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# Physical Fitness, Physical Activity and Sedentary Activities of 7 to 11 Year Old Boys with Different Body Mass Indexes

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## Abstract

***Purpose*: The purpose of this study was to examine the differences in physical fitness, physical activity, and sedentary activities among 7 to 11 year old boys with varying body mass index in Ardabil, Iran.**

***Methods*: The sample consisted of 766 boys who participated in eight weight bearing (1 mile walk/run, sit ups, standing long jump, vertical jump, shuttle run 4 × 10 m, 30-meter sprint, pull ups, pushups) and four non-weight-bearing physical fitness tests (flamingo balance, handgrip; sit and reach and finger reaction time). Physical activity and sedentary activities were assessed by questionnaires. Body mass index (BMI) was computed to classify participants into normal weight, underweight, overweight and obese groups.**

***Results*: The prevalence of underweight, overweight and obesity was 10.7%, 14.1% and 4.2% respectively. Cardiorespiratory fitness ($VO_{2max}$) decreased progressively as the BMI increased and differences among the all body mass index categories were significant (*P*<0.01). Obese subjects performed worse in all weight bearing fitness tests than normal weight subjects (*P*<0.01). Moreover, overweight subjects performed worse in one mile, pushups and pull ups than normal weight subjects (*P*<0.01). Underweight subjects had significantly lower Pushups than normal weight subjects (*P*<0.01). Obese subjects had significantly higher sedentary activities and lower physical activity than other counterparts (*P*<0.01).**

***Conclusions*: This study showed that weight bearing physical fitness, cardiorespiratory fitness and physical activity progressively decreased as the BMI increased and conversely, sedentary activities increased as the BMI increased.**

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## INTRODUCTION

Physical fitness can be thought of as an integrated measure of most, if not all, the body functions (skeletomuscular, cardiorespiratory, hematocirculatory, psychoneurological and endocrine–metabolic) involved in the performance of daily physical activity and/or physical exercise [1]. Hence, when physical fitness is tested, the functional status of all these systems is actually being checked. This is the reason why physical fitness is nowadays considered one of the most important health markers, as well as a predictor of morbidity and mortality for cardiovascular disease and other causes [1]. Some studies reported that being overweight and obesity decreased the physical exercise capability and then reduced health-related physical fitness, such as cardiorespiratory fitness and speed of movement [2, 3]. Childhood and adolescence are crucial periods of life, since dramatic physiological and psychological changes take place at these ages. Likewise, lifestyle and healthy/unhealthy behaviors are established during these years, which may influence adult behavior and health status [1]. On the other hand adequate fitness in childhood is likely to carry beneficial biological and behavioral effects into adulthood, for example physically active children are more likely to become physically active adults [4] and physical fitness in children may protect against future cardiovascular disease [5]. The importance of understanding how fitness is related to obesity is further stressed by the recent worldwide trends in increasing obesity and sedentary habits and declining fitness among youth [6]. Moreover, being underweight is still a public health problem which is undergoing nutritional and lifestyle transition [7]. So it is meaningful to explore the relationship between being underweight and physical fitness performance, in addition to obesity.

In this study we examined whether physical fitness, physical activity and sedentary activities [such as: television (TV) watching and videogame playing] were different in children in the lowest or highest weight categories as compared to children with normal weight in a sample of 7 to 11 year old boys in Ardabil, Iran.

## METHODS AND SUBJECTS

### *Participants:*

This cross-sectional study was carried out on 766 normal, healthy school going boys of age range 7-11 years. The selection of the subject was made on the basis of random sampling from student populations of different schools in urban areas of Ardabil, Iran. All children and their parents were thoroughly informed about the purposes and contents of the study and written informed consent was obtained from one parent. The age of the subject 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 that the children underwent were carried out during regularly scheduled physical education classes. This study was approved by the ethical committee of the Ardabil department of education.

### *Measurement of 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 years. If completed by 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 videogames (time spent on a home computer or videogame). Parent estimates of child viewing and playing time have been shown to be reliable predictors of child screen time [8]. In order to further ensure the validity of TVVPT estimates, the physician 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.

