

Correlation between Aerobic Fitness and Body Composition in Middle School Students

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ABSTRACT

Background: Since correlations have been found between body composition and physical activity in different parts of the world, inactivity and poor physical condition likely contributes main factors in childhood obesity. This study was implemented to determine the relationship between cardiovascular fitness and body-composition in a group of Iranian middle school students.

Methods: In this descriptive study, subjects comprised of 12,946 students (10,531 girls and 2,415 boys aged 11–13 years) in the city of Isfahan. Height, weight, body-fat percent, body mass index, and cardiovascular fitness of the aforesaid students were measured by valid tests.

Results: This study showed that fat percentage and aerobic fitness (VO₂ max) of girls were 24.73%, and 29.5 (ml/kg/min) and boys 19.32% and 36.4 (ml/kg/min) respectively. Results also revealed that there was a negative significant correlation between fat percent and aerobic fitness of boys ($r = -0.81$), and girls ($r = -0.77$) respectively.

Conclusions: To conclude, this study signifies that fat percentage augmentation leads to a decrease in aerobic fitness of children. Thus, fat percentage can be associated with different chronic diseases such as cardiovascular ones.

Keywords: Body composition, aerobic fitness, Isfahan, obesity, students

INTRODUCTION

Incidence of obesity and overweight in children of some societies had increased dramatically; this is one of the main factors seems related to the development of obesity.^[1,2] Different studies in this area indicate that one in four children aged 6–14 years (from 11% to 39%) in developed and developing countries, is overweight or obese.^[3] On the other hand, low levels of physical activity are not only associated with the failure of health related physical fitness, but also inactivity correlates with the development of hypercholesterolemia, hypertension, metabolic syndrome, type 2 diabetes and cardiovascular diseases, in both adults and

children.^[4] In addition, it seems plausible to assume that higher level of physical fitness in children results in a more favorable body composition. Nonetheless, lack of ample data and applicable examinations, in regards to the relationship between aerobic fitness and body fatness, obscure the correlation between cardiovascular fitness and body composition in Iran.^[5] Moreover, little is known about the relationship between physical fitness and different body composition indicators such as body mass index (BMI), and the percentage of body-fat in children. To the best of our knowledge, no information is available demonstrating interdependence between obesity and physical activity indicators in Isfahan school children. Therefore, this study was carried out to determine the relationship between cardiovascular fitness and body-composition in school children aged 10–13 years in Isfahan.

METHODS

Subjects

This cross-sectional study comprised 12,946 students of middle schools from the city of Isfahan. Evaluations were performed during February to May 2010 school program, and stratified random sampling was used. At first, 30 schools were identified and randomly selected from the city of Isfahan, and their pupils were become familiar with the aims of the study. Not only, informed consents were obtained from guardians of students, but also medical history questionnaires were filled by parents. Participants and their guardians were informed that they could withdraw from the study at any time. Furthermore, the aims of the study explained to both physical education teachers and school administrators. All of the Participants, at the time of the project implementation, were in good health status comprising different aspects of locomotive, cardiovascular, and endocrine systems. In addition, no participant was on medication at the time of the study.

Measurements

Each child underwent a 1-day testing session. During this session, anthropometric assessment and physical fitness test were carried out. Height and weight were measured by using a stadiometer and

calibrated balance beam scale (Novin, Iran) while scale intervals were 0.5 cm and 0.2 kg respectively. Skin-fold tests at three sites were implemented by a validated caliper. The skin-fold site included triceps, subscapular, and medial calf. The landmarks were identified and measured in accordance with Lohman and Timothy procedure.^[6] The percentage of body-fat was determined in accordance with gender-specific equations: (If triceps and sub-scapular >35 mm; %fat = $0.783 \sum SF + I$ males and %fat = $0.546 \sum SF + 9.7$ females; and If triceps and subscapular <35 mm; %fat = $1.21 [\sum SF] - 0.008 [\sum SF]^2 + I$ males and %fat = $1.33 [\sum SF] - 0.013 [\sum SF]^2 + 2.5$ females).^[6] BMI was calculated as weight (kg)/height (m)². Children were considered overweight or obese based on age-specific BMI reference guidelines.^[7,8] Both Waist and hip circumferences were measured by a flexible tape at the level of the narrowest point between the lower costal border and the iliac crest, and the widest region of the hip, respectively.^[6] Aerobic fitness or VO₂ max of subjects was determined by pacer 20-m shuttle-run test.^[9] Subjects were required to run back and forth on a 20 m course and be on the 20 m line at the same time a beep is emitted from tape. The frequency of sound signals increased in such a way that running speed starts at 8.5 km/h and increased by 0.5 km/h each min. When the subjects could no longer follow the pace, the stage, the subjects were able to run for, was recorded and used for calculating the VO₂ max.^[9]

