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Metabolic Syndrome in School Children in Mardin, South-Eastern of Turkey

Türkiye'nin Güneydoğusu Mardin'de Okul Çocuklarında Metabolik Sendrom

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Abstract

Objective: To determine the prevalence of the metabolic syndrome (MES) in a school children population.

Materials and Methods: Three thousand four hundred and sixty children aged between 7 and 15 in three elementary schools in the city of Mardin, located in the south-eastern region of Turkey, were included in this study in April and May 2011. Age, gender, height, weight, waist circumference (WC), hip circumference, waist/hip ratio, systolic and diastolic blood pressure were measured and a variety of blood tests were done. The International Diabetes Federation (IDF) criteria were used for the diagnosis of MES.

Results: It was found that 9.42% of those tested were overweight, and 8.0% were obese. The study found that more girls (9.1%) were obese than girls (6.9%). The prevalence of obesity was significantly higher among girls than boys ($p<0.001$). A positive correlation was found between body mass index (BMI) and the other parameters, namely waist and hip circumference, waist/hip ratio, systolic and diastolic blood pressure (BP), triglyceride (TG) ($p=0.0001$). It was found that total cholesterol (T-Chol), TG, BMI, systolic and diastolic BP were significantly different among obese MES's group and non-obese children ($p<0.05$). The waist/hip ratio reference value in girls was significantly higher than boys ($p>0.05$). The prevalence of MES was 6.3%. The number of components of MES was higher in girls and obese children. The rate of MES was 30.3% in obese children.

Conclusion: The frequency of obesity, hypertension and MES in childhood period have been steadily increasing. Children who are classified having central obesity and high body mass index should be more carefully evaluated to its potential to progress to MES. And the quality of the life should be improved by reducing the risks resulted from life style changes, necessary treatments and follow ups.

Key Words: Childhood obesity, metabolic syndrome, hypertension

Özet

Amaç: Okul çocukları popülasyonunda, metabolik sendrom (MES) prevelansının tespit edilmesi amaçlandı.

Gereç ve Yöntem: Türkiye'nin güneydoğusundaki, Mardin şehir merkezinde, üç ilköğretim okulundaki, 7-15 yaşları arası, üç bin dört yüz altmış çocuk, Nisan-Mayıs 2011'de çalışmaya dahil edildi. Yaş, cins, boy, ağırlık, bel çevresi, kalça çevresi, bel/kalça oranı, sistolik ve diyas tolik kan basınçları ölçüldü ve kan testleri kaydedildi. MES tanısı için Uluslararası Diyabet Federasyonu (IDF) kriterleri kullanıldı.

Bulgular: Çocukların %9,42'si fazla kilolu ve %8'i obezdi. Obezite kızlarda %9,1, erkekler de %6,9'du. Obezite prevelansı, kızlar arasında erkeklerden daha yüksek ve anlamlıydı ($p<0.001$). Vücut kitle indeksi (VKI) ve bel ve kalça çevresi, bel/kalça oranı, sistolik ve diyasto lik kan basıncı, trigliserid arasında pozitif korelasyon bulundu ($p=0.0001$). Total kolesterol, trigliserid, VKI, sistolik ve diyastolik kan basıncı obez MES'lu grupta, obez olmayanlardan anlamlı farklı idi ($p<0.05$). Kızların bel/kalça oranı referans değerleri, erkeklerinkinden anlamlı olarak daha yüksekti ($p>0.05$). MES prevelansı %6,3'tü. MES, kızlarda ve obezlerde daha yüksekti. Obez çocuklarda MES oranı %30,3'tü.

Sonuç: Çocukluk döneminde obezite, hipertansiyon ve MES sıklığı her geçen gün artmakta dır. Santral obezite ve yüksek vücut kitle indeksine sahip olan çocuklar, MES için daha dikkat li değerlendirilmelidir. Ve toplumun yaşam kalitesi, yaşam tarzı değişiklikleri ile risklerin azaltılması yoluna gidilerek, gerekli tedavi ve takiplerle sağlanmalıdır.

