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The relationship between serum lipid levels, high blood pressure and obesity in children

Çocuklarda serum lipit seviyeleri, hipertansiyon ve obezite arasındaki ilişki

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ABSTRACT

Objective: The purpose of this study was to determine serum lipid, cholesterol and obesity levels in healthy children, and then to explore the relationships between these factors.

Methods: The sample group consisted of 103 students at Gelik Elementary School in Zonguldak, Turkey who was willing to participate in the study, had not been medically diagnosed with a chronic ailment, and were not taking regular medications.

Results: When the students' mean BMI (Body Mass Index) measurements were considered, it was found that mean BMI at 13 years of age (21.03 ± 0.23) was higher than at 14 years (20.05 ± 0.20) and that this difference was strongly significant (p=0.002). When the relationships between the students' height, weight, BMI, blood pressure, FBS (Fasting Blood Sugar), cholesterol, LDL (Low Density Lipoprotein), HDL (High Density Lipoprotein) measurements were considered, it was seen that there was a positive significant relationship between height-weight (r=0.472; p<0.001), height-blood pressure (r=0.432; p<0.001), and height-FBS (r=0.332; p=0.001).

Conclusion: The conclusion drawn was that monitoring blood pressure, cholesterol, LDL and HDL levels in childhood medical examinations is not only important in terms of identifying obesity, but also in identifying nutritional mistakes and deficiencies at an early stage.

Key words: Children, hypertension, obesity, body mass index, Zonguldak, Turkey

ÖZET

Amaç: Bu çalışmanın amacı sağlıklı çocuklarda serum lipit, kolesterol ve obezite seviyesini tespit ederek, bunlar arasında ilişki olup olmadığını araştırmaktır.

Yöntemler: Örneklem grubunu Nisan-Mayıs 2011 tarihleri arasında Zonguldak'ta Gelik ilköğretim okuluna devam eden, hekim tarafından tanı konulmuş kronik hastalığı ve sürekli kullandığı bir ilacı olmayan ve araştırmaya katılmayı kabul eden 103 öğrenci oluşturdu.

Bulgular: Öğrencilerin yaşları ile VKİ (Vücut Kitle İndeksi) ortalamalarına bakıldığında; 13 yaşta VKİ ortalaması (21,03 ± 0,23), 14 yaşa göre (20,05 ± 0,20) daha yüksek olup bu farklılığın istatistiksel olarak anlamlı olduğu bulundu (p=0,002). Öğrencilerin boy, ağırlık, VKİ, tansiyon, AKŞ (Açlık Kan Şekeri), kolesterol, LDL (Low Density Lipoprotein), HDL (High Density Lipoprotein) seviyeleri arasındaki ilişkiye bakıldığında; boy-ağırlık (r=0,472; p<0,001); boy-tansiyon (r=0,432; p<0,001) ile boy-AKŞ (r=0,332; p=0,001) arasında pozitif yönde anlamlı ilişki görüldü.

Sonuçlar: Sonuç olarak, çocukluk çağında yapılacak sağlık muayenelerinde kan basıncı, kolesterol, LDL, HDL'nin izlenmesi yalnız obezite için değil; çocuklara yönelik beslenme alışkanlıklarındaki yanlışlık ve eksikliklerin erken teşhisinde de önemli olduğu kanısına varıldı.

Anahtar kelimeler: Çocuklar, hipertansiyon, obezite, vücut kitle indeksi, Zonguldak, Türkiye

INTRODUCTION

The most important cardiovascular risk factors in children and adolescence have been identified as obesity, smoking, dyslipidemia, high blood pressure, and reduced physical activity [1,2]. The medical significance of obesity stems from its close association with various diseases and with coronary artery disease, in particular [3]. The first stages of obesity involve metabolic and endocrinological changes. When left untreated, asymptomatic metabolic changes present a clinical profile which may