### *Measures of Anthropometric variables:*

To estimate body weight and height the participants were barefoot and wore only underwear. 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. The subjects stood upright, with feet together, knees straight, heels, buttocks and back touching the back part of the stadiometer and the head held so that the Frankfurt line was horizontal. To compute BMI (kg/m2), data were converted into metric units of kilograms (mass) and meters (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 [7,9].

Tricipital skin folds (TSF) and subscapular skin folds (SESF) 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 (TSF measured on the right upper arm, midway between the acromion and the olecranon, and the SESF is measured two fingers below the low point of the right scapula). Body adiposity was then estimated using the equation and sex-specific reference values



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proposed by Lohman [10,11], based on summing the two skinfold measurements. Fat mass was then evaluated by the below equation:

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

***Measurement of physical activity (PA):***

Physical activity for children was measured using the Physical Activity Questionnaire - Children (PAQ-C) [12]. The PAQ-C is used to assess the PA behaviors 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 questionnaire is a reliable and valid measure of PA for children during the school year. Kowalski, Crocker, and Faulkner [12] 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 [13]. This instrument is widely used in research in order to assess PA of large and small populations at low cost [14].

***Physical fitness measurements:***

Physical fitness was determined using twelve physical fitness tests which were completed during regularly scheduled physical education classes. At the beginning of taking each test, the examiner explained the testing procedures to the participants in detail.

**Cardiorespiratory fitness** ($VO_{2max}$)**:** The 1-mile walk/run was used to assess $VO_{2max}$. 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. This test has shown to be valid and reliable for the prediction of the $VO2_{max}$ in children [15].

**Sit ups:** Maximum number of sit ups achieved in 60 seconds. This test measures the endurance of the abdominal muscles [15].

**Modified pull ups:** To measure upper arm and shoulder girdle strength and muscular endurance [15].

**Pushups:** This test measures upper arm and shoulder girdle strength/endurance [15].

1. **Sit and reach:** Reaching as far as possible from a sitting position. This test measures the flexibility of the hamstrings, buttocks and lower back [16].
2. **Standing long jump**: Jumping for distance from a standing start. This test measures explosive strength[16].
3. **Hand grip**: Squeezing a calibrated hand dynamometer as forcefully as possible with the dominant hand. Static strength is assessed [16].
4. **Vertical jump:** The vertical difference in centimeters (cm) between the original trace (extension, standing on the toes), before jumping, and the trace after the jump. This test measures explosive strength [16].
5. **4×10m shuttle run test**: Speed of movement, agility and coordination assessment [17].
6. **30-meter sprint (from standing position):** This test measures speed.

**Simple finger reaction time:** The simple reaction time ruler set and instrument measures how fast a person reacts [18].

**Flamingo balance**: Balancing on one leg as long as possible while standing on the preferred foot. This test measures general balance [16].

***Statistical analysis:***

Descriptive statistics were run on all variables. One-way analyses of variances (ANOVA) were carried out to assess differences in the anthropometric variables, TVVPT, physical fitness tests, and physical activity scores among the underweight, normal weight, overweight and obese subjects of this study. The Scheffe correction was used for multiple comparisons. All calculations were performed using SPSS v.18.0 software for Windows. The significance level was set at $P < 0.05$.

## RESULTS

Table 1 shows the children's anthropometric characteristics and TV watching and video playing

**Table 1:** Mean (SD) differences in the anthropometric variables and TV and video playing daily time among BMI categories

| variable | Underweight group (n= 82) | Normal weight group (n= 544) | Overweight group (n= 108) | Obese group (n= 32) | F- value | P value* |
|---|---|---|---|---|---|---|
| **Height (cm)** | 130.0 (8.7) | 131.5 (8.5) | 139.0 (8.6) | 138.6 (10.9) | 27.4 | 1≠3*, 1≠4*, 2≠3*, 2≠4‡ |
| **Weight (kg)** | 23.7 (4.0) | 28.3 (5.1) | 41.2 (7.5) | 47.7 (13.1) | 267.5 | 1<2<3<4* |
| **BMI (kg/m$^{2)}$** | 13.9 (0.6) | 16.2 (1.3) | 21.1 (1.6) | 25.1 (2.9) | 805.8 | 1<2<3<4* |
| **Fat Mass (kg)** | 4.3 (1.4) | 6.4 (2.4) | 14.4 (4.8) | 21.6 (12.2) | 310.2 | 1<2<3<4* |
| **TVVPT (min/day)** | 182.9 (61.0) | 180.0 (81.0) | 190.6 (97.0) | 257.0 (104.0) | 5.1 | 1≠4‡, 2≠4*, 3≠4‡ |

