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CARDIORESPIRATORY FITNESS, ACTIVITY LEVEL, HEALTH-RELATED ANTHROPOMETRIC VARIABLES, SEDENTARY BEHAVIOUR AND SOCIOECONOMIC STATUS IN A SAMPLE OF IRANIAN 7-11 YEAR OLD BOYS

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ABSTRACT: The purpose of this study was to evaluate cardiorespiratory fitness (CRF), activity level, some health-related anthropometric variables, sedentary behaviour and socioeconomic status (SES) of 7-11 year old boys in the city of Ardabil, Iran. Of 21 253 school boys aged 7-11 years, 766 participated in this study using the cluster sampling method. Subjects underwent standard anthropometry. One-mile test was used to evaluate $\dot{V}O_2max$. BMI cut-off points were used to identify weight status. Child's TV watching and video playing daily time (TVVPT) was taken for sedentary behaviour evaluation. SES and activity level were measured by standard questionnaires. Of all participants, 8.9% (N=68) of students had CRF lower than normal and 58.6% (N=449) of them had inadequate physical activity. There was a significant adverse relationship between $\dot{V}O_2max$ and body mass index (BMI), waist to height ratio (WHtR), waist circumference (WC), and fat mass (FM) ($p<0.05$). A significant direct association between SES and both FM and TVVPT was observed ($p<0.05$). Significantly lower physical activity and $\dot{V}O_2max$, and higher TVVPT were observed in the obese boys than their counterparts ($p<0.05$). The results of this study indicated a significant relationship between CRF and physical activity, and health-related anthropometric variables in a selected sample of 7-11 year boys. Moreover, the obese subjects had not only lower physical activity but also longer sedentary behaviour time than their counterparts.

KEY WORDS: cardiorespiratory fitness, activity level, BMI, socioeconomic status

INTRODUCTION

Cardiorespiratory fitness (CRF) is an independent determinant of health across the lifespan [16]. CRF is associated with a decreased risk of all-cause mortality and chronic illnesses, especially cardiovascular disease [3]. Cross-sectional studies and randomized clinical trials suggest that CRF is associated with brain structure and function [4] and improvements in CRF brought about by exercise training are implicated in the restoration of neural and cognitive functioning in older adults [5,6]. Moreover, several longitudinal studies [21,39] have shown that, rather than the level of physical activity (PA), the level of physical fitness in childhood and adolescence (especially CRF and muscular strength) determines the future risk of cardiovascular disease. Adverse associations between fitness and disease risk factors may be a direct function of the relationship between CRF and adiposity. Physical fitness is partially determined by genetic endowment, yet it is highly modified by environmental factors [2]. For example, it was reported that physical fitness was affected by several environmental factors such as PA levels [19,34], socioeconomic status [18,22], television viewing [31] and anthropometric factors 11,23,28].

Simultaneous assessment of CRF (especially in children), anthropometric variables, and environmental factors such as socioeconomic status, sedentary behaviour, and activity levels is scanty. On the other hand, CRF data in Iranian children are lacking. Therefore, the purpose of this investigation is to survey CRF, activity level, various anthropometric variables, sedentary behaviour, and socioeconomic status in 7-11 year old boys in the city of Ardabil, Iran.

MATERIALS AND METHODS

Participants. This cross-sectional study was carried out in 766 normal, healthy 7-11 year male students. The selection of subjects was made on the basis of random cluster sampling from a 7-11 year student population (N= 21 253) of different schools in urban areas of the city of Ardabil in the northwest of Iran. All children and their parents were thoroughly informed about the purposes and contents of the study and written informed consent was obtained from parents. The age of the subjects was determined from their date of birth in their school register. The age was rounded off to the nearest whole number. The measurements and the tests of participants were carried out during regularly scheduled physical education classes. The protocol of the study was approved by the university ethics committee in accordance with the Helsinki Declaration.

Cardiorespiratory fitness (CRF)

The 1-mile run test was used to assess $\dot{V}O_2max$ [40]. The objective of the mile run was to cover a mile in the shortest time possible. Students were encouraged to run throughout the test and to take walking breaks only as needed. The physical education instructor also reminded children to avoid starting too fast to avoid premature fatigue. The CRF is then calculated according to the following formula [40]:

$$\dot{V}O_2max = (0.21 * age * gender) – (0.84 * BMI) – (8.41 * time) + (0.34 * time * time) + 108.94$$

Gender = 1 for males and 0 for females.

Time is in minutes.

