Original Article

ASSESSMENT OF BODY COMPOSITION AND SERUM LIPID PROFILE IN SCHOOL CHILDREN

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ABSTRACT

Objective: To determine the relationship between body composition and blood lipid concentrations in school aged children

Methodology: In this cross-sectional study, 159 children between the ages of 6 to 11 years were included Anthropometric measurements and serum total lipids profile were assessed.

Results: Overweight was 6% for boys and 5% for girls. A positive correlations were observed between Total Cholestrol (TC), and BMI, waist circumference, waist to hip ratio, percentage of fat mass, arm fat area (AFA) and between triglyceride (TG), and AFA; while a negative correlation was determined between HDL-C, and fat mass, AFA for boys. No correlation was observed for these values obtained from girls.

Conclusion: This study has shown that in comparison to girls, the overweight and the correlation of body composition and lipid profiles were higher in boys with a tendency to develop the higher risk level of cardio vascular disease.

KEY WORDS: Body composition, Anthropometry, Lipid profile, School children, Risk of cardiovascular disease.

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INTRODUCTION

In addition to dietary information, the assessment of nutritional status included various anthropometric measurements for providing information on growth and body composition.[1] Anthropometric measurements can be used to assess body size and proportions as well as total body and regional body compositions. Measurements include body weight and height, circumferences, skinfold thickness. Anthropometric indices include body mass index (BMI), waist circumference and waist to hip ratio (WHR).[2] These data are not always easy to interpret, but they are important to obtain because overweight youth are at increased risk for adverse health outcomes, including mortality, in later life.[1] Prospective and retrospective studies have shown that risk factors related to cardiovascular diseases (CVD) namely obesity, lipid profiles, unhealthy diets and sedentary lifestyle, have their roots in childhood and tend to track into adulthood.[3-6]

Obesity relates to other risk factor variables in children as well as in adults, but there is little information on the effects of persistent obesity in early life. Because obesity begins in childhood, it is important to determine the level at which obesity begins to influence cardiovascular risk. Consequently, individuals who have been obese since childhood are of particular interest for studying the early natural history of obesity and its relationship to the development of CVD. In childhood, obesity is associated with high levels of blood pressure levels, very low-density lipoprotein cholesterol (VLDL-C) and insulin, lower levels of high-density lipoprotein cholesterol (HDL-C), increased heart rate, & increased cardiac output.[7]

Abnormal serum concentrations of lipids such as total cholesterol (TC) and low- density lipoprotein-cholesterol (LDL-C) are strongly correlated with early atherosclerotic lesions.[8,9] Serum lipid levels may be affected by obesity or body fat distribution patterns.[10] An examination of five-year longitudinal relationships of change in triceps skinfold thickness to change in levels of serum lipids and lipoproteins in children who were initially five to twelve years of age, revealed significant positive associations for total cholesterol, triglycerides, VLDL-C, and LDL-C, and an inverse association with HDL-C.[7]

The present study was planned and performed with the aim of identifying the relationship between anthropometric measurements, body composition and some biochemical parameters in school-aged children.

METHODOLOGY

Subjects: This research was conducted in two primary schools located in a low socioeconomic district of Ankara, Turkey. With parental consent, 159 healthy children (99 boys, 60 girls), between the ages of 6 and 11 years, were recruited for this research. Approval to conduct this survey was granted by the Ethical Committee of Gazi University.

Anthropometric Measurements: The weight of children wearing minimal clothing was measured to the nearest 0.5kg with a portable scale. Height to the nearest 0.5 cm was measured with a fiberglass tape. BMI (kg/m^2) as body weight (kg) divided by height (m) squared was calculated. Since reference data on BMI for the Turkish population were not available, The National Health and Nutrition Examination Survey (NHANESII) reference data were used. The children were grouped into five categories, underweight, at risk of being underweight, normal-weight, overweight and obese, in accordance with the cut-off points of <5th, >5-15th, >15-85th, >85-95th and >95th percentiles respectively.[11] Hip and waist circumferences were measured to the nearest 0.5cm in a standing position. According to Cruz and Goran,[12] the children's waist circumferences were grouped under age and sex, at risk for metabolic syndrome in pediatrics. Skinfolds were taken at four sites: triceps, biceps, subscapular, and suprailiac. Each skinfold was measured twice with Holtain skinfold caliper. Arm muscle area (AMA) and arm fat area (AFA) were calculated by using equations.[13] The triceps and subscapular skinfold thickness were used to predict percent body fat using the following equations based on multi-component models for Caucasian children.[14]