Anahtar Kelimeler: Çocukluk çağı obezitesi, metabolik sendrom, hipertansiyon

Introduction

The prevalence of childhood overweight and obesity has increased worldwide, reaching epidemic proportions and becoming a serious public health problem. The increases in BMI during childhood may be related to the development and acceleration of adverse cardiometabolic risk factors, such as hypertension, dyslipidemia (high TG and low high-density lipoprotein (HDL) cholesterol), hyperinsulinemia and glucose intolerance, known as MES [1]. The increasing obesity

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prevalence in childhood and adolescence has increased the prevalence of MES. The criteria for the diagnosis of MES are described by the United States of America (USA) "National Cholesterol Education Program (NCEP)-Adult Treatment Panel (ATP) III" and World Health Organization (WHO) [2, 3]. These two organisations describe obesity, dyslipidemia, hypertension, fasting blood glucose, however some personal references value differences are present. The diagnosis of MES in children is not clear, usually the NCEP-ATP III and WHO criteria are needed for a diagnosis and for the adjustment of abnormal values in children. The IDF criteria modified for age and gender in children have been used in this study for the diagnosis of MES [4]. In clinical studies the prevalence of this disease among children was found to be approximately 3-4%, however it is not completely clear because of the application of different criteria for the definition of MES. This percentage is quite low compared to adults. The Bogalusa Heart Study is the first study conducted on MES in children [5]. Therefore, this study aimed to determine the prevalence of MES and its individual components in a sample of Mardin school students, and to identify clinical or biochemical characteristics associated with MES in children.

Materials and Methods

This is a descriptive study. There were 4030 students in three schools. 3460 (1667 female, 1793 male) volunteer children in the 6-15 years age group were surveyed for the study, which was carried out in the city center of Mardin in the southeastern region of Turkey. 86% of the targeted participants were reached. The data were collected in April and May 2011.

Anthropometric measurements

Weight, height and WC were measured according to standardized procedures [6]. All measurements were taken while their summer uniforms on (only coat without jacket) and shoes off. The weight was measured using an electronic scale to the nearest 0.1 kg, and the height was measured using a flexible tape to the nearest 0.1 cm. With the head in the Frankfort horizontal plane; WC was measured using a flexible elastic measuring tape at the umbilical level. Hip circumference was measured using a flexible elastic measuring tape at the widest portion of the buttocks. Age was calculated in decimal units based on the date of the survey relative to birth date. BMI was calculated with reference to measured height and weight and was evaluated using the WHO normative data for age and gender [7]. A BMI value exceeding ≥95th percentile was defined as obese, a BMI value 85-95th percentile as overweight. BP was obtained on the right arm with the patient seated, after rest, using a non-digital sphygmomanometer and appropriate sized cuff. After three measurements, the lowest BP value was chosen. Children were classified according to sex, height and age-specific charts [8]. Abdominal obesity was defined using the sex and age-specific 90th WC percentile [9]. Ethical approval was given by the Mardin Artuklu University, Mardin Educational and Health Directorate Office.

Clinical and biochemical measures

Baseline blood samples were collected by venipuncture in the morning (8:00 to 9:00 am) after an overnight fast (10 to 12 hours). Both plasma and serum were separated by centrifugation. The glucose oxidase method was used to determine blood glucose levels. Serum lipids T-Chol, HDL cholesterol, LDL (low-density lipoprotein) cholesterol, TG were measured using the enzymatic colorimetric method.

Definition of MES

MES was defined according to the IDF criteria [4]. This definition was chosen since it is based on age and gender specific cut-offs and it has been used in several paediatric studies.

Age 6 to <10 years:

- Obesity ≥90th percentile as assessed by WC

Age 10 to <16 years:

- Obesity ≥90th percentile (or adult cut-off if lower) as assessed by WC;
- Plus any two or more:

1. TG ≥150 mg/dL
2. HDL- cholesterol ≤40 mg/dL
3. Systolic/diastolic BP percentile for age, sex and height [8].
4. Fasting glucose ≥5.6 mM (100 mg/dL).

Statistical analysis

Collected data were coded and digitized. The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) statistical software and Microsoft Office Excel programs. According to the reference values, the categorical variables of children with MES were evaluated by the chi-square test, and metric measurement variables were compared using the independent samples t-test. A BMI Z-score is calculated as follows: (observed value) - (median reference value of a population) /standard deviation of reference population. The Pearson Product-Moment coefficient was used to determine difference between variables. $p<0.05$ was considered statistically significant.

Results

The female ratio of the study group was 48.2%, and 51.8% was male. The average age of the students was 10.78±2.11