*Significance of differences among BMI categories were evaluated by ANOVA for all variables*
*Significant at ≤0.05, **Significant at ≤0.01
SD: Standard Deviation; BMI: Body Mass Index; TVVPT: Television watching and video playing daily time



daily time. Classification by BMI showed that the majority of boys had healthy weights (71%). A total of 18.27% of the boys were overweight (14.1% were overweight and 4.2% were obese) and just 10.7% were underweight. Comparison by ANOVA revealed that all measured anthropometric characteristics (height, weight, BMI, and FM) were significantly higher in the overweight and obese subjects than underweight and normal weight subjects (*P*<0.01). Obese subjects had significantly higher TV watching and video playing daily time than other counterparts (*P*<0.01).

The differences in the fitness parameters among BMI categories are presented in Table 2. Comparison by ANOVA revealed that the mean values of vertical jump, sit ups, sit and reach, time in run speed, standing long jump and time in shuttle run were not significantly different among underweight, normal weight and overweight subjects. Also the mean values of Reaction time and Pushups were not significantly different among underweight, overweight and obese subjects. Normal weight subjects were significantly better than other counterparts in pushups (*P*<0.01). Obese subjects performed worse in Vertical jump and shuttle run compared with normal weight, underweight, and overweight subjects (see Table 2). Both overweight and obese subjects had significantly higher Hand grip strength and One mile time than normal weight and underweight subjects (*P*<0.01). Obese subjects had significantly lower sit ups than underweight (*P*=0.02) and normal weight subjects (*P*=0.03). The mean values of Sit and reach, time in Run speed and Standing long jump in the obese subjects were significantly lower than normal weight and overweight subjects (Table 2). Overweight subjects were significantly better than normal weight subjects in Reaction time test (*P*= 0.01). Normal weight and underweight subjects were significantly better than overweight and obese subjects in Pull ups (*P*<0.01) and even overweight subjects were significantly better than obese subjects of doing Pull ups (*P*=0.04). No differences were found for the mean values of flamingo balance among BMI categories (*P*=0.2). The mean values of $VO_{2max}$ were significantly different among all BMI categories (*P*<0.01) and $VO_{2max}$ decreased progressively as the BMI increased. The mean values of PA score decreased with an increase of BMI, and obese subjects had the lowest score among all subjects (Table 2). Physical activity score among other counterparts were not significantly different.

## DISCUSSION

Obesity prevalence among the 7 to 11 year old Ardabilian boys of this study was 4.2%. In comparison to this study a similar (4.3% and 4 %), lower (1% and 2%) and higher (6.3%) prevalence of obesity (in 6 to 12 year old boys) were reported at different cities in Iran [19].

The results of this study showed that except hand grip strength, flamingo balance and reaction time, obese subjects performed worse in all the other fitness tests compared with normal weight subjects and also performed worse in vertical jump, sit ups, shuttle run, one mile and pull ups compared with underweight subjects and performed worse in vertical jump, speed, standing long jump, shuttle run, one mile and pull ups compared with overweight subjects. Also overweight



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**Table 2:** Mean (SD) differences in the physical fitness parameters and physical activity scores among BMI categories