Statistical analysis

Descriptive statistics were run on all the variables. The relationships between body-fat, BMI, and waist-hip ratio (WHR) and aerobic fitness (VO₂ max) were examined by Pearson's product-moment correlation coefficient, and $P < 0.05$ considered as statistically significant. Data were analyzed using the SPSS-PC software (version 20, IBM SPSS inc., USA).

RESULTS

The descriptive data (mean \pm standard deviation) of the measured variables including height, weight, WHR, BMI, body fat percent and cardiovascular fitness are shown in Table 1, and the results of statistical analysis and comparison of measured

variables are shown in Table 2 and Figures 1-4. There were significant differences between male and female students' fat percentages (21.12% vs. 19.32% $P < 0.05$, respectively). In comparison with girls, boys showed significantly lower BMI, WHR, and body-fat percent ($P < 0.05$). Moreover, boys attained better performance in aerobic fitness test and therefore had higher VO_2 max ($P < 0.05$). Relationship between body-fat and VO_2 max for each gender is illustrated in Table 2. There were significant and inverse correlations between fat percent and VO_2 max of subjects. This inverse correlation was higher in boys ($r = -0.81$; $P < 0.01$), whereas girls demonstrated moderate correlation ($r = -0.77$; $P < 0.01$).

DISCUSSION

This study demonstrated that aerobic fitness increases in inverse proportion to body-fat in Isfahan school children aged 11–14 years, also findings demonstrated that the prevalence of overweight differed between boys and girls. Moreover, the latter ones had lower levels of aerobic fitness compared with their male counterparts. Previous studies reported that the prevalence of obesity in Belgian adolescents was 7.5%. However the prevalence of overweight and obesity differed significantly by level of education.^[8,9] It has been

reported that prevalence of overweight in Mexican boys and girls using Centers for Disease Control and Prevention percentiles ranged from 10.8% to 16.1% and 14.3% to 19.1% respectively, whereas their obesity prevalence altered differently (from 9.2 to 14.7% and 6.8 to 10.6% in boys and girls respectively). Furthermore, obesity prevalence among Spanish children ranged from 5% to 8%.^[9] This prevalence in Qatari adolescents were 7.9% 4.7% in males and females, respectively.^[4,10]

Childhood obesity was emerging as a worldwide epidemic problem (38% for boys and 63% girls) when children, who were obese and overweight by BMI criteria, were considered together. Another study reported that over 37% of children from Birmingham fell into overweight and obese classifications. Indeed, one in five children (22%) had more than 30% body fat, and obese group comprised almost girls (90%).^[11] This report also showed that 71% of children had a percentage of body-fat in excess of 20%, which was recognized as the upper end of the optimal range. In fact, the above-mentioned study indicates that boys tend to have a higher prevalence of obesity than girls (17% vs. 15% respectively).^[11] On the other hand, an interesting gender difference was suggested considering sexual maturation, with a positive association with overweight and obesity in girls but the associations were reverse for boys.^[12] One of the primary behavioral and environmental factors are food consumption patterns, sedentary behavior, and socioeconomic status,^[12] that led to gradual increase in body weight and obesity, that is also the consequence of a prolonged positive energy balance, that is, when energy intake exceeds energy loss.^[2] However, there are many factors that can influence energy balance and therefore, be identified as contributors to the current obesity epidemic in children, with biological, behavioral, environmental, and social being most cited.^[13,14] Although the relative contribution of energy intake to the obesity epidemic is controversial,

Table 1: Descriptive data related to measured variables in students ($n=12,946$)

