

## Relationship between Body Mass Index, Lipids and Homocysteine levels in university students

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### Abstract

**Objective:** To determine the effects of obesity on blood lipids and homocysteine levels of university students.

**Methods:** The study comprised of 172 male and 183 female students who were classified according to their body mass index (BMI) into 3 groups as underweight, normal weight and overweight. Anthropometric measurements, blood lipids and homocysteine levels were analyzed.

**Results:** Mean fat mass percentage (FM %), triceps, biceps, suprailiac and the sum of skinfold thickness were significantly higher in girls than boys ( $p < 0.001$ ). Frequency of overweight (BMI=25.0-30.0 kg/m<sup>2</sup>) in boys and girls was found to be 13.3% and 6.6% respectively. There was a negative correlation between the body weight and HDL-cholesterol ( $r = -0.33$ ,  $p < 0.01$ ), a positive correlation between WHR and VLDL-cholesterol levels ( $r = 0.42$ ,  $p < 0.01$ ). As long as body weight, WHR and FM (%) increase, homocysteine level also increases. Overweight students had significantly higher level of VLDL-C, triglycerides (TG), TC/HDL-C ratio and LDL-C/HDL-C ratio than normal and underweight students ( $p < 0.05$ ).

**Conclusion:** Obesity effects blood lipid and homocysteine levels negatively. The early detection and control of obesity and the management of dyslipidemia and homocysteine levels may help reduce the risk of cardiovascular diseases in the young population (JPMA 57:491:2007).

## Introduction

Obesity is an emerging public health problem throughout the world especially in our country (Turkey) where it is on the rise during childhood, adolescence and adulthood.<sup>1</sup> Obesity is associated with hypertension, osteoarthritis, dyslipidemia, indigestion, respiratory and musculoskeletal disorders. In addition, it can cause psychological effects influencing, the quality of life.<sup>2,3</sup> Central obesity is related to increase in LDL-C/HDL-C ratio, blood pressure and TG levels.<sup>4</sup> The elevated plasma homocysteine concentration is a strong risk factor for coronary artery diseases as well as peripheral artery disease and stroke.<sup>3,5</sup>

Published anthropometric and biochemical data on Turkish adolescent is scarce and restricted. The purpose of the present study is to broaden the knowledge and understanding on the interrelationship of certain cardiovascular diseases risk factors, such as lipid profile, homocysteine levels and anthropometric parameters.

## Methods

This study was conducted on 172 male and 183 female students with the age range 19 to 23 years, at Gazi University Vocational Education Faculty in Ankara, Turkey. The students did not use any medicines, vitamins, mineral supplements, oral contraceptives; and none of the girls were pregnant.

Height was measured to the nearest 0.1 cm, and weight to nearest 0.5 kg in light clothing and without shoes. Body mass index (BMI) was calculated as weight (kg)/height (m<sup>2</sup>). All measurements were taken by trained dieticians. Since reference data on BMI for Turkish population are not available, WHO reference data were used for estimating obesity in young Turkish subjects.<sup>6</sup>

Students were classified according to their BMI into 3 groups as underweight (BMI<18.5 kg/m<sup>2</sup>), normal weight (BMI=18.5-24.9 kg/m<sup>2</sup>) and overweight (BMI>25.0 kg/m<sup>2</sup>). The amount and distribution of body fat was assessed by measuring the thickness of subcutaneous adipose tissue with Lange skinfold caliper. The skinfold thickness was measured on the left side of the body at four sites: biceps, triceps, subscapular and suprailiac thickness. The sum of the four skinfold thickness measurements was considered an indicator of total subcutaneous fat and the sum of skinfold thickness as an index of central obesity. The waist to hip (WHR) ratio was used to assess body fat distribution and specifically as indicators of intra abdominal or visceral fat deposition.<sup>7</sup>

Measurements were taken of the mid upper arm circumference (MUAC) on the bare arms of the students,

who stood in a straight position with left arm bent at a 90° angle. The distance between acromion and olecranon was measured with a tape measure and marked at the middle point. Later a measurement was made with a non-stretch measuring tape around the circumference at the mark with arms at sides and inner palms towards the femur. Mid upper arm muscle circumference (MUAMC) and mid upper arm muscle area (MUAMA) were calculated according to the formula below.<sup>7</sup>

$$\text{MUAMC (cm)} = \text{MUAC (cm)} - [3.1416 \times \text{Triceps SFT (cm)}]$$

$$\text{MUAMA (cm}^2\text{)} = [\text{MUAC (cm)}] - [3.1416 \times \text{Triceps SFT (cm)}] / 4 \times 3.1416$$