This test has been shown to be valid and reliable for the prediction of $\dot{V}O_2max$ in children [40].

Subjects were classed as having a high CRF level (those who met the minimum criteria for the “healthy fitness zone”) or low CRF level (those who did not), according to the criterion-referenced standards for CRF proposed by the Cooper Institute [10,38].

Physical activity (PA)

Physical activity for children was measured using the PA Questionnaire - Children (PAQ-C) [24]. The PAQ-C is used to assess the PA behaviours of the participants at different times and places (i.e., during school, after school, recess, weekend, etc.) during the previous seven days. Scoring is based on a 5-point Likert type scale, with an overall PA score derived from the mean of each scored item. Greater levels of PA are indicated by higher scores and vice versa. The PAQ-C has been tested and re-tested and results have shown that the instrument is a reliable and valid measure of PA for children during the school year. Kowalski, Crocker, and Faulkner [24] reported moderately high validity coefficients for the PAQ-C when compared to a variety of criterion measures, including activity ratings, recall questionnaires, and activity monitors ($r = 0.39$ to 0.63). The test retest reliability for the PAQ-C ranged from $r = 0.75$ to 0.82 and internal consistency reliability values (coefficient alpha) ranged from 0.81 to 0.86 [9].

The current PA recommendations for young people, i.e., 60 minutes or more of moderate to vigorous PA daily, were used to classify the subjects into high PA level (those who met the PA recommendations) and low PA level (those who did not) [36].

Anthropometric variables

Body weight (kg) was measured using a standard balance beam (Seca-220). Body height (cm) was measured using a precision stadiometer (Seca-220), attached to the balance beam. To compute BMI ($kg \cdot m^{-2}$), data were converted into metric units of kilograms (mass) and metres (height). Cut-off points for BMI defining underweight, normal weight, overweight and obesity were identified by using the International Obesity Task Force (IOTF) BMI cut-off points [7,8].

Waist circumference (WC) was measured at the level of the umbilicus and the superior iliac crest. The measurement was made at the end of a normal expiration while the subject stood upright, with feet together and arms hanging freely at the sides. Cut-off points for WC defining normal weight and overweight/obese boys were identified by using the waist girth cut-offs [37].

Waist circumference was divided by the height to determine the waist to height ratio (WHtR). A WHtR cut off of 0.5 was used to define abdominal obesity for 7- to 11-year-old boys [27].

In order to evaluate body fat percentage (fat%), tricipital skin folds (TSF) and subscapular skin folds (SSF) were measured three times on the right side of the body using an adipometer (Lange, Beta Technology Incorporated, Cambridge, USA) and the mean of all three measurements was used for analysis. Body adiposity was then estimated using the equation and sex-specific reference values proposed by Lohman [25,26], based on summing the two skin-fold measurements. Body fat percentage and then fat mass were calculated according to the following equations:

Prepubescent white males:

BF%= 1.21(SS*) - 0.008(SS) 2- 1.7

*SS= Sum of triceps and subscapular skinfolds

For a sum of triceps and subscapular > 35 mm

All males: BF%= 0.783(SS) + 1.6

Fat mass (FM) = weight * fat percentage/100

Cut-off points for FM% defining normal weight and overweight/obese boys were identified by using the FM% cut-offs [38].

TV watching and video playing daily time (TVVPT)

Children and their parent(s) were given a written questionnaire, which was filled out by the parent(s) only if the child was aged less than 8 years, and both parent and child together if the child was between the ages of 8 and 11. If completed by the parent and child together, they were instructed to agree on and record a single estimate of average daily time spent watching TV (time spent watching TV, videotapes, or DVDs) and playing video games (time spent on a home computer or video game). Parent estimates of child viewing and playing time have been shown to be reliable predictors of child screen time [1]. In order to further ensure the validity of TVVPT estimates, we verbally reviewed and confirmed the time estimate obtained from the questionnaire during the clinical interview with the parent(s) and, if aged over 8 years, the child.

Socioeconomic status (SES)

Socioeconomic status was computed from parent education and occupational status using the four-factor Hollingshead index [20].

Based on the Hollingshead criteria, scores were computed for parental occupational status and education and combined to form the SES score. In cases where SES scores were available for both parents, the mean was used.

