-up included arm swings, trunk twisting, high marching, stride jumping, high knees, side bending, side stretching, skipping leg swings, backward sprinting, and lateral shuffles.

The cool-down included traditional movements such calf stretches, quadriceps stretches, back stretches, straddle stretches and groin stretches.

Cardiovascular endurance consisted of a variety of training exercises, including running, walking, circuits, sprint intervals and agility (i.e., the ladder exercise), performed gradually from 20 to 30 minutes. This training program was incorporated into every training session.

Dynamic strength included resistance training and body weight plyometrics such as jump squats, lunges, push-ups, pull-ups, curl-ups, half squats, long jumps, planks and medicine ball tosses. This program began with 1-2 set of 8–15 repetitions with 45 sec of slow walking between each exercise and adequate exercises to include all major muscle groups. In addition, this training program was included into every session and lasted 10 to 20 minutes.

Flexibility was trained using both dynamic and static stretches, typically as a part of the warm-up or cool-down phase of each training session.

The team-building activities of the training program consisted of team games such as volleyball, basketball, handball and soccer. The adolescents also played modified forms of these sports. The activities were characterized by a predominantly playful approach to encourage enthusiasm, socialization and participation of the young students. These activities were performed at the end of the session, before the cool-down.

Furthermore, adolescents in the EG were encouraged to remain active during these 12 weeks; to this end, we provided some tips on lifestyle and nutrition education. For example, we recommended to parents that there not be a television in the children's bedrooms, and we encouraged family rules restricting television viewing and recommended not having the television on during dinner. Additional instructions included purchasing healthy foods, practicing regular meal times, allocating individual portions, creating opportunities for physical activities, and encouraging the parents to act as role models for healthy eating.

2.4 *Statistical analyses*

All analyses were performed using SAS Jmp Statistics (v. 12.1, Cary, NC, USA), and the data are presented as group mean values and standard deviations.

Because we could not detect significant differences between males and females ($p > 0.05$), the data were pooled for males and females.

A multivariate analysis of variance (MANOVA) was used to detect differences between the study groups in all baseline variables. A mixed between-within subjects analysis of variance (ANOVA) was used to determine the interaction between the two independent variables of training (pre/post; within-subjects factor) and group (EG and CG; between-subjects factors) on the dependent variables of physical fitness. When 'Time x Group' interactions reached the level of significance, group-specific post hoc tests (i.e., paired t-tests) were conducted to identify the significant comparisons.

Additionally, classification of the effect size (*f*) was used to estimate the magnitude of differences within each group by calculating the partial η^2. According to Cohen (1988), $0.00 \leq f \leq 0.24$ indicates a small effect, $0.25 \leq f \leq 0.39$ indicates a medium effect, and $f \geq 0.4$ indicates a large effect. Statistical significance was set at $p < 0.05$.

3. Results

All subjects received the treatment conditions as allocated. Twenty participants completed the training program, and none reported any training-related injury. Table 3 describes the pre- and post-intervention results for all outcome variables. Overall, there were no significant differences in mean age, height, weight and baseline values between the two intervention groups ($p > 0.05$).

	Control group (n = 10)					Experimental group (n = 10)					p-value (effect size *f*)		
Variables	**Pre**		**Post**		**Δ (%)**	**Pre**		**Post**		**Δ (%)**	**Main effect: Time**	**Main effect: Group**	**Interaction: Time x Group**
	M	**SD**	**M**	**SD**		**M**	**SD**	**M**	**SD**				
BMI (kg/m^2)	26.74	0.82	26.82	0.92	0.30	26.99	1.43	25.98	1.37	-3.74	< 0.0001 (0.21)	0.5687 (0.14)	< 0.0001 (0.24)
WC (cm)	88.20	2.44	88.10	2.56	0.11	88.60	3.86	85.00	3.53	-4.06	< 0.0001 (0.31)	0.3446 (0.22)	< 0.0001 (0.29)
505 COD time (s)	3.87	0.23	3.94	0.19	1.81	3.94	0.27	3.61	0.26	-8.37	0.0006 (0.27)	0.2137 (0.29)	< 0.0001 (0.50)
10 m speed (s)	2.88	0.18	2.97	0.11	3.12	2.92	0.24	2.73	0.15	-6.51	0.3872 (0.15)	0.0854 (0.30)	0.0202 (0.43)
300 m run (s)	65.59	3.24	67.14	3.58	2.36	67.39	4.03	65.03	3.28	-3.50	0.2448 (0.06)	0.9215 (0.02)	< 0.0001 (0.29)