Table 1. Metabolic syndrome positive 6-9 and 10-15 age group children values

	Mean±S.D/ range 6-9 age girl	Mean±S.D/ range 6-9 age boy	Mean±S.D/ range 10-15 age girl	Mean±S.D/ range 10-15 age boy
Waist circumference (cm)	68.64±3.82/14	75.00±8.66/26	85.17±5.81/14	88.50±2.38/5
Hip circumference (cm)	77.27±5.04/18	82.33±7.12/20	94.17±7.38/16	94.00±5.59/12
Waist/Hip ratio	0.90±0.03/0.12	0.88±0.03/0.10	0.94±0.02/0.07	0.90±0.03/0.06
BMI (kg/m^2)	20.27±1.84/7.00	22.83±3.29/11.00	25.333±1.75/5.00	24.25±1.50/3
Blood glucose (mg/dL)	86.45±7.50/27	91.92±10.80/41	85.17±13.15/39	98.75±18.17/37
Cholesterol (mg/dL)	148.27±26.40/92	155.08±33.84/128	127.67±10.93/28	161.25±25.65/61
Triglyceride (mg/dL)	114.20±74.31/241	100.18±36.34/126	177.67±26.26/63	237.00±151.05/310
HDL_cholesterol (mg/dL)	47.33±5.77/10	42.00±15.55/22	38.13±6.35/11	
LDL_cholesterol (mg/dL)	80.33±26.10/52	58.00±8.48/12	85.33±5.77/10	
Sistolic pressure (mmHg)	94.55±8.20/20	95.00±10.87/30	123.33±8.16/20	120.00±16.33/40
Diastolic pressure (mmHg)	56.36±5.04/10	58.33±10.29/30	80.00±6.32/20	77.50±5.00/10

BMI: body mass index; HDL: high-density lipoprotein; LDL: low-density lipoprotein

Table 2. Metabolic syndrome negative 6-9 and 10-15 age group children values

	Mean±S.D/ range 6-9 age girl	Mean±S.D/ range 6-9 age boy	Mean±S.D/ range 10-15 age girl	Mean±S.D/ range 10-15 age boy
Waist circumference(cm)	54.84±3.86/24	57.311±3.86/19	66.63±8.32/41	66.35±8.20/51
Hip circumference(cm)	62.632±3.954/21	65.082±6.86/51	77.46±9.33/43	75.990±7.89/49
Waist/Hip ratio	0.89±0.04/1. 49	0.89±0.18/0.22	0.88±0.04/0.38	0.87±0.05/0.29
BMI (kg/m^2)	15.250000±1.84/10	15.63±1.63/8	18.32±3.52/17	17.59±2.95/17
Blood glucose (mg/dL)	87.0000±8.79/45	91.26±10.87/75	90.12±7.85/48	92.59±10.22/71
Cholesterol (mg/dL)	147.397±24.13/109	144.87±28.37/141	143.59±27.70/165	141.06±26.91/216
Triglyceride (mg/dL)	79.1343±37.01/208	83.87±33.83/142	94.55±46.26/225	88.40±45.39/283
HDL_cholesterol (mg/dL)	51.94±12.48/59	46.19±8.44/25	49.03±11.72/62	48.23±10.14/52
LDL_cholesterol (mg/dL)	78.81±19.17/62	85.07±29.51/117	76.88±19.00/87	75.77±23.72/100
Sistolic pressure (mmHg)	81.62±9.71/50	85.57±10.57/50	95.95±13.19/60	95.27±12.29/70
Diastolic pressure (mmHg)	53.24±8.54/30	52.13±8.77/30	62.90±9.90/50	61.44±10.02/70

BMI: body mass index; HDL: high-density lipoprotein; LDL: low-density lipoprotein

years, their mean height was 141.4±14.5 cm, their average weight was 37.6±13.24 kg and their average BMI was 18.27±3.53 (min: 11.28-max: 42.08). According to their BMI values, the overweight frequency of the children was 9.42% (n=321), the obesity rate 8.0% (n=269) and 17.42% of the children were identified as overweight to varying degrees. A Z-score of-0.33 is equivalent to the .85- <.95th centile value, and a z-score of-0.63 is equivalent to the >95th centile value. The prevalence of obesity according to gender was found to be 9.1% (n=147) in girls and 6.9% (n=122) in boys. There was a statistically significant relationship between gender and prevalence of obesity. The prevalence of obesity was significantly higher in girls (χ^2=7.244; p<0.01). Systolic BP average was 91.60±13.23 mmHg (min: 60-max: 160 mmHg), diastolic BP average was 58.7±10.08 mmHg (min: 30-max: 110 mmHg). Hypertension prevalence; 1.30% prehypertension, 2.02% hypertension according to systolic hypertension; 2.65% prehypertension, 2.74% hypertension according to diastolic hypertension. Hip circumference average was 73.91±11.26 cm in girls, 74.35±10.44 cm. in boys (min: 24.90-max: 120 cm). WC average was 64.19±9.74 cm in girls, 65.23±10.15 cm. in boys (min: 33-max: 124 cm). Waist/hip ratio average was 0.87±0.05 cm in girls (n=1667), in boys (n= 1791) 0.87±0.06 (min: 0.51-max: 2.21). (Tables 1, 2). Over waist/hip ratio refer-

Table 3. Comparison of risk factors. Metabolic characteristics and anthropometric measurements in children with MES and without MES