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include hypertension, dyslipidemia and diabetes. At the same time, childhood obesity has been reported to be the cause of childhood hypertension [4]. High blood pressure (hypertension) in children is defined as systolic and/or diastolic blood pressure that is the same or higher than 95% of children of the same age and gender [5,6]. High blood pressure is a decidedly serious risk factor for cardiovascular diseases and is closely associated with cardiovascular morbidity. It has been reported that childhood hypertension is not benign [5]. In obese individuals, prevalence rates of hypertension at all ages have risen. Every 10-kilogram increase in body weight adds 3.0 mmHg to systolic and 2.3 mmHg to diastolic blood pressure [7]. A long-term result of obesity, hypercholesterolemia, is cited as among the major risk factors for coronary arteriosclerosis. The risk and mortality rates of arteriosclerotic heart disease in later ages can only be reduced by treatment [8,9]. It is for this reason that it is important in terms of protective pediatrics to diagnose hyperlipidemia during medical screening in children. The U.S. National Cholesterol Education Program and the American Pediatrics Academy recommends a screening of children from families with high serum cholesterol or with family members that developed cardiovascular disease before the age of 55 [10,11]. In studies on this subject, it has been shown that screening only children with family histories may lead to the result that more than half of children with hypercholesterolemia are overlooked. Recent studies have shown that arteriosclerosis starts in childhood but that symptoms present themselves only at later ages [10,12,13].

The purpose of this study was to determine serum lipid, cholesterol levels and obesity in healthy children, and then to explore the relationships between these factors.

METHODS

Design and sample

All of the students enrolled in the elementary schools in the provincial center of Zonguldak, Turkey (n=12939) comprised the study population. Sample size was calculated as 380 with the formula used for samples with a defined universe. However, families of the 103 students accepted this study. Out of the study population, which encompassed the province of Zonguldak, Gelik Elementary School was taken into the study. Gelik Elementary School was selected because of its location in a geographical area where families of different socio-cultural backgrounds lived. The sample group consisted of students who were willing to participate in the study, were enrolled at Gelik Elementary School during the period April-May 2011, had not been medically diagnosed with a chronic disease, and were not taking regular medications. However, students who had genetic conditions (those with a history of taking medications such as anti-epileptics or anti-hypertension drugs, those with systemic, chronic, neurological disease or hypothyroidism, endocrinological diseases such as Cushing's syndrome, or with syndromic obesity) were excluded from the study.

Data collection

Data was collected with a data collection questionnaire developed by the researchers. The data collection questionnaire was prepared on the basis of a review of the literature [14,15]. The questionnaire was designed to test the comprehensibility and usability of the questions and was first administered to 10 elementary school children, after which it was revised based on the feedback received. The last version of the questionnaire was drawn up at the end of this process. Ten children who had responded to the questionnaire were excluded from the study population.

The data collection questionnaire comprised 32 questions on the children's demographic characteristics (age, gender, educational status of the family, social status of the family, etc.) and their obesity risk factors (height, weight, nutritional peculiarities, parents' chronic illnesses, etc.). The data collection questionnaire was filled out in face-to-face interviews. The researchers do not apply any measurement for family. The students in the study were measured for body weight, height, systolic and diastolic blood pressure by researcher. The children were carefully weighed on a 100-gram-sensitive electronic scale wearing their school uniforms but in their bare feet. Care was also taken to weigh the children before their snack-time. Height was measured with a tape measure with the children standing up straight with their bare feet together, back to the wall and the back of their heads, their backs and heels touching the wall; the height from the floor to the top of the child's head was accepted as the measure of height. The weight of the students in the study was evaluated in terms of the body mass index (Quatelet Index).

The Body Mass Index (BMI) was calculated with the following formula: BMI= weight (kg) / height² (m²). In the evaluation of BMI, the BMI reference graphs adapted to Turkish children by Bundak et al [16] were used. According to the definition of the International Obesity Task Force (IOTF), individuals whose BMI's are in the 85th-95th percentile relative to their age and gender are considered overweight and those with BMI's in the 95th percentile and over are accepted as obese [17]. Systolic and diastolic blood pressure measurements were taken from the right arm with a manometer with an age-appropriate cuff while the child was seated after a 20-minute period of rest. The data of the National High Blood Pressure Education Program Working Group (NHBPEP) indicate that appropriate to a child's age and gender, measurements of systolic and diastolic blood pressure that are in the 95th percentile or more is assessed as hypertension [18].