| variable | Underweight group (n= 82) | Normal weight group (n= 544) | Overweight group (n= 108) | Obese group (n= 32) | F- value | *P* value |
|---|---|---|---|---|---|---|
| **Time in One-mile (s)** | 614.2 (94.1) | 638.6 (98.3) | 715.7 (109.2) | 825.8 (140.6) | 38.4 | 1≠3*, 1≠4*, 2≠3*, 2≠4*, 3≠4* |
| **$VO_{2max}$ (ml/kg/min)** | 49.4 (1.7) | 47.0 (2.0) | 42.2 (2.2) | 40.0 (2.8) | 236.5 | 1<2<3<4* |
| **Sit and reach (cm)** | 27.4 (5.8) | 28.2 (6.2) | 29.2 (6.5) | 24.9 (6.8) | 4.024 | 2≠4‡, 3≠4‡ |
| **Vertical jump (cm)** | 22.2 (5.2) | 22.2 (4.9) | 20.8 (4.8) | 17.5 (5.1) | 9.4 | 1≠4*, 2≠4*, 3≠4‡ |
| **Standing long jump (cm)** | 114.8 (24.8) | 120.9 (24.6) | 120.6 (22.6) | 103.2 (13.2) | 4.7 | 2≠4‡, 3≠4‡ |
| **Hand grip (kg)** | 16.6 (5.35) | 18.3 (5.6) | 23.9 (5.5) | 23.5 (6.3) | 40.4 | 1≠3*, 1≠4*, 2≠3*, 2≠4* |
| **Time in run speed (s)** | 6.9 (1.0) | 6.6 (0.80 | 6.7 (0.7) | 7.2 (0.7) | 5.2 | 2≠4*, 3≠4‡ |
| **Time in 4×10m shuttle run (s)** | 12.8 (1.3) | 12.8 (1.1) | 12.6 (0.9) | 13.8 (0.9) | 7.1 | 1≠4*, 2≠4*, 3≠4* |
| **Flamingo balance (s)** | 66.0 (45.0) | 56.5 (38.0) | 53.0 (30.0) | 68.5 (32.0) | 1.1 | 0.2 |
| **Pull ups (n)** | 9.6 (5.8) | 10.0 (6.6) | 6.4 (4.6) | 2.5 (2.7) | 19.95 | 1≠3*, 1≠4*, 2≠3*, 2≠4*, 3≠4‡ |
| **Pushups (n)** | 8.8 (8.0) | 14.3 (9.6) | 8.4 (7.9) | 6.5 (8.0) | 20.2 | 1≠2*, 2≠3*, 2≠4* |
| **Simple reaction time (cm)** | 32.1 (9.8) | 31.6 (9.3) | 28.2 (7.7) | 29.3 (11.2) | 4.3 | 2≠3‡ |
| **Sit ups (n)** | 20.2 (11.0) | 19.0 (10.8) | 17.3 (10.5) | 12.8 (9.5) | 4.014 | 1≠4‡, 2≠4‡ |
| **Physical activity score** | 3.3 (1.5) | 3.3 (1.7) | 3.0 (1.6) | 1.9 (2.1) | 5.9 | 1≠4*, 2≠4*, 3≠4‡ |

Significance of differences among BMI categories were evaluated by ANOVA for all variables
*Significant at ≤0.01; ‡Significant at ≤0.05; SD: Standard Deviation

subjects performed worse in one mile, pushups and pull ups than normal weight and performed worse in one mile and pull ups than underweight subjects.

By dividing the measured fitness tests of this study in two non-weight-bearing (reaction time, flamingo balance, hand grip strength and sit and reach) and weight-bearing tests (all the other fitness tests) it will be found that weight-bearing fitness tests required propulsion or lifting of body which was at a disadvantage in overweight and obese children due to the extra body load to be moved while performing these tests. Some studies showed that by increasing the accumulation of body fat, weight bearing fitness tests of subjects declined continuously [20-23].

However, overweight and obese children can perform equally well, such as sit and reach [20,21] and flamingo balance [24]; or even better, such as handgrip strength test [25,26] than children with normal weight in those muscular fitness tests where their body does not have to be transported. Higher hand grip strength was found in both overweight and obese subjects than normal weight and underweight subjects, which is in agreement with other studies [25,26]. This greater strength in the overweight and obese children can be explained by their increased fat-free mass. Obese individuals develop increased fat-free mass as they accumulate excess adiposity; the increase of fat-free mass may be to support this extra load [27,28]. Also except the obese subjects, other counterparts were not different in performing the sit and reach test. Some studies reported no relationship between obesity and flexibility [21,29], which our results are not accordance with. The results of this study found no differences for flamingo balance among BMI categories which is in agreement with the results of Raudsepp et al [24] and adversely is in contrast to the results of Deforche et al [30].

