Research Paper

EVALUATION OF PHYSICAL FITNESS IN PRE-ADOLESCENT BOYS FROM NORTHERN GREECE IN COMPARISON WITH INTERNATIONAL STANDARDS

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Abstract

Although normative data for physical fitness parameters are available at International and European level, contemporary normative scores from North-East Greece are sparse. Moreover, direct comparison of physical fitness data to European norms is still absent. **Objective**. This investigation aimed to evaluate the cardiorespiratory and musculoskeletal fitness of Greek pre-adolescents from North-East Greece in comparison to current European reference norms. **Method**. 300 pre-adolescent (mean Tanner stage A: 1.67 ± 0.6; mean Tanner stage B: 1.65 ± 0.6) boys and girls (mean age: 9.4 ± 1.1 years) completed a testing battery of 20-m shuttle run test (20m SRT), handgrip strength, and standing broad jump. Scores for each testing parameter were compared against European age- and sex-specific centiles and then grouped into quintiles. **Results**. For all testing parameters, 60-81% of participants were classified as having physical fitness performance scores of "moderate" or lower level. No differences were noted between boys and girls. Data corroborated that physical fitness levels of Greek pre-adolescent boys and girls are among the lowest recorded in the European region. **Conclusion**. This data suggest that physical fitness levels of pre-adolescents in North East Greece may be suboptimal, which strongly indicates the need for adopting large-scale fitness assessments in this particular region

Key words: cardiorespiratory fitness; musculoskeletal fitness, 20m shuttle run test, handgrip testing, standing long jump

Introduction

Physical fitness or physical conditioning is a number of physical attributes (i.e. body composition, cardiovascular conditioning, muscular strength and muscular endurance, muscle power, speed, agility, reaction time, joint range of movement, balance) that are associated with both performance and health (4,13). In youth, the attributes that are inherently to health status are body composition, musculoskeletal conditioning (i.e. muscular strength, endurance and power), cardiovascular conditioning, and joint range of motion (4,10,11,25,33). Cardiovascular conditioning refers to the ability of the contracting muscles to acquire and use oxygen to support its substrate energy metabolism during exertion (1) and represents a significant overall health index of (18). As maximal or peak oxygen consumption (VO_{2max}) is considered the highest rate of oxygen consumption during physical activity (PA) (1) and is globally utilized as a marker of cardiovascular fitness in children and adolescents (1). VO_{2max} is typically expressed per kg of body mass (mL/kg/min) since it is highly associated with body mass (1). The level of cardiovascular conditioning is inversely related to the risk of metabolic and cardiovascular diseases as well as with all-cause mortality, academic status, and mental health (6,9,18,24). On the other hand, the level of musculoskeletal conditioning is associated with youth's overall physical and psychological integrity (25).

Although cardiovascular fitness is of paramount importance for the youth, it is debatable whether this physical attribute deteriorates over time (8,20,30) mainly due to variations in the operational definitions assigned to it by the scientific community (2), i.e. expressed relatively to body mass (mL/kg/min) or not with former representing relatively small fluctuations over time (1). However, when cardiovascular fitness is expressed in terms of performance based on field test (e.g. shuttle run tests), it appears to decline during the last 50 years (2,3,20,26,31,32,35). For instance, in England field test based cardiovascular fitness appears to deteriorate at a rate of 8% per decade (23,26) while other countries demonstrate lower declining rates for this physical attribute (30). According to the European fitness maps for cardiorespiratory and muscular fitness, Greece is among the lowest ranked countries in the European Union (EU) region (18). Moreover, the increased prevalence of obesity in Greece (17) appears to have a negative impact on physical performance of Greek pre-adolescents (12,33). As such, the aim of this study was to evaluate the physical fitness status of Greek pre-adolescents in comparison to international data.

Methods

Study design

The work is part of a larger project studying the effects of organized sport participation on bone metabolism and physical fitness in pre-adolescent primary school children. The study here used a cross-sectional design to determine the physical fitness status of boys and girls in the year 8 to 12 cohorts in the city of Komotini in North-Eastern Greece.

Participants

Study participants were recruited by word of mouth, fliers posted in schools, playgrounds as well as other places that children spend time in the city of Komotini. Participation was secured if children (girls) were at the premenarcheal period, had an age of 8-12 years, were free of any musculoskeletal or other health issue 12 months prior to the study, had a maturity level on Tanner scale ≤ 3 and were not involved in organized sports or systematic exercise. Initially, the parents/guardians of 585 boys and girls were approached and 486 agreed to participate. Thereafter, 186 children were excluded because they did not meet the inclusion criteria or failed to follow the study's procedures. The experimental procedures were in accordance with the World Medical Association Code of Ethics (Helsinki Declaration, as revised in 2013), and approval was obtained from the Institutional Ethics Committee. Participants legal parents/guardians signed an informed written consent and each child provided a verbal consent to participate in this investigation.