All of the students' antecubital venous blood samples were taken at 8:00 a.m.-10:00 p.m. after a minimum 12-hour fasting period, to be tested for cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triglycerides.

Statistical analysis

Data were assessed by using the SPSS 15.0 program. In order to analyses the data, means, frequencies, percentages were calculated, t test and ANOVA used for reviews and solution. Tukey test used for detection of difference between two groups. A p-value of <0.05 was taken as the level of significance. In addition, Correlation analysis used for height, weight, BMI, blood pressure, FBS, cholesterol, LDL, HDL and triglyceride. The results were found to be in the 95% confidence interval; significance was considered to be p<0.05.

Ethical approach

Permission for research was obtained from the Ethics Committee of Medical Faculty of Zonguldak Karaelmas University prior to the study (Reg. No: 2011/08-10). After the working protocol was drawn up and approved by the Provincial Directorate of National Education and the Governor's Offices, the cooperation of the school principal and teachers was enlisted with a presentation of information on the purpose and methodology of the study. A letter explaining the purpose, plan and benefits of the research was first written to the parents of the children who met the study inclusion criteria; this was sent to the parents in a sealed envelope and the parents were asked to sign this information sheet. Later, the students themselves were given information about the study and those who were willing to participate were asked to sign the consent sheet, after which the implementation of the study began.

RESULTS

The distribution of the identifying characteristics of the students is given in Table 1. Of the mothers, it was found that 69.9% were elementary school graduates, 98.0% were housewives and their mean age was 38.07 ± 4.99 (min:29, max:51). Among the fathers, it was determined that 55.4% were elementary school graduates, 58.4% were blue-collar workers and their mean age was 42.55 ± 5.84 (min: 32, max: 60). A look into whether there was any chronic disease in the students' families showed that 67% of the mothers had no illness, 11.7% had high blood pressure, 1.9% had high cholesterol and other blood lipid levels, and 1.0% was diabetic. Of the fathers, 80.2% had no illness, 8.9% had high blood pressure, and 1% (n=1) was obese.

As can be seen in Table 2, there are significant differences between the ages of the students and their mean BMI values. Mean BMI at 13 years of age (21.0 ± 0.2) is higher than at 14 years (20.0 ± 0.2) and this difference is statistically and strongly significant (p=0.002). Another difference can be seen in mean FBS levels. Here, mean FBS at 13 years of age, which is 92.3 ± 10.9, rises to 97.9 ± 12.6 at 14 years. This too is statistically significant (p=0.02).

On the other hand, there are no differences observed between the age variable and the cholesterol (p=0.30) and triglyceride variables (p=0.20).

When the identifying variables of the students were compared in terms of their genders and their BMI, FBS, cholesterol and triglyceride values, it was found that the BMI variable (p=0.03) and the cholesterol variable (p=0.02) displayed differences in terms of gender but that the FBS and triglyceride variables did not.

Again, when the family type and allowance status variables were compared in the same table with the BMI, FBS, cholesterol and triglyceride variables, no statistically significant difference could be found in any of the factors. Another analysis was performed to explore the difference between exercising and the BMI, FBS, cholesterol and triglyceride variables; it was seen that there was a statistically significant difference only between exercising and FBS (p=0.04).

In an analysis of the students' eating habit variables compared with the BMI, FBS, cholesterol and triglyceride variables, it was found that there were no statistically significant differences (p>.05) according to eating speed, who prepared the meal, lunch-supper habits, snack habits and number of snacks, or whether the student was in the habit of eating something while watching TV. The only significant difference found in the analysis was between eating breakfast and the cholesterol variable (p=0.01) (Table 3).