Although the results of this study revealed that overweight and obese subjects had better simple reaction time than normal weight and underweight subjects, significant difference was found between overweight and normal weight subjects. To the authors' knowledge there was no similar research about the relationship between finger reaction time and weight status in children, so it needs extra investigations to be well understood.



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In comparison, the fitness parameters of the normal weight and underweight subjects were significantly better in Pushups which is in agreement with Bovet et al [31].

In addition to the higher fatness and lower fitness level of the obese subjects of this study, significant higher TVVPT was found in the obese subjects than other counterparts. Some studies reported a positive association between watching TV at baseline and the subsequent development of obesity [32,33] while some studies reported no association [34,35]. However, two primary mechanisms by which television viewing contributes to obesity have been suggested: reduced energy expenditure from displacement of PA and increased dietary energy intake, either during viewing or as a result of food advertising [36].

Not only higher fatness and TVVPT and lower fitness levels of the obese subjects were found but the results of this study showed that obese subjects had significantly lower PA score than other counterparts, while among the other subjects there was no significant differences for the PA score and TVVPT. Some researches in their studies demonstrated that more TV watching and video playing was associated with lower levels of PA [34,37] while some couldn't [38]. Fogelholm et al [38] found that child habitual PA was inversely associated to being overweight and obesity. But in contrast to this study he found no relation between physical inactivity (such as TV watching and video playing daily time) and obesity. However, recent studies suggest that decreasing sedentary activity is very effective in promoting weight loss [39]. Epstein et al [40] showed that both adding PA and reducing sedentary behaviors were effective in promoting weight loss and aerobic fitness in the children. But to encourage adherence to PA in obese youth, it is important that activities are tailored to their capabilities and weight-bearing activities should be limited at the start of an intervention with obese participants and alternative activities that rely more on static strength used [30].

One of the important findings of this study was about cardiorespiratory fitness among BMI categories. The results of this study showed that the cardiorespiratory fitness of the subjects differed significantly from one another in the various BMI categories, with the subjects of underweight possessing a higher cardiorespiratory fitness than the normal weight, overweight or obese subjects. Aerobic capacity therefore decreased progressively as the BMI increased. These results correlate with other studies that researched the same variables [20,41-43]. The benefits of higher levels of cardiorespiratory fitness in both children and adults are well documented. It was reported that some inflammatory markers such as Interleukin 6, C-reactive protein and white blood cells count were inversely associated with aerobic or cardiorespiratory fitness levels measured by $VO2_{max}$ in children [44]. On the other hand it was showed that aerobic training has more beneficial than other kind of trainings (such as resistance training) and can be used as a preventive measure in patients who are at risk of developing cardiovascular diseases due to obesity or blood pressure [45,46]. Some studies also showed that obese children had similar cardiovascular fitness to normal-weight children after adjustment for body composition [47]. However, the obese children are inconvenient in mobility and less self-confidence, which makes them to participate in less physical activities and subsequently, the low PA level will increase risk for chronic disease [23].

The cross-sectional design of the study does not permit this study to distinguish whether low physical fitness or activity precedes or follows excess body weight. Longitudinal studies are needed to determine the directionality of the relationship among physical activity, fitness, sedentary behavior and obesity. Furthermore, we did not have a direct measure of body composition in this study. Also this study couldn't take subjects of both sexes. Future studies examining the relationship between adiposity and fitness should consider using such a measure to provide a more accurate assessment.

## CONCLUSION

Findings of this study showed that being overweight and especially obese was a disadvantage in performing weight bearing physical fitness tests compared with



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normal weight and underweight Ardabilian 7 to 11 year old boys. Also regarding higher TVVPT, lower physical fitness, cardiorespiratory fitness and physical activity in the obese subjects than other counterparts, inactive periods in the obese children should be exchanged for active behavior as much as possible.