Ó Triceps + subscapular = Ó Skinfold (SKF)

Ó SKF>35mm

Boys (all ages) %fat = 0.783 (Ó SKF) +1.6

Girls (all ages) %fat = 0.546 (Ó SKF) +9.7

Ó SKF<35 mm

Pre-pubertal boys

%fat = 1.21 (Ó SKF) –0.008 (Ó SKF)^2 –1.7

Girls (all ages)

%fat = 1.33 (Ó SKF) –0.013 (Ó SKF)^2 –2.5

The other equation for calculating fat mass (FM), which was recently evaluated by Dezenberg et al. (15), which is as follows:

FM (kg) = 0.38 x body weight + (0.30 x triceps) + (0.87 x gender) + (0.81 x ethnicity) –9.42

Where gender =1 for males and 2 for females and ethnicity= 1 for Caucasians and 2 for African-Americans. Arm muscle area (AMA) and arm fat area (AFA) were calculated by using equations (13) is as follows:

Arm muscle area (AMA) (cm^2) =
[MUAC – (ë x TSF)]^2 _ /4 ∏ 10 cm^2 (male)
_ 6.5 cm^2 (female)
Arm Fat Area (AFA) (cm^2) =
(MUAC x TSF) /2 _ (∏x TSF)/4
2 4

TSF: Triceps skinfold ∏: 3.1416

Plasma Lipids and Lipoproteins: Early morning venous blood samples were taken from each child for biochemical screening tests following a 12-hour overnight fasting. Professional staff performed venipuncture was by using vacutainers to obtain 10 ml of whole blood. The blood samples were transferred to the laboratory in tanks containing ice packs which maintained the temperature at 3-4°C. Aliquot was used for blood analyses of triglycerides (TG), total cholesterol (TC) and high-density lipoprotein cholesterol (HDL-C) measurements on the same day as blood were drawn.

Statistical Analysis: All values are reported as the mean ± SEM. Statistical evaluation of the results was performed with the SPSS 10.0 computer program. The Kolmogorov-Smirnov test was used to determine whether outcome variables were normally distributed. As the analysis showed that all variables were not distributed normally, the Mann-Whitney U test was used. Spearman correlation coefficients were used to assess relationships between independent variables. The level of significance was set at a probability of less than 5% ($p<0.05$).

RESULTS

Descriptive data for body composition and both central and peripheral adiposity for all girls and boys are shown in Table-I. Of the 159 students included in this study, 62.3% were boys (n:99) and 37.7% were girls (n:60).

Table-I: Sample characteristics

Parameters	*Boys(n:99) Mean±SEM*	*Girls (n:60) Mean±SEM*	*p value*
Age (year)	8.9±0.14	7.9±0.11	0.655
Body weight (kg)	27.6±0.49	23.7±0.52	0.000*
Height (cm)	131.6±0.76	125.4±0.85	0.000*
BMI (kg/m^2)	15.8±0.16	15.0±0.22	0.004*
Waist (cm)	57.5±0.61	54.5±0.54	0.000*
Hip (cm)	70.0±0.60	65.5±0.67	0.000*
Waist/ Hip ratio	0.82±0.006	0.83±0.005	0.294
MUAC	18.1±0.18	17.2±0.21	0.004*
Skinfold (mm)			
Triceps	8.8±0.29	9.2±0.32	0.096
Biceps	4.7±0.16	5.1±0.22	0.078
Subscapula	5.2±0.19	5.6±0.20	0.078
Suprailiac	5.2±0.21	6.1±0.30	0.001*
Ó4 skinfolds	14.0±0.45	14.8±0.48	0.098
FM (kg)	5.4±0.24	4.9±0.26	0.379
% FM	16.2±0.40	14.2±0.44	0.002*
AMA	8.9±0.33	9.9±0.34	0.015*
AFA	7.5±0.32	7.4±0.32	0.656

*p<0.05 indicate differences between boys and girls by Mann-Whitney *U* test

**MUAC; Mid Upper Arm Circumference; AMA; Arm Muscle Area ; AFA; Arm Fat Area; FM; Fat Mass

Analyses of all the children revealed significant differences between gender for body weight, height, BMI, waist and hip circumference, mid upper arm circumference (MUAC), suprailiac skinfold, % FM, and AMA ($p<0.05$). Detailed evaluation of the parameters showed that boys had higher mean values of body weight, height, BMI, waist, hip, MUAC, and % FM than girls, while suprailiac skinfold and AMA mean values were higher in the girls.

