Journal of Physical Education and Sport ® (JPES), 14 (3), Art.66, pp.431-437, 2014
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Physical fitness level in Italian high-school adolescents: a cross-sectional study

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Published online: September 30, 2014
(Accepted for publication September 29, 2014)

DOI:10.7752/jpes.2014.03066;

Abstract:
Physical activity is known to be an important factor in the promotion of people's health and physical efficiency. Regular physical activity participation has been associated with several health benefits; nevertheless, along with a high prevalence of overweight, obesity and sedentary behaviour, young people's physical inactivity has been found to be the main threat to health in the twenty-first century. Physical fitness is the best marker of health condition at any age and it is connected with both motor and psychological-affective benefits. However, young people show low levels of physical fitness. The goal of the study is to analyse the physical fitness levels in Italian adolescents in connection with gender differences. The sample consists of 460 students, attending the second and third year of high school (boys: n: 262, age: 16,2±0,7 years, height: 173,5± 6,1 cm, weight: 68,3±10,7 kg, BMI: 22,7±3,2; girls: n=198, age: 16,2±0,7 years, height: 159,8±5,9 cm, weight: 57,6±9,0 kg, BMI: 22,5±3,0). They underwent anthropometric and motor assessment (Standing broad jump, 2 Kg Overhead Medicine Ball Throw, Sit-reach, Sit-up, 10x5 m Shuttle Run test, Legér test) during physical education classes. The outcomes pointed out that boys produced a better performance than girls in standing broad jump, 2 Kg Overhead Medicine Ball Throw, 10x5 m Shuttle Run test and Legér test, while girls only produce a better performance in Sit-reach. They need to increase physical fitness levels, particularly girls, by attending physical education classes, which must offer a larger variety of motor contents and respect gender differences.
Key word: physical fitness, young, adolescent, school.

Introduction

Physical activity is known to be an important factor in the promotion of people's health and physical efficiency (U.S. Department of Health and Human Services, 2010; Janseen & LeBlanc, 2010). Participating in a regular physical activity has been associated with several health benefits (Biddle et al., 2004), nevertheless, young people's physical inactivity, in conjunction with high prevalence of overweight, obesity and sedentary behaviour, has been found to be the main threat to health in the twenty-first century (Blair, 2009).
Physical fitness has been defined as the result of body movement generated by muscles' action which increase expenditure of energy (McArdle et al., 2001).
It has been erroneously defined as a synonym of aerobic fitness rather than being considered a definition that embraces all components concerning health (Hands et al., 2009). Indeed, it includes different components such as endurance, strength, flexibility, coordination, balance (Knapik et al., 2006).
Physical fitness represents the best index of health condition at any age (Ortega et al., 2008). It has been positively associated with benefits on cardiovascular system, levels of total and abdominal adiposity, skeletal apparatus, depression, anxiety, self-esteem and school achievement (Catley & Tomkinson, 2013; Van Dusen et al., 2011; Ortega et al., 2008).
Childhood and adolescence represent crucial moments of life, when lifestyle and healthy or unhealthy behaviour determined at this age may affect health condition in adulthood (Ortega et al., 2008). It has been demonstrated that physical fitness is determining of lifestyle in connection with motor performance as well as individual health condition, and this information has produced much evidence on variation of this aspect in adolescents (Catley & Tomkinson, 2013; Dyrstad et al., 2012; Sandercock et al., 2012; Marta et al., 2012a,b; Sauka et al., 2011).
A number of researches reported that today children are not physically active as their peer were in past decades (Dyrstad et al., 2012; Huotari et al., 2010), although other Authors did not notice any difference (Malina, 2007; Jurimae et al., 2007).
Some researches have pointed out that annual decrease of physical fitness is about 0,36% since 1970 (Hardly et al., 2007).