Table 1. Distribution of student identifying characteristics (n=103)

Characteristics	n	%
Age		
13	53	51.5
14	50	48.5
Gender		
Girl	52	50.5
Boy	51	49.5
Birth order		
First	38	36.9
Second	32	31.1
Third	24	23.3
Fourth	9	8.7
	$\overline{X}$ ± SD	
Weight	46.1±9.1	
Height	154.7±6.2	
Body Mass Index	20.5±1.6	

Table 2. Relationships between some identifying characteristics of the students and their Body Mass Index (BMI), Fasting Blood Sugar (FBS), Cholesterol and Triglyceride Levels (n=103)

Variable	n	BMI $\overline{X}$ ± SD	FBS $\overline{X}$ ± SD	Cholesterol $\overline{X}$ ± SD	Triglycerides $\overline{X}$ ± SD
Age					
13	53	21.0 ±0.2	92.3 ± 10.9	177.3± 17.2	84.8 ± 22.3
14	50	20.0 ±0.2	97.9 ± 12.6	173.9± 16.6	90.9 ± 25.7
Test, p value		p=0.002	p=0.02	p=0.30	p=0.20
Gender					
Girl	52	20.8 ± 1.5	95.0 ± 13.2	172.0 ± 16.9	86.0 ± 25.0
Boy	51	20.2 ± 1.6	95.0 ± 10.8	179.4 ± 16.3	89.5 ± 23.3
Test, p value		p=0.03	p=0.98	p=0.02	p=0.46
Family type					
Nuclear	82	20.4 ± 0.1	95.6 ± 1.4	175.6 ± 1.9	88.0 ± 2.6
Expanded	19	20.9 ± 0 .4	93.8 ± 1.7	176.5 ± 3.6	85.5 ± 6.0
Broken home	2	22.6 ± 0.6	82.5 ± 7.5	171.0 ± 12.0	96.5± 28.5
Test, p value		p=0.08	p=0.28	p=0.90	p=0.80
Pocket money					
Every day	65	20.5 ± .2	95.9 ± 1.5	174.6 ± 2.0	87.6 ± 2.9
4-5 days a week	10	20.5 ± .6	91.9 ± 3.4	177.3 ± 6.4	88.4 ± 8.0
2-3 days a week	15	20.6 ± .3	95.3 ± 3.2	178.6 ± 4.6	88.0 ± 5.8
Once a week	11	20.5 ± .3	93.0 ± 3.3	173.6 ± 4.8	82.2 ± 7.9
I don't get an allowance	2	20.9 ± .5	92.5 ± 2.5	192.0 ± 2.0	119.0 ± 24.0
Test, p value		p=0.99	p=0.85	p=0.60	p=0.42
Exercising					
I never exercise	30	20.7 ± .2	91.9 ± 1.6	171.4 ± 3.2	83.0 ± 4.0
About a half-hour	38	20.5 ± .2	97.4 ± 2.1	175.7 ± 2.4	90.6 ± 4.5
About an hour	18	20.2 ± .4	94.0 ± 2.6	173.5 ± 4.2	84.1 ± 5.1
about 2-3 hours	11	20.6 ± .4	91.3 ± 3.6	184.4 ± 4.9	92.6 ± 5.8
About 4-6 hours	6	20.3 ± .9	106.0 ± 6.1	186.6 ± 7.1	95.5 ± 9.3
Test, p value		p=0.90	p=0.04	p=0.10	p=0.53

*Test t and Test of One Way Anowa

As can be seen in table 4, 5.8% of the 13 year-old girls and 6.8% of the boys are overweight. In the 14-year-old group, 1.0% of the girls and 1.9% of the boys were overweight. In both age groups, the percentage of overweight boys was higher than the percentage of overweight girls.

When the relationships between the students' height, weight, BMI, blood pressure, FBS, cholesterol, LDL, HDL, triglyceride level measurements were considered, it was seen that there was a positive significant relationship between height-weight (r=0.47; p<0.001), height-blood pressure (r=0.43; p<0.001), and height-FBS (r=0.33; p<0.001), but a statistically negative relationship between height-BMI (r=0.99; p<0.001). A positive relationship was found between weight and blood pressure (r=0.37; p<0.001) and FBS (r=0.55; p<0.001); the relationship between weight and BMI (r=0.47; p<0.001) was negative. Negative relationships were also seen between BMI and blood pressure (r=0.42; p<0.001) and FBS (r=0.32; p<0.001) (Table 5).