Descriptive data of the children's lipid profiles are presented in Table-II. Girls had a higher TC, LDL-C and TC/ HDL-C than boys

Table-II: Lipid profile by gender

Parameters	*Boys (n:99) Mean±SEM*	*Girls (n:60) Mean±SEM*	*p value*
Triglycerides (mg/dL)	57.5±3.08	61.8±3.90	0.428
Total cholesterol (mg/dL)	124.1±2.71	130.1±2.64	0.028*
HDL cholesterol (mg/dL)	38.9±1.29	36.3±1.55	0.252
LDL cholesterol (mg/dL)	73.7±2.39	81.5±2.44	0.004*
TC/ HDL –C ratio	3.5±0.13	3.9±0.16	0.021*

*p<0.05 indicate differences between boys and girls by Mann-Whitney *U* test

Table-III: BMI, Waist Circumference, TC, HDL-C, LDL-C, TC/ HDL –C ratio distribution by gender

	Boys (n:99) n (%)	*Girls (n:60) n(%)*	*Total (n:159) n(%)*
BMI (percentile)			
Underweight	9 (9.1)	14 (23.3)	23 (14.5)
Risk of underweight	18 (18.2)	10 (16.7)	28 (17.6)
Normal	66 (66.7)	33 (55.0)	99 (62.3)
Overweight	6 (6.0)	3 (5.0)	9 (5.6)
Waist (cm)			
Normal	76 (76.8)	57 (95.0)	133 (83.6)
High	23 (23.2)	3 (5.0)	26 (16.4)

($p<0.05$), while all other variables were not significantly different between two gender (Table-II).

Table-III shows BMI, waist circumference, TC, HDL-C, LDL-C, and TC/ HDL –C ratio distribution by gender. It is clear from the Table-III that 23.3% of girls and 9.1% of boys were underweight (<5th). It was seen that the overweight (>85-95th) was 6% and 5% for girls and boys, respectively. We have not found obese (>95th) children in this study. Risk of CVD based on waist circumference measurements was found to be 23.2% in boys and 5% in girls. Correlation of lipid profiles to body composition is presented in Table-IV. A positive correlations were observed between TC and BMI (r_s: 0.222, $p<0.05$), waist circumference (r_s: 0.211, $p<0.05$), waist to hip ratio (r_s: 0.212, $p<0.05$), % FM (r_s: 0.282, $p<0.05$), AFA (r_s: 0.289, $p<0.05$) and between TG and AFA (r_s: 0.262, $p<0.05$), while negative correlations were found in HDL-C and FM (r_s: -0.219, $p<0.05$), AFA (r_s: -0.200, $p<0.05$) for boys. However, none of these parameters showed any correlation, in girls.

DISCUSSION

From a nutritional point of view, Turkey seems to have problems associated with both developing and developed countries. Nutrition in Turkey varies considerably by region, season, socio-economical status and settlements. One of the main causes of this variation is, of course, income distribution. It also has an impact on nutritional problems as well as the frequency of occurrence of these problems.[16]

This study mainly focused on analysis of obesity and cardiovascular risk factor, BMI, body composition, and lipid profile in children between the ages of 6 and 11 years. Obesity is not so prevalent among children of the lower socio-economic classes in Turkey.[17] Based on the study performed by Mahley et al.,[18] in lower socio-economic regions, 9% of boys and 8% of girls are overweight. A similar study by Soylu et al.,[17] showed 1.4% of obesity in both sexes. Likewise, this study showed that overweight is 6% for boys and 3% for girls. In general, anthropometric values in boys are higher than that in girls. Waist circumference cut-off points associated with adverse levels of CVD risk factors and obesity were also determined in children. Waist circumference reflects central adiposity, as well as general adiposity; cut-off points based on waist circumference may be uniquely related to disease risk.[19-21] Based on

Table-IV: Correlation between serum lipid profile and whole-body composition by gender