Variables	Mean±SD	
	Boys (2415)	Girls (10,531)
Height (cm)	155.80±9.47	145.23±7.17
Weight (kg)	48.52±11.45	49.25±10.12
WHR	0.91±0.09	0.95±0.12
BMI (kg/m ²)	19.79±3.88	21.12±5.28
Body-fat (%)	19.32±8.99	24.73±6.42
Aerobic fitness (ml/kg/min)	36.4±7.3	29.5±5.6

BMI=Body mass index, WHR=Waist-hip ratio, SD=Standard deviation

Table 2: Pearson correlation coefficient between aerobic fitness and body composition of subjects

	Boys			Girls		
	Aerobic fitness	Body-fat (%)	BMI (kg/m ²)	Aerobic fitness	Body-fat (%)	BMI (kg/m ²)
Aerobic fitness	1	-0.81**	-0.72**	1	-0.77**	-0.65**
Body-fat (%)	-0.81**	1	0.61**	-0.77**	1	0.63**

** $P < 0.01$, * $P < 0.05$. BMI=Body mass index

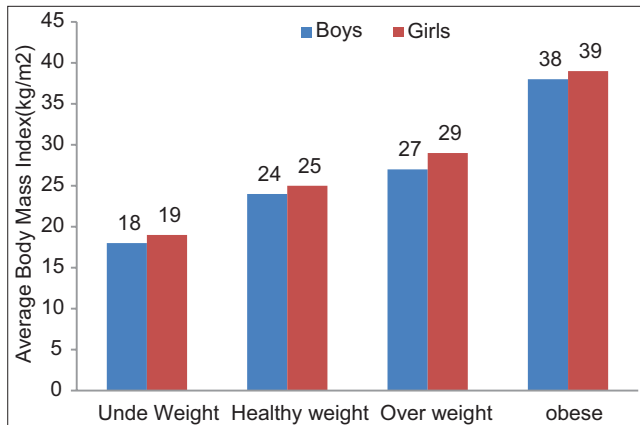


Figure 1: Body composition distribution of subjects

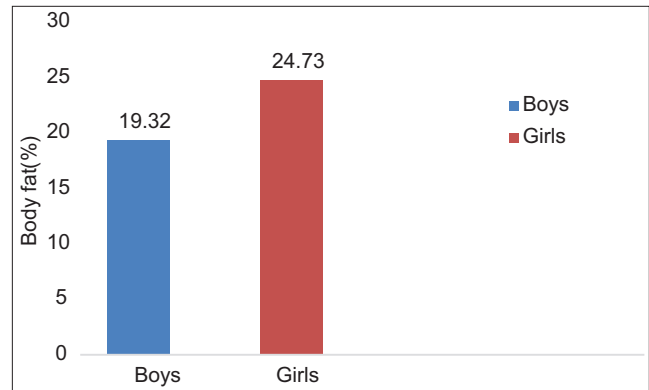


Figure 2: Comparison of body fat percent of students

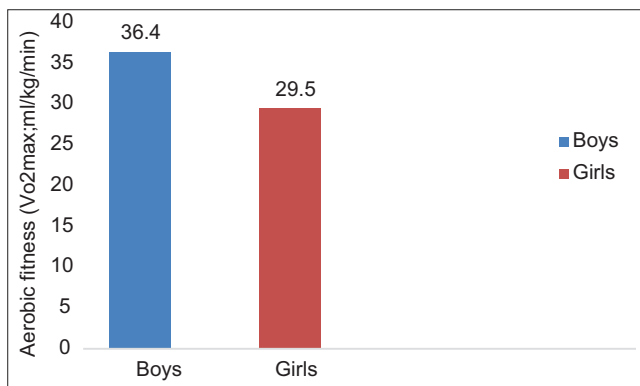


Figure 3: Comparison of aerobic fitness of students

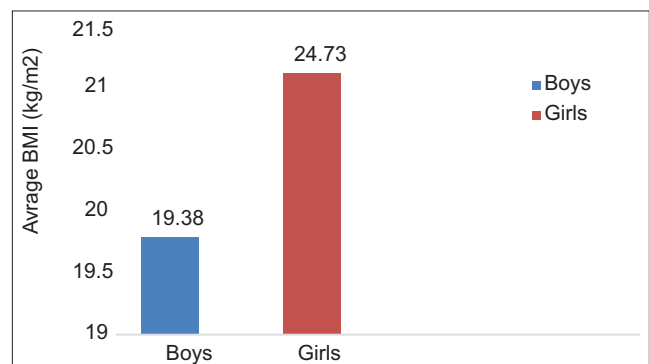


Figure 4: Comparison of body mass index of students

available data clearly indicate that physical activity plays an integral role in the prevention of obesity.^[14,15]