Note: M = mean; SD = standard deviation; BMI = body mass index; WC = waist circumference; COD = change of direction; Δ = mean difference.

Table 3. Effects of the multilateral training program on measures of physical fitness.

Body mass index (BMI)

A significant main effect of ‘Time’ ($F_{1,18} = 31.05$, $p < 0.0001$, $f = 0.21$), but not of ‘Group’, was found for BMI. In addition, a significant ‘Time x Group’ interaction was detected ($F_{1,18} = 41.85$, $p < 0.0001$, $f = 0.24$) (Figure 2a). The post hoc analysis revealed a significant decrease in BMI measurements from pre- to post-test in the EG (Δ –3.74%, $p < 0.0001$) (Table 3).

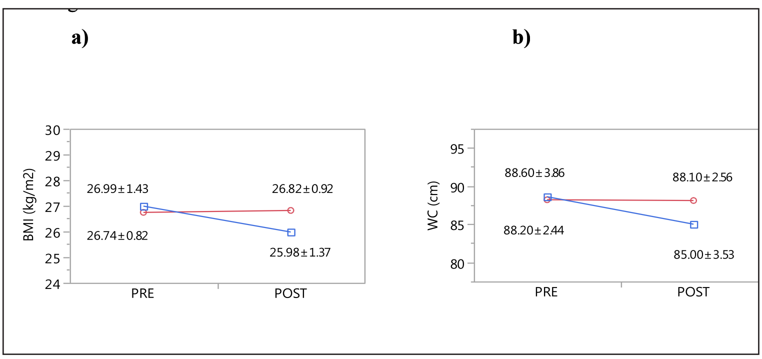

Figure 2. Mean ± SD pre- and post-testing data for a) BMI and b) WC in the experimental group (EG, multilateral training program) and control group (CG, only standard program). Unfilled squares indicate mean data of the EG, and unfilled circles indicate mean data of the CG.

Waist circumference (WC)
Our statistical calculations revealed a significant main effect of 'Time' ($F_{1,18} = 57.84$, $p < 0.0001$, $f = 0.31$), but not of 'Group', for WC. However, a significant 'Time x Group' interaction was found ($F_{1,18} = 51.76$, $p < 0.0001$, $f = 0.29$) (Figure 2b). The post hoc analysis revealed a significant decrease in WC measurement from pre- to post-test in the EG (Δ –4.06%, $p < 0.0001$) (Table 3).

505 CODS test
505 COD time
The statistical analysis indicated a significant main effect of 'Time' ($F_{1,18} = 17.2$, $p = 0.0006$, $f = 0.27$), but not of 'Group', for the 505 COD time. Again, a significant 'Time x Group' interaction was found ($F_{1,18} = 45.79$, $p < 0.0001$, $f = 0.50$) (Figure 3a), and the post hoc analysis revealed a significant decrease in time to run the 505 CODS test from pre- to post-test in the EG (Δ –8.37%, $p < 0.0001$) (Table 3).