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A study carried out on Finnish adolescents reported a reduction of aerobic fitness of 6-10% between 1976 and 2001 for boys and girls aged 13-18 (Huotari et al., 2010), whereas they found no difference in Danish adolescents aged 15 to 19 in terms of maximum oxygen consumption during 1983,1997 and 2003 (Andersen et al., 2010).
A recent study indicated that in Norwegian teenagers between 1980 and 2000, the annual rate of decline in aerobic fitness is 0.50% for boys and 0.36% for girls (Dyrstad et al., 2012).
Some researchers have confirmed this trend: they have shown a decrease in aerobic fitness in both sexes among English young people and they pointed out that 27.1% of boys and 19.8% of girls do not follow the international recommendations (Sandercock et al., 2012).
The analysis of components such as muscular strength, speed and flexibility did not show a homogeneous trend (Luguetti et al., 2010; Albon et al., 2010; Jurimae et al., 2007).
A review analysing speed and strength performance in children (aged 6-12) from different countries between 1958 and 2003, revealed it is emerging a new negative trend since 1980 (-0.08% - -0.25% per year), even though values for these abilities resulted stable during that period (Tomkinson, 2007).
Analysing performance of children aged 7 to 16 years in 9-minute run, standing broad jump, medicine ball throw and 1-minute curl-up, some researchers have drawn attention to a reduction (often over 50%) of performance in all tests, for both sexes, particularly girls (Luguetti et al., 2010).
Whereas a recent study showed that Spanish adolescents improved performance in 4x10m and 20m shuttle run test and they worsened performance in hand grip test and standing broad jump comparing 2001-2002 and 2006-2007 (Moliner-Urdiales et al., 2010).
With respect to this evidence, there are few studies on Italian adolescents aiming to analyse various components of physical fitness (Lovecchio et al., 2012; Olds et al., 2006).
The aim of this study wants to analyse physical fitness levels in Italian high-school student according to sex in a cross-sectional study

Materials and methods

Participants

The sample consists of 460 students (boys: n= 262, age: 16,2±0,7 years, height: 173,5± 6,1 cm, weight: 68,3±10,7 kg, BMI: 22,7±3,2; girls: n=198, age: 16,2±0,7 years, height: 159,8±5,9 cm, weight: 57,6±9,0 kg, BMI: 22,5±3,0) attending the second and third year of high school. Adolescents were selected on a voluntary basis. Before selection, adolescents parents or tutors were informed about aim and methods of the study and they were asked for a written informed consent for their children to participate in the study.

Procedure

Subjects underwent anthropometric and motor assessment carried out between January 2012 and May 2013 during curricular physical education lessons.
Height was measured to the nearest 1.0 cm using a portable stadiometer (SECA 220; Hamburg, Germany).
Weight was measured with a high precision electronic scale (SECA 761; Hamburg, Germany), which was calibrated before each measurement using a standard weight. The body mass index (BMI) was calculated by dividing the weight (expressed in kg) by the square of the height (expressed in metres).
Motor abilities were assessed by:

- **Standing broad jump (SBJ)**: Subject is positioned behind the starting line with feet slightly apart in line with shoulders. Then he is required to jump horizontally as far as possible, with both feet. Distance is measured in cm from the starting point to the subject's heels. Two tests were recorded and the best one was chosen. This test evaluates lower limb explosive-strength. (Council of Europe Committee for the Development of Sport, 1993; Adam et al., 1988);
- **Sit-up test (SU)**: Subject is in supine position, with the knees bent and hands behind the head. The examiner places himself in front of the subject, holding his heels. On the starting-signal, the subject raises the trunk touching knees with elbows, and then he comes back in the starting position with shoulders on the ground. Examiner counts how many times subject flexes his trunk for 30 seconds. This test evaluates endurance of the abdominal muscles (Council of Europe Committee for the Development of Sport, 1993; Adam et al., 1988)
- **2 Kg Overhead Medicine Ball Throw (MBT)**: Subject stands behind the starting line with feet slightly apart in line with shoulders, then he throws 2kg medicine ball overhead. Two tests are performed and the longest distance is reported in cm. This test evaluates the upper limb strength (Morrow et al., 2005);
- **10x5 m Shuttle run test (10x5)**: Subject is required to run back and forth as fast as possible ten times, along a 5 m course. Test is performed twice and the best performance is chosen and expressed in decimals. This test evaluates speed of movement, agility and coordination (Council of Europe Committee for the Development of Sport, 1993;Adam et al., 1988);

- **Sit and reach test (SR)** : Sitting down with legs out straight ahead, subject bends forward slowly without dashing, trying to push fingers as far as possible on the measuring board. The position of utmost extension has to be held for 2-3 seconds. The value obtained is recorded, and it is positive if it is greater than zero and negative if it is less than zero. Test is performed twice with a few minutes rest between each set. This test evaluates flexibility of lower limbs (Council of Europe Committee for the Development of Sport, 1993; Adam et al., 1988);
- **Legér test (VO_2Max)**: Subject is required to run back and forth between two lines 20 metres apart, maintaining a pace set by a pre-recorded sound signal. Initial running speed is 8.5 km/h, increased by 0.5km/h each minute. Subjects runs in a straight line and changes direction at the end of the course, respecting the sound order. Test ends when subject is not able anymore to reach the end of the course at the rhythm of the sound signal for three consecutive times. VO_2Max indirect value is registered using the following formula: VO_2Max (ml kg^{-1} min^{-1})= $31.025+3.238X_1$ $-3.248X_2$ $+0.1536X_1X_2$ where X_1=shuttle run maximum speed (Km h^{-1}) and X_2= age of the subject. This test evaluates aerobic endurance (Leger & Boucher, 1980).