Statistical analysis

Means and standard deviations were calculated for each variable using descriptive statistics. One-way analyses of variances (ANOVA) were carried out to assess differences in the TVVPT and physical activity scores among the underweight, normal weight, overweight and obese subjects of this study. The Scheffe correction was used for multiple comparisons. Pearson's correlation was used to assess the relationship of CRF, TVVPT, and SES with anthropometric variables and physical activity. All statistical analyses were performed using SPSS (Statistical Package for Social Sciences, version 17.0). The Kolmogorov-Smirnov normality test was used to determine whether the data set was well modelled by a normal distribution. The significance level was set at $p < 0.05$.

TABLE 1. PHYSIOLOGICAL AND ANTHROPOMETRIC CHARACTERISTICS OF SUBJECTS

Age (year)	9.2 ± 1.4
Height (cm)	132.6 ± 9.1
Weight (kg)	30.4 ± 8.4
BMI ($kg \cdot m^{-2}$)	17 ± 2.9
WHtR	0.45 ± 0.05
Fat Mass (kg)	7.9 ± 5.5
Waist Circumference (cm)	59.6 ± 8.65
One-mile Record (s)	653.1 ± 110.8
$\dot{V}O_2max$ ($ml \cdot kg^{-1} \cdot min^{-1}$)	46.4 ± 3.1

TABLE 2. PREVALENCE OF OVERWEIGHT AND OBESITY AMONG STUDENTS

	Under and Normal Weight	Overweight and Obese
Prevalence (BMI)	626 (81.8%)	140 (18.2%)
Prevalence (WC)	653 (85.2%)	113 (14.8%)
Prevalence (WHtR)	646 (84.3%)	120 (15.7%)
Fat %	605 (79%)	161(21%)

Note: BMI - body mass index; WC - waist circumference; WHtR - wait-to-hip-ratio

RESULTS

According to the data, 8.9% (N=68) of students had CRF lower than normal, and based on recommended PA time, 58.6% (N=449) of them did not have adequate physical activity. The mean values and standard deviations for various anthropometric variables are shown in Table 1. Prevalence of overweight and obesity among students based on BMI, WC, WHtR and fat% is listed in Table 2. Our data indicated a significant relationship of physical fitness and sedentary behaviour ($\dot{V}O_2max$ and TVVPT respectively) with anthropometric variables (BMI, WHtR, WC and FM) (Table 3) and physical activity. Furthermore, we observed a significant direct relationship between SES and both FM and TVVPT (Table 4). The differences in the PA, TVVPT and $\dot{V}O_2max$ among the underweight, normal weight, overweight and obese children are presented in Table 5. Comparison by ANOVA revealed that the mean values of PA, $\dot{V}O_2max$ and TVVPT in the obese children were significantly different compared to their counterparts (Table 5).

TABLE 3. CORRELATION OF PHYSICAL FITNESS (VO2MAX) AND SEDENTARY BEHAVIOUR (TVVPT) WITH ANTHROPOMETRIC VARIABLES AND PHYSICAL ACTIVITY (PA)

	BMI	WHtR	WC	FM	PA
$\dot{V}O_2max$	-0.81***	-0.77***	-0.72***	-0.70***	0.22***
TVVPT	0.15***	0.15***	0.11**	0.16***	-0.172***

Note: $\dot{V}O_2max$ - maximal oxygen uptake; TVVPT - TV watching and video playing daily time; BMI - body mass index; WHtR - wait-to-hip-ratio; WC - waist circumference; PA - physical activity; **Significant at $p<0.01$, ***Significant at $p<0.001$.

TABLE 4. CORRELATION OF SES WITH FM AND TVVPT

	FM	TVVPT
SES	0.093*	0.13**

Note: SES - Socioeconomic status; FM - fat mass; TVVPT - TV watching and video playing daily time;*Significant at <0.05, **Significant at <0.01.

TABLE 5. MEAN (SD) DIFFERENCES IN PHYSICAL ACTIVITY, TV AND VIDEO PLAYING DAILY TIME AND VO2MAX AMONG DIFFERENT WEIGHT CLASSES

Variable	Underweight (1)† (n= 82)	Normal weight (2) (n= 544)	Overweight (3) (n= 108)	Obese (4) (n= 32)	F- value	P value*
Physical activity score	3.32±1.5	3.3±1.75	3±1.6	1.9±2.1	5.9	1≠4**,2≠4**, 3≠4*
TV and video playing ($min \cdot day^{-1}$)	182.9±61	180±81	190.6±97	257±104	5.1	1≠4*, 2≠4**, 3≠4*
$\dot{V}O_2max$ ($ml \cdot kg^{-1} \cdot min^{-1}$)	49.4±1.7	47±2	42.2±2.2	40±2.8	236.5	1<2<3<4**

Note: Significance of differences among BMI categories was evaluated by ANOVA for all variables. *Significant at p≤0.05, **Significant at p≤0.01.
† Numbers show groups: underweight (Group 1), normal weight (Group 2), overweight (Group 3) and obese (Group 4).