Table 3. The Relationship between Students' eating habits and BMI, FBS, cholesterol and triglyceride levels (n=103)

Variable	n	BMI $\bar{X}$ ± SD	FBS $\bar{X}$ ± SD	Cholesterol $\bar{X}$ ± SD	Triglycerides $\bar{X}$ ± SD
Eating speed					
Fast eater	6	20.5 ±0.3	99.3 ± 6.4	181.1± 4.0	87.3 ± 7.5
Normal eater	85	20.5 ±0.1	95.4 ± 1.2	175.4 ± 1.8	88.6 ± 2.6
Slow eater	12	20.9 ± 0.6	90.2± 3.0	174.4 ± 5.5	82.0 ± 6.9
Test, p value		p=0.63	p=0.25	p=0.70	p=0.67
Who prepares meal					
Mother	98	20.5 ± 0.1	95.4 ± 1.2	175.4 ± 1.6	87.6 ± 2.4
Someone in the family	5	21.0 ±0 .9	85.2 ± 4.2	173.7 ± 9.5	80.2 ± 11.7
Test, p value		p=0.28	p=0.16	p=0.46	p=0.86
Breakfast					
I never eat breakfast	14	20.4 ± .4	100.2± 4.1	180.3 ± 3.7	89.1 ± 7.2
Once a week	5	20.5 ± .4	93.4 ± 3.4	163.6 ± 4.9	67.6 ± 5.0
Twice a week	9	20,1 ± .5	102.4 ± 5.1	177.5 ± 3.5	88.8 ± 7.2
Three times a week	3	20.0 ± .3	85.0 ± 5.7	163.3 ± 3.3	60.6 ± 10.4
Four times a week	2	20.2 ± .1	87.5 ± 2.5	141.5 ± 11.5	86.5 ± 38.5
Every day	70	20.6 ± .2	93.8 ± 1.2	176.9 ± 2.0	90.0 ± 2.7
Test, p value		p=0.95	p=0.08	p=0.01	p=0.15

*Test t and Test of One way Anova

Table 4. Distribution of students by BMI values in terms of age and gender variables

Variable	BMI							
	Girl				Boy			
	Normal		Overweight		Normal		Overweight	
	n	%	n	%	n	%	n	%
Age, years								
13	18	17.5	6	5.8	22	21.4	7	6.8
14	27	26.2	1	1.0	20	19.4	2	1.9
Total	45	43.7	7	6.8	42	40.8	9	8.7

Table 5. The Relationships between the students' height, weight, BMI, blood pressure, FBS, cholesterol, LDL, HDL and triglyceride values (n=103)

	Height	Weight	BMI	Blood pressure	FBS	Cholesterol	LDL	HDL	Triglycerides
Height	r=1 p=-	r=0.47** p<0.001	r=-0.99** p<0.001	r=0.43** p<0.001	r=0.33** p<0.001	r=0.08 p=0.42	r=0.06 p=0.51	r=0.01 p=0.86	r=0.09 p=0.32
Weight	r=.47** p<0.001	r=1 p=-	r=-0.47** p<0.001	r=0.37** p<0.001	r=0.55** p<0.001	r=0.10 p=0.29	r=.13 p=.16	r=0.19 p=0.05	r=0.08 p=0.40
BMI	r=-0.99** p<0.001	r=-0.47** p<0.001	r=1 p=-	r=-0.42** p<0.001	r=-0.32** p<0.001	r=-0.07 p=0.47	r=-.06 p=.52	r=-0.02 p=0.79	r=-0.09 p=0.32
Blood pressure	r=0.43** p<0.001	r=0.37** p<0.001	r=-0.42** p<0.001	r=1 p=-	r=0.40** p<0.001	r=0.02 p=0.78	r=.15 p=.12	r=0.01 p=0.91	r=0.11 p=0.23
FBS	r=0.33** p<0.001	r=0.55** p<0.001	r=-0.32** p<0.001	r=0.40** p<0.001	r=1 p=	r=0.15 p=0.11	r=.16 p=.09	r=0.16 p=0.09	r=0.18 p=0.05
Cholesterol	r=0.08 p=0.42	r=0.10 p=0.29	r=-0.07 p=0.47	r=0.02 p=0.78	r=0.15 p=0.11	r=1 p=-	r=.79** p=.00	r=0.58** p<0.001	r=0.67** p<0.001
LDL	r=0.06 p=0.51	r=0.13 p=0.16	r=-0.06 p=0.52	r=0.15 p=0.12	r=0.16 p=0.09	r=0.79** p<0.001	r=1 p=-	r=0.68** p<0.001	r=0.71** p<0.001
HDL	r=0.01 p=0.86	r=0.19 p=0.05	r=-0.02 p=0.79	r=0.01 p=0.91	r=0.16 p=0.09	r=0.58** p<0.001	r=.68** p=.00	r=1 p=-	r=0.46** p<0.001
Triglycerides	r=0.09 p=0.32	r=0.08 p=0.40	r=-0.09 p=0.32	r=0.11 p=0.23	r=0.18 p=0.05	r=0.67** p<0.001	r=.71** p=.00	r=0.46** p<0.001	r=1 p=-