Statistical analysis

Descriptive statistics has been used for statistical analysis (mean ± D.S.).

One-way analysis of variance (ANOVA) has been used to examine differences according to gender in motor tests. Data has been analyse using the SPSS (Version 12; SPSS Inc., Chicago) and significance set by $p<0.05$.

Results

Differences in gender in motor test

Significant differences emerged in favour of boys in standing broad jump (SBJ) ($F(1,456)=567,135$, $p<0.0005$), in sit-up ($F(1,458)=156,465$, $p<0.0005$), and in 2 Kg overhead Medicine ball throw (MBT) ($F(1,458)=487,354$, $p<0.0005$), in 10x5 m shuttle run test ($F(1,457)=100,813$, $p<0.0005$) and in Léger test ($F(1,417)=268,111$, $p<0.0005$), while significant differences emerged in sit-reach for girls ($F(1,458)=156,465$, $p<0.0005$). Results are summarised in table 1:

Table 1 Motor tests results by boys and girls (mean ±D.S.)

	SBJ (cm)	SR (cm)	SU (n°)	MBT (cm)	10x5 (s)	VO_2Max (ml/kg/min)
Boys (n=262)	190,2±25,3#	-0,6±9,5	20,3±3,6#	799±150,6#	19,70±2,28#	42±5,8#
Girls (n=198)	136,3±22,2	6,3±8,8#	15,9±4,0	521,9±106,2	21,93±2,44	33,8±3,7

# $p<0.0005$

Discussion

Physical fitness is a powerful marker of physical condition, especially in adolescents (Ortega et al., 2008), and this stresses need for significative and accurate assessment on this issue in young people.

Although international literature has been dealing with this topic for several years, there are still few data on Italian adolescents' physical fitness (Lovecchio et al., 2012; Olds et al., 2006). Apparently, this is the first cross-study which analyses physical fitness levels in adolescents.

Results from this study pointed out that boys have greater performance than girls in standing broad jump, in sit-up, in 2 Kg overhead Medicine ball throw, in 10x5 m shuttle and in Léger test, whereas, in comparison with boys, girls have greater performance in sit-reach test.

Comparing these values with those in other studies (Catley & Tomkinson, 2013; Lovecchio et al., 2012; Ortega et al., 2011; Sauka et al., 2011; Castro-Piñero et al., 2009), it emerged that, apparently, these results are lower than European values (Ortega et al., 2011; Sauka et al., 2011) and extra-European ones (Catley & Tomkinson, 2013).

Results from this study confirm those of other Authors who emphasise better performance of boys' tests for speed, strength and endurance (Catley & Tomkinson, 2013; Marta et al., 2012b; Cepero et al 2011; Castro-Piñero et al., 2009; Hands et al., 2009).

More recent studies pointed out that boys show better values than girls in tests for speed, strength and endurance (Catley & Tomkinson, 2013; Sauka et al., 2011). Some researchers pointed out that, compared to girls, boys, aged 12 to 15, showed better performance in vertical jump, medicine ball throw, sit-up and push-up tests (Bovet et al., 2007). Similar results have been found in Spanish adolescents aged 13 to 18 years in standing broad jump and sit-up (Casajus et al., 2007; Ortega et al., 2005), and in Latvian teenagers in standing broad jump, sit-up, 10x5 m shuttle run test, and in handgrip test and in endurance shuttle run test (Sauka et al., 2011).

This difference in gender might be explained by factors of physical growth such as specific sex changes in terms of lean and fat body mass (Marta et al., 2012b; Artero et al., 2010), length of bones (Neu et al., 2002) and hormonal modification, particularly in testosterone (Sheffield-Moore, 2000).