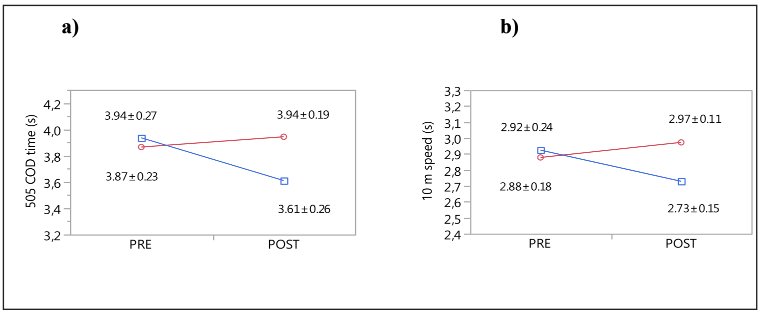

Figure 3. Mean ± SD pre- and post-testing data for a) 505 COD time and b) 10 m speed test in the experimental group (EG, multilateral training program) and control group (CG, only standard program). Unfilled squares indicate mean data of the EG, and unfilled circles indicate mean data of the CG.

10 m speed test
In terms of the approach speed across the first 10 meters, the statistical analysis revealed a significant 'Time x Group' interaction ($F_{1,18} = 6.49$, $p = 0.0202$, $f = 0.43$) (Figure 3b). However, we could not detect a significant main effect of 'Group' or 'Time.' The post hoc analysis revealed a significant decrease in the run time from pre- to post-test in the EG (Δ –6.51%, $p = 0.0268$) (Table 3).

300 meter run test
A significant 'Time x Group' interaction was found ($F_{1,18} = 33.46$, $p < 0.0001$, $f = 0.29$) (Figure 4). However, no significant main effects of 'Group' and 'Time' were detected. The post hoc analysis revealed a significant decrease in run time from pre- to post-test in the EG (Δ –3.50%, $p = 0.0004$), whereas a significant increase was found in the CG (Δ 2.36%, $p = 0.0157$) (Table 3).

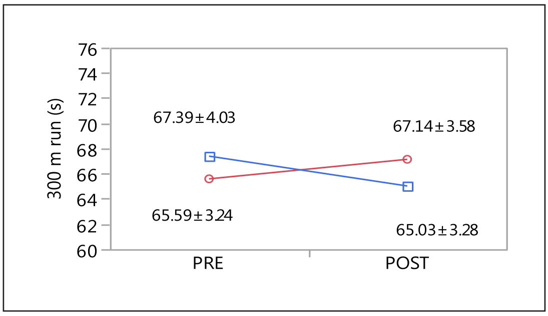

Figure 4. Mean ± SD pre- and post-testing data for the 300 m run test in the experimental group (EG, multilateral training program) and control group (CG, only standard program). Unfilled squares indicate mean data of the EG, and unfilled circles indicate mean data of the CG.

4. Discussion

This study sought to fill some gaps identified in the literature about extracurricular physical activity interventions for adolescents outside the school setting. Thus, through a randomized and controlled research design, this study investigated the effects of an extracurricular MT compared to an ST program performed at school, on health- and skill-related components of physical fitness in adolescents. The main findings of this study were that *(1)* anthropometric values (i.e., BMI and WC) decreased in the EG after the 12-week training period, indicating weight loss, and *(2)* performance in physical fitness tests (i.e., 505 CODS test, 10 m speed test and 300 meter run test) significantly improved in the EG after the same training period.

At baseline, the students' BMI was classified as overweight (Cole et al. 2007), which is similar to that reported by Lazzeri et al. (2014) for adolescents in Southern Italy. Even the WC values were high, indicating an increased risk of cardiovascular disease (Savva et al. 2000). It is well known that overweight and obesity have a negative impact on the health of youths (Ebbeling, Pawlak, and Ludwig 2002; Janssen et al. 2005; Must et al. 1992) who respond effectively to preventive treatments (Lau et al., 2007; Rees, 1990).