*0.00-0.25 çok zayıf ilişki, **0.26-0.50 zayıf ilişki, ***0.51-0.69 orta düzeyde ilişki, ****0.70-0.89 yüksek düzeyde ilişki. *****0.90-1.00 çok yüksek düzeyde ilişki

DISCUSSION

The importance of obesity in terms of health stems from its association with cardiovascular diseases, which are cited as one of the major causes of mortality in the world. Obesity leads not only to metabolic anomalies such as hypertension and dyslipidemia; it also increases the risk of coronary artery disease [19]. The major complications of obesity, which are cardiovascular disease, diabetes mellitus, hypertension, and hyperlipidemia, generally originate from accumulations of abdominal fat [20]. While there is a significant increase in adult obesity, the increase of childhood and adolescent obesity is also striking.

Because it is known that obesity at early stages of life are a precursor to adult obesity, one of the important goals of protective medicine should be to prevent weight gain in children and adolescents. In the U.S., the prevalence of obesity in children has doubled in the last 30 years. It is assumed that there are 22 million children in the world under the age of 5 who are overweight [21]. In Europe, prevalence of obesity among the 15-24 age group (BMI>30 kg/m^2) displays variations from country to country. Childhood obesity is steadily increasing. In the U.K., 15% of the child population was overweight in 1989 and 5% was obese; these percentages had risen to 24% and 9% respectively in 1998.

The increase in childhood obesity all around the world and in the U.S. is so rapid that it cannot be explained by changes in genetic structure. It is however accepted that environmental factors have played a leading role in this increase. While 3-5 year-olds with parents of normal weight have a 24% chance of becoming obese later on in life, having one parent that is obese brings this risk factor up to 62%. The possible risk increases even more in the 10-14 age group, reaching 64% and 79%, respectively. The risk of developing obesity with parents of normal weight has been accepted to be 10%, 40% when one parent is obese, and 80% when both parents are obese [21]. Many studies have been conducted in Turkey on the obesity for different age of children. The average of obesity for pre-school children was 2.2% in Turkey [22]. Şimşek et al. [23] found that the average of obesity was 4.8% for the primary education students. Kutlu, Çivi and Köroğlu [24] mentioned that the average of overweight was 7.7% and obesity was 1.9% among primary education students. Also, Babaoğlu and Hatun [25] said that the average of overweight was 9.0% and obesity was 4.1% among same age students. In the present study, it was determined that 11.7% of the mothers had high blood pressure, 1.9% high cholesterol and blood lipids and 1.0% was a diabetic; among the fathers, 8.9% had high blood pressure and 1% was obese.