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**Conflict of interests:** None



## REFERENCES

1. Ortega FB, Ruiz JR, Castillo MJ, Sjostrom M. Physical fitness in childhood and adolescence: a powerful marker of health. *Int J Obesity* 2008;32:1-11.
2. Ding Z, Jiang J, Xu J. Injury of obesity in aerobic capacity in Children. *Chin J Pediatr* 1990;28:341-3.
3. Kovacs VA, Fajcsak Z, Gabor A, Martos E. Schoolbased exercise program improves fitness, body composition and cardiovascular risk profile in overweight/obese children. *Acta Physiol Hungarica* 2009;96:337-47.
4. Boreham C, Riddoch C. The physical activity, fitness and health of children. *J Sports Sci* 2001;19:915-29.
5. Twisk JW, Kemper HC, van Mechelen W. The relationship between physical fitness and physical activity during adolescence and cardiovascular disease risk factors at adult age. The Amsterdam Growth and Health Longitudinal Study. *Int J Sports Med* 2002; 23:S8-14.
6. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev* 2004;5:4-104.
7. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240-3.
8. Anderson DR, Field DE, Collins PA, et al. Estimates of young children's time with television: a methodological comparison of parent reports with time-lapse video home observation. *Child Dev* 1985;56:1345-57.
9. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* 2005;335:194-7.
10. Lohman TG. Applicability of body composition techniques and constants for children and youth. In: Pandolf KB (ed). *Exercise and sport sciences reviews*. New York: Macmillan. 1986; Pp:325-357.
11. Lohman TG. The use of skinfold to estimate body fatness on children and youth. *J Phys Educ Recreat Dance* 1987;58:98-102.
12. Kowalski KC, Crocker PRE, Faulkner RA. Validation of the physical activity questionnaire for older children. *Pediatr Exerc Sci* 1997;9: 174-86.
13. Crocker PRE, Bailey DA, Faukner RA, et al. Measuring general levels of physical activity: Preliminary evidence for the physical activity questionnaire for older children. Med *Sci Sports Exerc* 1997;29:1344-9.
14. Kowalski KC, Crocker PRE, Donen RMD. The physical activity questionnaire for older children (PAQ-C )and adolescents (PAQ-A) manual. Available at: http://www.hkin.educ.ubc.ca/behavioural/PAQ%20manual.pdf. Access date: April 10, 2007
15. Welk GJ, Meredith MD. Fitnessgram / *Activitygram Reference Guide*. 3rd ed. Dallas, TX: The Cooper Institute. 2008.
16. EUROFIT. European test of physical fitness. *Rome: Council of Europe, Committee for the Development of Sport*, 1988.
17. Ortega FB, Artero EG, Ruiz JR, et al. Study Group. Reliability of health related physical fitness tests in European adolescents. The HELENA Study. *Int J Obes* (Lond) 2008;32:S49-57.
18. Selim AA, Mahmoud AMS, Mohamed MM. Comparison between ruler set and instrument for assessment of simple reaction time in workers occupationally exposed to cyanide. *Egypt J Commun Med* 2009;27:51-62.
19. Mirzazadeh A, Sadeghirad B, Haghdoost AA, et al. The Prevalence of Obesity in Iran in Recent Decade; a Systematic Review and Meta-Analysis Study. *Iran J Pub Health* 2009;38:1-11.
20. Chen LJ, Fox KR, Haase A, Wang JM. Obesity, fitness and health in Taiwanese children and adolescents. *Eur J Clin Nutr* 2006;60: 1367-75.
21. Kamtsios S. Physical fitness, nutritional habits and daily locomotive action of 12-year-old children with different body mass index. *South African J Sports Med* 2008;20:32-6.