SFT: Skinfold Thickness

Waist circumference was measured with a non-elastic tape at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration. Hip circumference was measured at the widest part of the hip at the level of the greater trochanter to the nearest half-centimetre.<sup>7</sup>

Early morning venous blood samples were obtained from each student for biochemical screening tests, following a 12-hour overnight fast. Professional staff performed venopuncture, using vacutainers to obtain 15 mL of whole blood. Blood was centrifuged for plasma separation at the local Ankara Government Hospital where the actual biochemical analyses were made.

Roche Diagnostic kits were used for total cholesterol (TC), HDL-C, VLDL-C and TG analysis and Modular D+P (Roche Diagnostics GmbH Monnherrin, Germany) was used for Analysis. The LDL-C was calculated by the Friedewald, Levy and Fredricson.<sup>8</sup>

$$\text{LDL-C} = \text{TC} - (\text{HDL-C} + \text{TG}/5)$$

Homocysteine level was analyzed by Chromsystems Chemicals (Munich-Germany) Kit System and Agilent 1100 Isocratic HPLC Analyser (Hewlett-Packard) (Waldbnoon-Germany) was used as florescent detector.

The data was entered and analyzed using the Statistical Packages for Social Sciences (SPSS) for Windows version 12.0. Descriptive statistics of continuous variables are expressed as the mean±standard deviation (SD). For the evaluation of anthropometric measurements according to sex, student's t-tests was used and for the effect of overweight status on biochemical tests one way analysis of variance (ANOVA) method was used. In addition to that, chi square test was made for BMI distribution and sex. Correlations of anthropometric measurement between blood lipids and homocysteine were assessed using the Pearson coefficient correlation. In all analyses, 95% significance level was used.

## Results

A total of 355 healthy volunteer students were studied. Anthropometric measurements of the boys and girls are presented in Table 1.

Body weight, height, BMI, MUAMC, waist and hip circumferences, FFM (%) were found significantly high in boys compared to girls ( $p < 0.001$ ). The triceps, biceps, suprailiac, sum skinfold thickness and FM (%) are larger in girls ( $p < 0.001$ ).

The frequency of overweight, underweight, and normal weight in the total sample was 9.9%, 25.4%, 64.8% respectively. Boys were more overweight and less

**Table 1. Anthropometric measurement of boys and girls (n: 355).**

Anthropometric Measurements	Boys (n: 172) Girls (n: 183)		P value
	Mean±SD	Mean±SD	
Weight (kg)	69.3±9.9	56.7±9.2	<0.001
Height (cm)	175.7±0.6	163.3±6.3	<0.001
BMI (kg/m <sup>2</sup> )	22.4±2.7	21.2±2.8	<0.001
MUAC (cm)	26.9±2.5	25.3±3.4	0.002**
MUAMC (cm)	23.9±1.9	19.4±3.0	<0.001
MUAMA (cm <sup>2</sup> )	194.4±20.5	130.1±14.8	0.001
Triceps SFT (mm)	9.4±4.3	18.8±6.8	<0.001
Biceps SFT (mm)	4.2±2.6	8.3±3.4	<0.001
Subscapular SFT (mm)	13.5±6.4	17.2±7.7	0.01
Suprailiac SFT (mm)	18.1±9.9	23.4±9.7	<0.001
Sum SFT (mm)	45.3±20.9	67.7±24.3	<0.001
Waist circumference (cm)	78.2±7.5	71.5±7.8	<0.001
Hip circumference (cm)	96.9±6.8	95.7±6.7	<0.001
FM (%)	21.7±5.4	30.9±4.7	<0.001
FFM (%)	78.3±5.4	69.0±4.7	<0.001

BMI: Body Mass Index, SFT: Skinfold Thickness, FM: Fat Mass, FFM: Fat Free Mass, MUAC: Mid Upper Arm Circumference, MUAMC: Mid Upper Arm Muscle Circumference, MUAMA: Mid Upper Arm Muscle Area