Parameters	*Boys (n:99)*					*Girls (n:60)*				
	TC	*TG*	*HDL-C*	*LDL-C*	*TC/HDL-C*	*TC*	*TG*	*HDL-C*	*LDL-C*	*TC/HDL-C*
Body mass (kg)	0.151	0.080	0.149	0.034	0.077	0.025	0.066	0.116	0.103	0.166
BMI (kg/m^2)	0.222*	0.193	0.062	0.140	0.057	0.034	0.223	-0.094	0.001	0.114
Waist (cm)	0.211*	0.106	-0.058	0.049	0.051	0.028	0.237	-0.057	0.017	0.107
Waist/Hip ratio	0.212*	0.011	-0.126	0.181	0.008	0.231	0.037	-0.096	0.210	0.035
FM (kg)	0.191	0.124	-0.219*	0.030	0.122	0.053	0.114	-0.050	0.094	0.130
% FM	0.282*	0.214	-0.175	0.141	0.028	0.150	0.236	-0.065	0.105	0.074
AMA	-0.157	-0.112	0.088	-0.082	-0.002	-0.125	-0.144	0.024	-0.145	0.092
AFA	0.289*	0.262*	-0.200*	0.123	0.049	0.078	0.159	-0.047	0.064	0.066

*$p<0.05$ by spearman correlation coefficient

Cruz and Goran ,[12] waist circumference cut-off points for boys and girls were higher than the values that were detected in this study. This result can be considered as an indication of low risk among Turkish children. Studies in Turkey has data on other anthropometric measurements which has shown similarities with the results of this research.[17,18]

Obesity and changes in blood lipid profile during childhood increases CVD risk in adulthood. Therefore, in CVD examination, one of the most important parameters is the analysis of total lipid profiles.[21] HDL-C levels are typically 10-15 mg/dL lower in Turkish adults than in Europeans and North Americans, and >50% of Turkish men and 5% of Turkish women have levels <35 mg/dL.[22] Onat and colleagues have confirmed these findings.[23,24] These low HDL-C levels appear to be largely of genetic origin as they are also observed in Turks living in Germany and the United States.[25,26] The results of this study showed that HDL-C values of children were lower than the mean value of 45 mg /dL determined by Mahley et al.[18] Although total cholesterol/ HDL-C ratio and other lipid values were normal, because of their relatively young age, low HDL-C value constitutes an important risk in CVD for our study population. One of the main findings of this study was the determination of low HDL-C values for Turkish children of low socio-economic status.

As mentioned earlier, BMI, body composition, and blood lipid profiles are important criteria for CVDs.[19-21] Therefore, evaluation of relationships between these parameters will identify the risk level for CVD in children. Correlations between anthropometric parameters and lipid levels have varied in different studies.[21,27-31] Williams et al.,[21] and Dwyer and Blizzard[27] have proposed percentage of fat standards for defining health-related obesity in children. In both studies percentage of fat was estimated from skinfold measurements and was related to blood lipid levels. Flodmark et al.,[28] found that BMI was significantly correlated with serum triglycerides. Anderson et al.,[29] reported that in adult men and women, the anthropometric measurements were inversely associated with levels of serum HDL-C. Another study showed that serum lipid concentrations have stronger correlations with BMI and FM.[30] Visceral adipose tissue is significantly related to concentrations of plasma LDL-C and TG in 11-15 year-olds.[31] Furthermore, abnormalities in lipid concentrations correlate with waist circumference in young people.[28] Waist circumference is a highly sensitive and specific measure of upper body fat in young people and so should be valuable in identifying overweight and obese children at risk of developing metabolic complications.[32] These various findings may have derived from the differences of age and nutritional status in the respective populations. In this study, it was also determined, that as TC values increased in boys, BMI, waist circumference, waist to hip ratio, % FM, and AFA increased and increases in TG values resulted in increased AFA values; while increases in HDL-C values lead to decreases in FM and AFA values. Although LDL-C values and TC/ HDL-C ratios were higher, no correlation was found between body composition and total lipid profile in girls. Our results revealed that because of a higher CVD risk for boys as they get older there is potential of obesity risk.

In conclusion, obesity is not prevalent among children of low socio-economic status in Turkey as a developing country. However, evaluation of anthropometric measurements and blood lipid correlation, especially for boys, and lower HDL-C values for children of both sexes, represent a high risk factor in terms of CVD. Considering that "School-Age" is the most appropriate time for acquiring knowledge and habits, the habit of having healthy and balanced nutrition acquired at that age might be carried into adulthood. For these reasons, nutritional programs in schools would be beneficial in helping children to develop physical health and, in turn enhance their cognitive abilities.

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