In effect, our results are in accordance with the literature regarding the efficacy of physical activity in preventing overweight and obesity, showing that insufficient physical activity is one of the important risk factors for obesity (Brock et al. 2009; Lau et al. 2007). However, few research studies conducted with a rigorous design and appropriate sample size have objectively evaluated the effects of physical activity performed after school compared to that performed only during school hours. For example, an observational design study by Crouter, Salas, and Wiecha (2016) found significant improvements in strength and body composition in obese youth after a three-month afterschool fitness program. Similarly, in a non-randomized controlled trial, Li et al. (2014) investigated the effects of a multi-component physical activity intervention lasting 12 weeks that included improvement of physical education, extracurricular physical activities for overweight/obese students, physical activities at home, and health education lectures for students and parents. The results showed an effective decrease in BMI among young students.

However, our findings extend the existing results because we additionally observed improvements in measures of agility, speed, and anaerobic power in adolescents following an extracurricular training program. In fact, we encourage this MT protocol because in addition to having obvious health-related benefits, it helps reveal the natural development potential of adolescents. In particular, CODS and agility maneuvers are multidimensional skills requiring the control of individual components of body position, muscle activation, force production and cognitive interpretation (Sheppard and Young 2006; Young and Farrow 2006). Consequently, improvements in the 505 CODS test by the EG after 12 weeks of training could indicate the development of motor skills such as agility, balance, coordination, speed and power. In addition, improvements in the 10 m and 300 m sprint performances could indicate increases in speed and anaerobic power, respectively.

With reference to the literature (Drinkard et al., 2001; Epstein, 1993) and our own findings, the positive effects of the MT on physical performance can most likely also be explained by the role of body composition. After 12 weeks, the subjects had lost weight, which resulted in improved physical fitness test results. Moreover, this improvement in performance could be a consequence of motor skill development, as these skills enable increased precision, accuracy and economy of movement (Garrett, Kirkendall 2000).

Also in support of our study, we provided parents and students with tips on lifestyle and nutrition education. It is known that family lifestyles have a large impact on the nutritional and behavioral choices of children; in fact, studies have shown an inverse relationship between children's BMI and family educational level (Gnavi et al., 2000).

This study has some limitations that need to be acknowledged. A major limitation of the present study is related to the origin of the subjects; the Apulian students cannot be considered a representative sample of the Italian population, although this group is representative of Southern Italy. In fact, there are differences in the lifestyles of adolescents due to their geographical areas of residence (Lazzeri et al., 2014). Further studies should be encouraged to perform research in other geographical areas. Moreover, we did not investigate the eating habits and lifestyles adopted at home or the level of parental education. However, the aim of this research was to determine the effects of physical activity and not the effects of nutrition education. Unfortunately, it was not possible for organizational reasons to investigate other components of physical fitness; therefore, further studies are needed to measure muscular strength, cardiorespiratory endurance and flexibility in young students.

However, the present research provides novel findings in the field of physical education. The findings indicate that a multilateral approach to training might play a key role in improving the health- and skill-related components of physical fitness while respecting the physiological and psychological maturation of adolescents. For this reason, promoting such activities after school would be beneficial for motor skill development and weight loss in students and would also improve their quality of life.

In summary, the review of literature underlines the lack of studies assessed objectively, and with a rigorous design, of interventions for adolescents outside the school setting. Our findings suggest that an extracurricular MT protocol was effective in improving physical efficiency and reducing weight in adolescents after a period of 12 weeks. Thus, inclusion of an extracurricular physical activity performed using a multilateral approach might be more beneficial than having only standard programs at school. More research on the importance of physical activity on the health of young students is needed, especially in Italy.

5. Practical applications

Professionals working in the fields of health, physical education, human movement studies and sport in schools should be encouraged to develop extracurricular activities with a multilateral approach consisting of cardiovascular endurance, agility, dynamic strength, flexibility, and team building, all characterized by a predominantly playful approach to encourage enthusiasm, socialization and participation of young students. Furthermore, these professionals should promote physical activity and plan social policies for the enhancement of sports for students, entrusting qualified personnel who are scientifically and pedagogically prepared to conduct motor and sports training programs.

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