**Table 2. Comparison of blood lipids and homocysteine levels among underweight, normal weight and overweight subjects (n:355).**

Biochemical Parameters	Underweight	Normal weight	Overweight	P value
TC (mg/dL)	151.1±23.9	161.6±30.1	183.2±41.7	0.09
HDL-C (mg/dL)	58.7±11.8	55.6±13.9	51.9±9.5	0.52
LDL- C (mg/dL)	76.8±14.2	87.4±26.7	102.8±35.3	0.10
VLDL- C (mg/dL)	15.6±5.2	18.6±8.5	28.5±15.7	0.01
TG (mg/dL)	78.1±26.6	93.0±42.0	142.3±78.4	0.01
TC/HDL- C	2.6±0.4	3.0±0.8	3.7±1.3	0.01
LDL-C/HDL-C	1.3±0.3	1.7±0.6	2.1±0.9	0.03*
Homocysteine (μmol/L)	11.1±2.1	12.6±5.7	14.3±7.2	0.45

TC = Total cholesterol  
HDL-C = High density lipoprotein cholesterol  
LDL-C = Low density lipoprotein cholesterol  
VLDL-C = Very low density lipoprotein cholesterol  
TG = Triglycerides

**Table 3. The relationship between anthropometric measurement of blood lipids and homocysteine levels (n: 355)**

	Pearson correlation coefficient (r)						
	TC	HDL-C	LDL-C	VLDL-C	TG	TC/HDL-C	Hcy
Weight	0.07	-0.33**	0.12	0.35*	0.35**	0.43**	0.11
BMI	0.21	-0.16	0.21	0.33**	0.35**	0.37**	0.08
WHR	0.10	-0.41**	0.18	0.42**	0.41**	0.47**	0.07
Triceps SFT	0.16	-0.33*	0.02	0.02	0.02	0.07	0.16
Sum SFT	0.30*	-0.21	0.17	0.21	0.21	0.12	0.05
FFM%	-0.26*	0.32*	-0.12	-0.07	-0.07	-0.03	0.08
FFM (kg)	-0.06	0.46**	-0.06	-0.28*	-0.28*	-0.40*	0.13
FM (kg)	0.24	-0.07	0.16	0.27*	0.27*	0.23	0.00
MUAMC	0.14	-0.38**	0.26*	0.29*	0.29*	0.41**	0.22
MUAMA	0.17	-0.36**	0.27*	0.31*	0.31*	0.41**	0.23

\* P<0.05 \*\*P<0.01

Hcy: Homocysteine, BMI: Body Mass Index, WHR: Waist Hip Ratio, SFT: Skinfold Thickness, FFM: Fat Free Mass, FM: Fat Mass, MUAMC: Mid Upper Arm Muscle Circumference, MUAMA: Mid Upper Arm Muscle Area

underweight compared to girls ( $p = 0.001$ ).

Table 2 reveals the effect of obesity on blood lipids and homocysteine levels in students.

VLDL-C ( $p = 0.01$ ), TG ( $p = 0.01$ ), TC/LDL-C ratio ( $p = 0.01$ ) and LDL-C/HDL-C ( $p = 0.03$ ) ratio were significantly higher in the overweight group as compared to students in the underweight group, whereas HDL-C levels were lower ( $p = 0.52$ ).

Table 3 shows the association of biochemical variables with the anthropometric variables. There was a positive relationship between TC and body weight ( $r = 0.07$ ,  $p > 0.05$ ), BMI ( $r = 0.21$ ,  $p > 0.05$ ), triceps skinfold thickness ( $r = 0.16$ ,  $p > 0.05$ ), sum of skinfold thickness ( $r = 0.30$ ,  $p < 0.05$ ) and negative correlation between FFM (%) ( $r = -0.26$ ,  $p < 0.05$ ). Obesity had a negative relations on HDL-C and HDL-C was significantly negative correlated with weight ( $r = -0.33$ ,  $p < 0.01$ ), WHR ( $r = -0.41$ ,  $p < 0.01$ ), triceps skinfold thickness ( $r = -0.33$ ,  $p < 0.05$ ), MUAMC ( $r = -0.38$ ,  $p < 0.01$ ) and MUAMA ( $r = -0.36$ ,  $p < 0.01$ ).