DISCUSSION

The aim of this study was to survey CRF, activity level, various health-related anthropometric variables, sedentary behaviour, and SES in the selected sample of 7-11 year boys in the city of Ardabil, Iran. According to our data, CRF of 8.9% (N=68) of students was lower than normal. Additionally, based on recommended PA time, 58.6% (N=449) of students had inadequate physical activity [36]. Additionally, we observed a significant correlation between CRF and physical activity rate in our population ($p<0.001$). These results were in agreement with Dennison et al., who found that very inactive young adults had the lowest aerobic fitness scores (as measured by the 600-yard run) when they were youngsters [12].

In regard to anthropometric health-related variables, 18.2% and 21% of students had BMI and fat% more than normal, respectively. In our previous study in 2010 at Pars-Abad, a city in Ardabil province almost 200 km from the city of Ardabil, the total prevalence of overweight and obesity was 12.3% among 7-11 year-old female students [30]. In the previous study, we observed that a low physical activity rate and lower SES were more likely to lead to higher weight [30]. In the present study the results are almost the same: There was a significant correlation between SES and FM, as well as an adverse correlation between CRF and BMI, WHtR, WC and FM in the present study (Table 3).

It is important to note that children with the lowest PA/fitness levels and highest percentage of body fat are most likely to develop other risk factors for CVD, including elevated blood pressure and serum cholesterol levels. Sedentary lifestyle habits may be formed at a young age, and aerobic fitness and PA behaviours tend to track throughout childhood, and possibly into adulthood [32]. Furthermore, a strong relationship between CRF and anthropometric health-related markers indicated that physical fitness can be one of the important factors to affect body composition. However, some studies showed that obese children had similar cardiovascular fitness to normal-weight children after adjustment for body composition [14]. Lower physical activity is the other important factor related to obesity. Obese children have impaired mobility and less self-confidence, which makes them participate in less physical activity [35].

We also observed a significant relationship between TVVPT as a marker of sedentary behaviour and anthropometric variables and physical activity (Table 3). It seems that the new generation is deeply interested in TV watching and video playing. They spend the majority of their recreational time at home or video clubs without any activity. Epstein et al. found that both adding PA and reducing sedentary behaviours were effective in promoting weight loss and aerobic fitness in the children [15]. Higher sedentary behaviour (TVVPT) and lower physical activity in the obese subjects than their counterparts in this study were found (Table 5). Some researchers in their studies demonstrated that more TV watching and video playing was associated with lower levels of PA [13,33] while some did not [17]. However, recent studies suggest that decreasing sedentary activity is very effective in promoting weight loss [41]. Epstein et al. (2000) [15] showed that both adding PA and reducing sedentary behaviours were effective in promoting weight loss and aerobic fitness in children.

Few studies have examined in depth the influence of SES on physical fitness, and the findings are so far contradictory [18,22,29]. Jimenez-Pavon et al. found that speed-agility and CRF (20 m shuttle run test) were not associated with parental educational or professional levels in boys. In contrast, girls with higher paternal educational level or higher parental professional level had higher levels in both fitness components. Moreover, a higher maternal educational level was associated with lower total and central body fat in boys, but not in girls. They concluded that there were modest associations of high SES with better fitness and fatness levels in Spanish adolescents [22]. Another study observed higher CRF ($\dot{V}O_2max$ estimated from 20 m shuttle run test) in both boys and girls with high SES (mother occupational level) [29]. We did not observe any relationship between CRF and SES, or PA and SES ($p>0.05$).

The discrepancies among studies could be due to the specific social and cultural contexts of each country together with the different methodologies used to assess fitness and SES factors.

The main limitation of this study is its cross-sectional nature. Moreover, this study could not take subjects of both sexes. Furthermore, we did not have a direct measure of body composition in this study. Future similar studies should consider using such a measure to provide a more accurate assessment.

CONCLUSIONS

The results of this study indicated a significant relationship of CRF and sedentary behaviour with physical activity and health-related anthropometric variables in a selected sample of 7-11 year boys. Moreover, the obese subjects had not only lower physical activity but also longer sedentary behaviour time than their counterparts.

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