Obese children are at an increased risk of acute medical illnesses and chronic diseases, particularly osteoarthritis, diabetes mellitus, and cardiovascular diseases, which can lead to poor quality of life, an increased personal and financial burden to individuals, families, and society, as well as a shortened lifespan.^[15,16]

Aerobic fitness or VO₂ max average for children assessed in the present study (32.9 ml/kg/min) was lower than previous reports. For example, VO₂ max for children aged 8–12 years ranged between 34 and 58 ml/kg/min,^[8,6,11] while boys had higher values of VO₂ max.^[6,11] However, differences in body-composition and level of physical activity, can result in inconsistent reports.^[17] For example, Léger and Lambert reported aerobic capacity from 38 to 52 ml/kg/min for children aged 6–18 years.^[9]

Cardiovascular fitness or VO₂ max changed by gender criteria (29.5 ± 5.6 vs. 36.4 ± 7.3 for girls and boys, respectively) in accordance with the results of previous studies. In fact, aerobic capacity is consistently greater in boys throughout childhood and this difference exceeded at puberty.^[11] The observed difference has been ascribed to cumulative effects of different factors including body composition and cardiac size and function.^[11] Regular physical activity plays an important role in the maintenance of body weight and composition as well as in the regulation of skeletal muscle and adipose tissue metabolism.

Several investigators reported an association between physical activity and body composition in children.^[4,11,18] Precise assessment of habitual physical activity is critical for accurately descriptive epidemiology of the physical activity-obesity relationship for designing appropriate interventions aimed at modifying body composition and related risk factors and for promoting change in lifestyles.^[17,19] Assessment of

aerobic fitness and body fat are probably a more valid approach than measurement of self-reported physical activity and body-weight, particularly in children.^[17,19] It has been reported that overweight and obese children showed a lower physical fitness than normal children.^[9,15,20] However, studies analyzing association between aerobic fitness and different measures of body-composition in this population are scarce. Indeed, results of the present study revealed a moderate-strong inverse relationship ($r = -0.81$ for boys vs. $r = -0.77$ for girls) between aerobic fitness and fat percentage of subjects.

Since people who have sedentary lifestyles also have low levels of fitness and excessive body fat,^[21] optimal altering of adiposity in children should begin with augmentation of physical activity and fitness, which leads to reductions in body-fat. Moreover, children, who improve their aerobic fitness during childhood, have less overall adiposity and abdominal adiposity than their counterparts during adolescence and adulthood.^[21] Due to the fact that BMI poorly correlates with aerobic fitness, other indicators of adiposity (body fat percentage or WHR) rather than weight has been shown to be associated with aerobic fitness.^[22,23]

Limitations

One of the main limitations of the study was that the number of male subjects participated in this research, were about one-fifth of female subjects, because of educational curriculum end at May. It seems that more accurate and specific fitness tests are required to determine if there is association between fitness level of children and their body composition. Moreover, analysis of the relationship between aerobic fitness and body-composition needs adjustments for pubertal development factors, which requires further investigation.

CONCLUSIONS

Our results suggest that cardiovascular fitness, as an indicator of physical activity, is linked to the increased level of adiposity in children. Inactivity is interconnected with obesity; however, it is likely to be as one of the easiest factors to be modified. Although guidelines for physical activity in youths recommend involvement in moderate to vigorous physical activities for at least 60 min a day for

health promotion and from a weight-control perspective.^[1,24] According to the results of the present study and the fact that academic curriculum of most countries of the world and Iranian middle school students included only 90-min physical activity per week, initiatives should be put forward to promote physical activity in children in both school and out-of-school environment. Certainly, diet modifications also have to be considered in implementation of school-based physical activity interventions, and it is vital that researchers and practitioners target alternative venues that still service a large amount of children, but are also accessible.

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