## Discussion

This research provides important information regarding anthropometric measurements, blood lipids and homocysteine levels of university students. While the increase in BMI is an important risk factor for cardiovascular diseases in adults, there are only few studies showing this among young population.

In recent years obesity has become a problem during childhood and adulthood almost all over the world. In Turkey, 33.4% of women are underweight and 18.8% overweight.<sup>9</sup> In the present study, the mean BMI in boys was 22.4±2.7, in girls 21.2±2.8 kg/m<sup>2</sup>, the results reflect a high prevalence of normal weight students among the

respondents (boys 69.8%, girls 60.1%, total 64.8%).

In a study done among Turkish children, 12% were underweight and the prevalence was higher among boys.<sup>10</sup> Another study among Turkish youth showed BMI<5th percentile was accepted as underweight and the frequency in boys was 1.7%, in girls 13.3%.<sup>11</sup> The present study showed that underweight was more prevalent among girls. Although the frequency of obesity according to BMI was lower in girls, FM (%) was higher. It is better and more accurate to use other anthropometric measurements of body composition, while evaluating obesity, rather than evaluating the body weight. Williams et al<sup>12</sup>, have found that there is a relation between body fatness and elevation in blood pressure and serum lipids.

Comparing the findings of the present study with the data recorded in developed countries, the prevalence of both overweight and obesity among Turkish young was found to be lower, that is, approximately 9.9% versus a range between 15.0 and 36.0% for other European countries and the USA.<sup>13,14</sup> Comparing our results with those of previous studies conducted in Turkey, the prevalence of overweight and obesity was found to be higher in the current population.<sup>11,15</sup>

Excess body fat has been attributed as a risk factor for several non-communicable disease such as diabetes, hypertension, hyperlipidemia and cardiovascular diseases. Recent statistics have indicated that there is a high prevalence of these diseases in Turkey.<sup>9</sup>

Elevation in TC and LDL-C levels in a community gives rise to increase in the risk of coronary heart diseases. In individuals body weight and lipid profiles should be evaluated so that preventive measures can be initiated in those who are overweight or have deranged lipid profiles.<sup>16</sup> In children and adolescents, TC levels higher than 170 mg/dL and LDL-C level higher than 110 mg/dL are high risk factors for heart diseases. Obesity, which affects the lipid profile, is accepted as an important risk factor for heart diseases.<sup>17</sup> In these studies, the TC, LDL-C and TG levels were found elevated. Moreover, there was a significant correlation between BMI and LDL-C, VLDL-C, TG, TC/HDL-C and LDL/HDL ratios. The Bogalusa Heart Study, a community-based study of risk factors for coronary vascular diseases in black and white youth, pooled data from 9167 subjects. These investigators found that youth with a BMI above the 85th percentile for age and sex were 2.4, 3.0, 3.4, 7.1 and 4.5 times more likely to have adverse levels of TC, LDL-C, HDL-C, TG, respectively, than normal weight subjects.<sup>18</sup> Also in another study there are supportive results showing that there is a relationship between obesity, blood lipids and cardiovascular risk factors.<sup>19</sup>

In the present study, there were significant

correlations among anthropometric measurements and blood lipids. As long as an obesity criterion increases, except for the HDL-C level, blood lipid and homocysteine levels elevate. There is a negative correlation between HDL-C and body weight, BMI, WHR, MUAMC, and MUAMA.

A high homocysteine level is now considered an independent major risk factor for coronary heart diseases depending on the blood level.<sup>20-21</sup> Pezzini et al<sup>20</sup> showed that total homocysteine concentrations were markedly higher in young patients with ischaemic stroke. In this study, the increase in the body weight was associated with elevated homocysteine levels. However, the difference between the groups was not significant. In another study all anthropometric measurements and serum homocysteine levels were found to be high in overweight and obese subjects.<sup>22</sup> Brasileiro et al<sup>23</sup> found no significant difference in the homocysteine levels in overweight and normal weight individuals.

In conclusion, body weight, BMI, FM, WHR, TC, LDL, VLDL-C, and homocysteine levels should be evaluated together. Anthropometric measurements, blood lipid and serum homocysteine levels should be routinely controlled in order to reduce the risk of cardiovascular disease; this will also minimize the risk of heart diseases in adults. The results of this study indicated that special attention should be given to preventative measures regarding increased body weight and an unfavourable lipid and homocysteine profiles in young.

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