In line with other studies of literature boys showed better values than girls in tests for endurance (Catley & Tomkinson, 2013; Nes et al., 2013; Ortega et al., 2011; Sauka et al., 2011). Explanation for this difference might depend on girls' modifications of cardiac section and capacity of oxygen transportation (Dencker et al., 2007), as well as an increase of fat mass associated with the process of growth (Nes et al., 2013).
In regard to flexibility, in this study girls showed higher values in sit-reach in comparison to boys. These results are in line with other studies which confirmed this gender difference for flexibility (Catley & Tomkinson, 2013; Castro-Piñero et al.,2013; Sauka et al., 2011). Some Authors reported that girls aged 6 to 18 have a better flexibility than boys (Chen et al., 2006). Similar results have been found in Spanish adolescents aged 13 to 18 years (Casajus et al., 2007; Ortega et al., 2005) and 6 to 17 years (Castro-Piñero et al., 2013).
Differences in gender in this study might be explained by difference in muscle and tendon extensibility, a greater passive dorsiflexion angle in girls, because boys have greater muscle volume (Marta et al., 2012b; Kato et al., 2005).
Gender differences might be connected with different physical activity levels in both sexes (Trang et al., 2012, Hallal et al., 2012).
Several study pointed out not only that boys have higher levels of physical activity in comparison with girls (Payne et al., 2013; Marta et al., 2012b; Hallal et al., 2012), but also that these levels are connected with physical fitness (Keiner et al., 2013; Nes et al., 2013; Dencker et al., 2008; Tovar et al., 2008).
Some Authors have found a positive and significant connection between physical activity and multistage fitness test (Tovar et al., 2008). More recent studies emphasized how subjects who have low physical activity levels have lower performance in both strength and aerobic endurance tests (Keiner et al., 2013; Nes et al., 2013).
A study examined relationship between aerobic fitness (cycloergometer) and physical activity (accelerometer) in 270 students aged 9 to 15 years and they found that, after puberty, difference between sexes might be explained by gender difference in physical activity levels (Sveinsson et al., 2009).

Conclusions

Physical fitness levels are one of the most important aspects for what concerns health condition in young people. This is the first analysis carried out on such a wide sample and that assessed different motor capabilities giving a more complete picture in physical fitness levels in Italian students.
From this study it emerged not only that boys have better performance in physical fitness than girls but above all that these values are not in accordance with European and extra-European standards (Catley & Tomkinson, 2013; Lovecchio et al., 2012; Ortega et al., 2011; Sauka et al., 2011; Castro-Piñero et al., 2009). This trend is nothing but the outcome of the decrease in terms of physical activity and physical fitness all over the world in last decades (Hallal et al., 2012; WHO, 2010).
In this context, school plays a key role in identifying and helping adolescents with low physical fitness levels (Ortega et al., 2011). School is recognized to be the ideal environment to promote activities concerning health, not only because it involves many young people, but also because some studies emphasized that interventions in this environment are more effective and successful (Londsale et al., 2013; Liukkonen et al., 2010). Physical education is part of the school curriculum and its goal is to achieve human and motor development through the knowledge and practice of various physical activities (Fairclough & Stratton, 2005). Besides, it aims to promote healthy life styles through an increase of modest and vigorous physical activity (Dudley et al., 2011; Liukkonen et al., 2010).
When students have a positive experience from their involvement in physical education, it is more likely that they will regularly engage in physical activity in adulthood (Hardman, 2008).
One of the advanced reasons for these decreased physical activity and fitness levels in young people is the reduced participation in physical education classes. It is partly due to a lack of planning, without any regard to interest, motivation and gender differences (Marta et al., 2012b). Physical education classes involve both boys and girls; therefore, teachers are required to find a connection between the intended goals and specificity defined by differences in gender.
Some Authors underlined how, in order to increase physical activity levels, more effective intervention strategies are determined by the choice of teaching strategies: they focus on the selection of physical activity matters, as well as the organization and management of class group, by integrating ordinary physical education class with high-intensity activities (Londsale et al., 2013). The goals of physical education are reached through mutually integrated teaching styles (production and reproduction) (Mosston & Ashoworth, 2002) and a wide variety of activities and motor tasks.
In particular, production styles promote the learning of motor skills, apart from differences in gender, since they foster autonomy and cooperation (social factors); revision and motor creativity (cognitive factors); student's enjoyment (emotional factors); cross learning among curricular teaching.
Teaching strategies (Rink, 2002) allow to personalize practical proposals, with regard to individual motivations and perception of competence which systematically requires the development of individual motor abilities.
Several studies pointed out how motivational climate caused by physical education teacher could affect students' motor experience during classes (Piccinno & Colella, 2013; Braithwaite et al., 2011). If it is aimed at personal

growth, opportunity to show leadership, and capacity to take a decision (e.g. selecting difficulty of motor subjects, rhythm and group composition), a motivational climate has a positive impact both on students' expected results and appreciation index for physical activity during classes (Piccinno & Colella, 2013). Moreover, physical education classes need to vary motor practice, in order to ensure an increase in appreciation index and, above all, a progressive increase of physical activity practice, particularly for girls (Juvancic-Heltzel et al., 2013; Barkley et al., 2011).

The choice of a varied physical activity allows body to be involved entirely and to adapt in different ways, and, therefore, to avoid the risk of accident of overuse or repeated movements, typical of chronic physical activity (A.C.S.M., 2009; Wong et al., 2008).

It's necessary to adopt strategies to improve physical fitness level in adolescents, particularly in girls, during physical education classes, respecting gender differences and developing a true motivational climate.

Conflicts of interest: The authors declare that they have no conflicts of interest.

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