Measurements

Participants' body mass was determined to the nearest 0.1 kg following fasting (8-h) in their underclothes on an electronic scale (Soehnle 7840; Soehnle, Nassau, Germany). Barefoot standing height was ASSESSED to the nearest 0.1 cm using a wall-mounted stadiometer (SECA 220; Seca, Hanover, MD). Body mass index (BMI) was calculated as mass (kilograms) per height (meters) squared. Body composition was measured using dual-emission X-ray absorptiometry (GE Healthcare, Lunar DPX-NT) as previously published (22). The Tanner's 5-stage diagrams (for breast and pubic hair development) were used to assess participants' pubertal stage (27).

Cardiorespiratory fitness (CRF) was measured using the 20-m Shuttle Run Test (SRT) (15) and it was expressed as the number of completed stages (18) using procedures previously described (29). The handgrip strength was used as a measure of muscular strength. Handgrip strength was measured using a calibrated Harpenden (British Indicators, UK) handgrip dynamometer with participants standing, their wrist at a neutral position, the measured elbow at full extension as previously described (21). Participants were requested to squeeze the dynamometer progressively and continuously for at least three seconds. Two efforts were allowed with a 3-minute interval in between and the maximum score was recorded for subsequent analysis. For this work, the average of the best score recorded from both hands (dominant and non-dominant) was used in our analyses. The muscular power of the lower limbs was determined using the standing broad jump performance. Participants stood behind a reference line with their feet together and jumped forward as far as possible. Participants were asked to land with their feet together and maintain an upright posture. Performance was assessed as the distance between the reference line to the back of the heel that landed closest to the reference line using a tape (5). Following three practice attempts, participants performed three jumps and the best performance was recorded for subsequent analysis.

Data analysis

Participants' performance for each physical fitness parameter was classified into age- and sex-specific centiles relative to International normative data (18,7,26). A quintile system was utilized for data reporting (28,29) according to which participants classified as: (i) in centiles < 20 were identified as exhibiting "very low" level of a fitness parameter; (ii) in centiles 20 through 40 were identified as exhibiting "low" level of a fitness parameter; (iii) in centiles 40 through 60 were identified as exhibiting "moderate" level of a fitness parameter; (iv) in centiles 60 through 80 were identified as exhibiting "high" level of a fitness parameter; and (v) in centiles > 80 were identified as exhibiting "very high" level of a fitness parameter; For each fitness parameter, we report both the frequency and percentage of participants in each quintile as previously described (29).

Results

Table 1 presents participants' characteristics. Participants' mean age was The mean age of the participants was 9.2 years, with a BMI 18.4 and mean body fat of 29.6. The mean Tanner values were < 2 suggesting that participants were in the pre-adolescent range. Boys completed an average of 3.59 stages (± 0.9) in the 20m SRT whereas girls completed a comparable mean number of stages in the same test (3.56 ± 0.9). Boys jumped on average a larger ($p < 0.05$) distance in the standing long jumps than the girls (1.31 ± 25.5 vs. 1.25 ± 22.8 m). Mean handgrip strength of the sample was 13.3 kg (Table 1). Boys and girls had a comparable performance in handgrip strength testing (16.3 ± 5.4 vs. 14.8 ± 4.4 kg).

Table 2 presents the quintile classification of participants for physical fitness parameters based on European normative values (18). For 20mSRT performance, 8.3%, 10.3%, 32%, 32.3% and 17% of participants' scores fell within the "very low", "low", "moderate", "high" and "very high" quintiles, respectively. For handgrip strength performance, 12.7%, 22%, 20.3%, 26.3% and 18.7% of participants' scores fell within the "very low", "low", "moderate", "high" and "very high" quintiles, respectively. For standing long jump performance, 19.3%, 20%, 18.7%, 23.7% and 18.3% of participants' scores fell within the "very low", "low", "moderate", "high" and "very high" quintiles, respectively. No differences were noted between boys and girls.

Table 1. Participants' characteristics.