22. Mak KK, Ho SY, Lo WS, et al. Health-related physical fitness and weight status in Hong Kong adolescents. *BMC Public Health*. 2010; 10:88.
23. Shang X, Liu A, Li Y, et al. The Association of Weight Status with Physical Fitness among Chinese Children. *Int J Pediatr* 2010(2010); Article ID: 515414.
24. Raudsepp L, Jurimae T. Physical activity, fitness, and adiposity of prepubertal girls. *Pediatr Exerc Sci*. 1996;8:259-67.
25. Artero EG, Espana-Romero V, Ortega FB, et al. Healthrelated fitness in adolescents: underweight, and not only overweight, as an influencing factor. The AVENA study. *Scandi J Med & Sci in Spor* 2010;20:418-27.
26. Ortega JP, Cruz-Sanchez EDL, Martinez-Santos R. Health-related fitness in school children: compliance with physical activity recommendations and its relationship with body mass index and diet quality. *Organo Oficial de la Sociedad Latinoamericana de Nutricion* 2010;60:198-203.
27. Bandini LG, Schoeller DA, Dietz WH. Energy expenditure in obese and non-obese adolescents. *Pediatr Res* 1990;27:198-203.
28. Forbes GB. Lean body mass and fat mass in obese children. *Pediatrics* 1964;34:308-14.
29. Minck MR, Ruiter LM, Van Mechelen W, et al. Physical fitness, body fatness, and physical activity: the Amsterdam Growth Study. *J Hum Biol* 2000;12:593-9.



30. Deforche B, Lefevre J, De Bourdeaudhuij I, et al. Physical fitness and physical activity in obese and nonobese Flemish youth. *Obes Res* 2003;11:434-41.
31. Bovet P, Auguste R, Burdette H. Strong inverse association between physical fitness and overweight in adolescents: a large school-based survey. *Int J Behav Nutr Physic Act* 2007;4:479-86.
32. Viner RM, Cole TJ. TV viewing in early childhood predicts adults body mass index. *J pediatr* 2005;147:429-35.
33. Janz KF, Burns TL, Levy SM. Tracking activity and sedentary behaviours in childhood: the Iowa Bone Development study. *Prev Med* 2005;29:171-8.
34. Robinson TN, Hammer LD, Killen JD, et al. Does television viewing increase obesity and reduce physical activity? Cross-sectional and longitudinal analyses among adolescent girls. *Pediatrics* 1993;91:273-80.
35. Gordon-Larsen P, Adair LS, Popkin BM. Ethnic differences in physical activity and inactivity pattern and overweight status. *Obes Res* 2002;10:141-9.
36. Robinson TN. Reducing Children's Television Viewing to Prevent Obesity. *JAMA* 1999;282:1561-7.
37. Eisenmann JC, Bartee RT, Wang MQ. Physical activity, TV viewing, and weight in US youth: 1999 Youth Risk Behavior Survey. *Obes Res* 2002;10:379-85.
38. Fogelholm M, Nuutinen O, Pasanen M, et al . Parent - child relationship of physical activity patterns and obesity. *Int J Obes* 1999;23: 1262-8.
39. Zwiauer K. Prevention and treatment of overweight and obesity in children and adolescents. *J Pediatr* 2000;159:56-68.
40. Epstein LH, Paluch RA, Gordy CC, Dorn J. Decreasing Sedentary Behaviors in Treating Pediatric Obesity. *Arch Pediatr Adolesc Med* 2000;154:220-6.
41. Graf C, Koch B, Kretshmann-Kandel E, et al . Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-Project). *Int J Obesity* 2004;28:22-6.
42. Tokmakidis SP, Kasambalis A, Christodoulos AD. Fitness levels of Greek primary schoolchildren in relationship to overweight and obesity. *Eur J Pediatr* 2006;165:867-74.
43. Truter L, Pienaar AE, Du Toit D. Relationships between overweight, obesity and physical fitness of nine- to twelve-year-old South African children. *South African Fam Pract* 2010;52:227-33.
44. Gaeini AA, Fallahi AA, Kazemi A, Kordi R. Association between Cardiovascular Fitness and Inflammatory Markers in Boys Aged 11-14 Years. *Iran J Pediatr* 2009;19:262-70.
45. Farahani AV, Mansournia MA, Asheri1 H, et al. The effects of a 10-week water aerobic exercise on the resting blood pressure in patients with essential hypertension. *Asian J Sports Med* 2010;1:159-67.
46. Amin-Shokravi F, Rajabi R, Ziaee N. Exercise effects on risk of cardiovascular disease among Iranian women. *Asian J Sports Med* 2011; 2:37-43.
47. Ekelund U, Franks PW, Wareham NJ, Aman J. Oxygen uptakes adjusted for body composition in normal weight and obese adolescents. *Obes Res* 2004;12:513-20.



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