When cholesterol levels are evaluated by age group, some studies show that these values do not change until puberty but then show a decrease in both genders at puberty, particularly in males, ultimately rising after puberty [26,27]. One study has reported increases in LDL levels in children between the ages of 5-10 [28]. In a study carried out in Saudi Arabia, it has been set forth that triglyceride levels increase with age [29,30]. The present study found the 13 year-old students' triglycerides level to be 84.8 ± 22.3 and that of the 14-year-olds to be 90.9 ± 25.7. No statistical significance could be determined related to this, however (table 2). In analyses of the relationships between gender and the lipid profile, FBS and BMI, some studies have shown that triglyceride and cholesterol values are higher in boys while others report higher triglyceride levels in girls [30,31]. A study in Costa Rica reported high triglyceride and VLDL levels in a group of girls 12-18 years of age while a Saudi Arabian study noted high levels of triglycerides in girls in the 9-12 age group [30,32]. On the other hand, the literature does not point to differences in lipid profiles according to gender [33,34]. This is consistent with the results of the present study. This outcome may stem from the similar socio-cultural background of the subjects in the studies. The literature reveals studies where cholesterol levels are higher in boys, and also those where triglyceride levels are higher in girls [30,31]. A study conducted in the U.S. has reported that 19% of children have high cholesterol levels [35]. Research in Saudi Arabia has revealed high levels of cholesterol in 32.7%, of LDL-C in 33.1% and of TG in 34.1% of the children studied [30]. The present study showed statistical differences according to gender in the BMI variable (p=0.03) and in the cholesterol variable (p=0.02), and it was found that girls had higher BMI values while boys had higher cholesterol levels. The differences in lipid, BMI and cholesterol levels discovered in similar age groups in studies conducted in different regions may be attributed to dietary and exercise habits and also to ethnic and geographical differences.

The reasons for the increase in the prevalence of obesity are associated with reduced physical activity related to the easier lifestyle made possible with advanced technologies and the changes in nutritional habits in contemporary lifestyles. The fat-rich fast food style of eating is one of the most important factors leading to obesity due to an excess intake of unhealthy foods that are enriched with an abundance of carbohydrates (CH) and refined sugar. Reducing sedentary behavior may be significantly helpful in preventing excessive weight gain [36]. One study has explored the relationship between fat composition in pre-school-age children and watching videos. The subjects were 2761 children between 1-5 years of age. The children's overweight condition (BMI>85th percentile) was analyzed in terms of how much time they spent in front of the TV or video and whether or not there was a TV set in the room in which they slept. TV and video-watching was more prevalent among black and Hispanic children and viewing time increased as the children got older. About 40% of the children had a TV set in their own bedrooms. These children were more likely to be heavier and spending more time in front of the TV/video (almost five hours a week) compared to children who had no TV in their bedrooms [36]. It was found in the present study that the students, most of them in the habit of eating something while watching TV, exhibited high cholesterol, triglyceride and BMI levels; this finding parallels the literature. Removing TV sets from bedrooms and limiting TV viewing time may be a protective precaution that families can take. It has been observed that although mean BMI values increase with age, they are slightly higher in boys compared to girls [37,38]. One study reported a higher percentage (7.69%) of overweight in boys compared to girls (3.82%) but a higher percentage of obesity in girls (2.29%) compared to boys (1.49%) [38]. The present study showed that 5.8% of 13 year-old girls were overweight, while this rate was 6.8% in boys. In the 14-year-old group, 1.0% of the girls and 1.9% of the boys were overweight. In both age groups, the percentage of overweight boys was higher than the percentage of overweight girls. This finding supports other study results in Turkey. The literature reports significant relationships between obesity and cholesterol levels but there are also publications that speak of only increases in serum triglyceride levels [31,39]. A few studies reveal no increase in cholesterol, triglyceride and other lipid parameter levels despite an increase in BMI [40,41]. In their study with 128 obese children, Cruz et al. [42] have indicated a rate of 26% for hypertriglyceridemia and a rate of 67% for low HDL. It was found in a study by Nebigil et al. [40] in the same region that, similar to the present study, obese children exhibited high triglyceride and VLDL levels. The present study found significant relationships and a positive correlation between cholesterol, LDL, HDL and triglyceride levels. In keeping with what is reported in the literature, however, triglyceride levels were discovered to be higher.

The study found significant differences between BMI and FBS values in terms of the students' ages, between BMI, cholesterol, exercising and FBS in terms of gender, and between eating habits and levels of cholesterol. Correlations were found between the students' height and weight and their BMI, FBS and blood pressure levels as well as between BMI and FBS and blood pressure values.

Nutritional habits formed at early ages later become risk factors for many medical conditions in adulthood. The conclusion drawn was that monitoring blood pressure, cholesterol, LDL and HDL levels in childhood medical examinations is not only important in terms of identifying obesity, but also in identifying nutritional mistakes and deficiencies at an early age. At the same time, a regular exercise program designed for children will serve as a first-step precaution and a way of more easily dealing with the issue of overweight and obesity.

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