Variable	
Sample size	
All	N = 300
Boys	N = 156
Girls	N = 144
Age (years)	
All	9.47 ± 1.1
Boys	9.49 ± 1.0
Girls	9.48 ± 1.1
Weight (kg)	
All	37.2 ± 10.7
Boys	37.3 ± 10.3
Girls	37.1 ± 11.1
Height (m)	
All	1.408 ± 12.0
Boys	1.408 ± 11.1
Girls	1.409 ± 12.9
BMI (m/kg^2)	
All	18.43 ± 3.2
Boys	18.55 ± 3.3
Girls	18.30 ± 3.0
Body fat (%)	
All	29.59 ± 9.9
Boys	27.55 ± 10.6
Girls	31.80 ± 8.6
Tanner A	
All	1.67 ± 0.6
Boys	1.75 ± 0.7
Girls	1.59 ± 0.6
Tanner B	
All	1.65 ± 0.6
Boys	1.69 ± 0.6
Girls	1.61 ± 0.7

Table 2. The quintile classification of participants for physical fitness parameters based on European normative values (Ortega, 2023).

Fitness Parameter	Total sample	Boys	Girls
20 m Shuttle running test (stages)			
Mean ± SD	3.57 ± 0.9	3.59 ± 0.9	3.56 ± 0.9
Very high	17.0%	17.9%	16.7%
High	32.3%	33.3%	31.3%
Moderate	32.0%	30.7%	33.3%
Low	10.3%	11.6%	9.00%
Very low	8.33%	6.50%	10.4%
Handgrip strength testing (kg)			
Mean ± SD	15.59 ± 5.0	16.3 ± 5.4	14.79 ± 4.4
Very high	18.7%	23.7%	13.3%
High	26.3%	23.1%	29.8%
Moderate	20.3%	17.3%	23.6%
Low	22.0%	24.4%	19.4%
Very low	12.7%	11.5%	13.9%
Standing long jump (meters)			
Mean ± SD	1.28 ± 24.4	1.30 ± 25.5	1.25 ± 22.8
Very high	18.3%	15.4%	21.5%
High	23.7%	22.4%	25.0%
Moderate	18.7%	19.3%	18.0%
Low	20.0%	21.1%	18.8%
Very low	19.3%	21.8%	16.7%

SD, standard deviation.

Discussion

Available published norms on physical fitness levels in Greek pre-adolescents are limited and in some parts of the country, entirely non-existent. The goal of this investigation was to determine the physical fitness parameters in 8- to 12-year-old children from North-Eastern Greece and compare them against European age- and sex-specific normative values (18).

Compared to the European fitness landscape using norms derived from 34 countries (n = 8,000,000), gathered by the FitBack network (18), the 20mSRT values for number of stages completed, 81% of our pre-adolescents had a CRF of "very low" to "moderate" (levels) with no differences noted between boys and girls. A similar trend has been reported for children of the same age in England (36) although boys scored higher than girls in that study. Although participants in this study demonstrated a relatively lower BMI, their body fat was increased corroborating previous findings of increased prevalence of obesity in northern Greece (12). Previous data suggest that obesity may contribute to a lower physical performance in Greek children of both sexes (33). However, there is no data available to show that children of a higher body fat mass may complete fewer shuttles in 20m SRT due to a limited cardiorespiratory fitness per se or it could be attributed to their ability to carry a higher body mass and thus perform more work per shuttle or even due to a lower muscle mass. To determine that would need a direct measurement of VO_{2peak} expressed in relative terms (per kg of body or fat-free mass) (16) and then to be contrasted with performance in 20mSRT, which was not within the aims of this study. These results corroborate previous findings suggesting that children in Northern (Denmark, Finland, Iceland and Norway) and Central Eastern European countries

(Slovenia, Czech Republic and Slovakia) have the highest level of CRF fittest while children in Southern European countries (Spain, Italy and Greece) and the UK are have the lowest level of CRF (18).

It is potentially alarming the fact that > 60% of participants' performance in handgrip strength and standing long jump performance was characterized as "moderately" or below (26) corroborating previous longitudinal data showing negative associations between decreasing musculoskeletal fitness from childhood to adolescence and changes in fat mass (14,34). In agreement with previous reports data for boys and girls were comparable in these two tests (26). However, it must be noted here that the standing long jump have high skill requirements and performance in this particular test is dependent on mechanics, coordinative abilities, and somatometrics of a child (5,19).

Collectively, data from this study indicate the need for using fitness testing batteries in youth (25). This is the first study to provide information on physical fitness level of 8- to 12-year-old boys and girls from North East Greece. A potential limitation of this investigation is its participants' small size and narrow age range and thus our data may not be generalized to children of the same age across all of Greece. This data suggest that physical fitness levels of pre-adolescents in North East Greece may be suboptimal, which strongly indicates the need for adopting large-scale fitness assessments in this particular region. Future investigations must recruit larger sets of pre-adolescents in that region and, if possible, performance data should be obtained at different time points during the school year and repeated longitudinally to track potential trends.

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