	MES absent	MES present	T value
Waist circumference (cm)	63.940±8.70	76.364±9.50	0.000**
Hip circumference (cm)	73.575±9.76	84.212±9.23	0.000**
Waist/Hip ratio	0.87±0.07	0.09±0.03	0.807
Sistolic BP (mmHg)	92.66±13.24	103.03±16.10	0.000**
Diastolic BP (mmHg)	59.87±10.47	63.94±12.48	0.033*
BMI (kg/m^2)	17.34±3.16	22.60±3.02	0.000**
Triglyceride(mg/dL)	88.9826±43.74	137.3548±82.69	0.000**

BP: blood pressure; BMI: body mass index

Table 4. Comparision of risk factors. Parameters of obese and non-obese children with metabolic syndrome

	Non obese med±sd	Obese med±sd	T value
Waist circumference (cm)	63.61±8.45	74.84±10.11	0.000**
Hip circumference (cm)	73.15±9.39	84.20±10.63	0.000**
Waist/Hip ratio	0.87±0.07	0.88±0.05	0.110
T_Cholesterol (mg/dL)	142.60±26.03	153.13±34.98	0.008*
Trigliceride (mg/dL)	89.77±46.93	111.06±54.44	0.003*
LDL_cholesterol (mg/dL)	76.09±21.13	87.41±27.50	0.46
HDL_cholesterol (mg/dL)	47.98±9.86	50.54±13.10	0.391
Sistolic BP (mmHg)	92.59±13.44	99.81±13.79	0.000**
Diastolic BP (mmHg)	59.63±10.45	64.72±11.36	0.001**
BMI (kg/m^2)	17.09±2.90	23.05±2.89	0.000**
Blood glucose(mg/dL)	90.71±9.61	90.83±9.33	0.934

BP: blood pressure; BMI: body mass index

ence value was higher in girls than in boys (χ^2=47.26; p<0.06). Impairment fasting glucose (IFG) was 16.8%, 0.7% diabetes mellitus was found. Blood glucose impairment was found to be higher in boys than in girls (χ^2=7.230; p=0.07). The rate of MES was found to be 6.3%. But there was no statistical correlation between genders (χ^2=0.579; p>0.05). MES in 1425 whole obese children were 2.3%. Overweight and obese children had higher rates of MES than non-over children. In obese 122 children, the rate of MES was 30.3% (Table 3). Obesity is such an important value for the diagnosis of MES, because the rate of obesity is 89% in children with MES. Hypertension was present, HDL was in low levels in children with MES aged 10-16 years. IFG was present in 18% of obese children. Hypertriglyceridemia was found in 51% of girls and 63% of boys with MES. T-Chol was the second most common variety in this group. TG was high in all children with MES aged 10-16. 6-<10 years age group of children with MES were accompanied by 11% high TG, 3% low HDL, 3% IFG and 69% high BMI. A strong relationship was found between MES and obesity; and hypertension and hypertriglyceridemia (Table 4). A positive correlation was found between BMI and the other parameters, namely waist and hip circumference, systolic and diastolic BP, TG (p=0.0001). There was no correlation between T-Chol, LDL cholesterol, HDL cholesterol, IFG (Tables 5, 6).

Discussion

BMI is most commonly used measure for monitoring the prevalence of owerweight and obesity. Lissau, in which they compared with the participation of 29242 boys and girls aged 13 and 15 years, the highest prevalences of overweight were found in the United States and the lowest in Lithuania [10]. Similarly, in Sur's study carried out on 1044 children in 12-13 age group in Istanbul, Ankara and Izmir provinces of Turkey

Table 5. Different variables correlations for 6-9 age group children

6-9 Age	1	2	3	4	5	6	7	8	9	10	11
Waist circumference (n=152) 1	1.000										
Hip circumference (n=152) 2	.863**	1.000									
Blood glucose (n=152) 3	.072	.010	1.000								
Cholesterol (n=152) 4	.005	.054	.118	1.000							
Trigliceride (n=148) 5	.233**	.203*	.025	.093	1.000						
HDL_cholesterol (n=32) 6	-.303	-.285	.279	.410*	-.431*	1.000					
LDL_cholesterol (n=35) 7	-.318	-.276	.194	.933**	-.100	.357	1.000				
Sistolic BP (n=152) 8	.437**	.468**	.041	.041	.058	-.230	-.183	1.000			
Diastolic BP (n=152) 9	.147	.193*	-.015	.073	-.014	.026	-.070	.621**	1.000		
BMI (n=152) 10	.820**	.751**	.035	.011	.247**	-.213	-.181	.386**	.225**	1.000	
Waist/Hip ratio (n=152) 11	.109	-.370**	.094	-.065	.025	-.141	-.236	-.136	-.119	.041	1.000

*Correlation is significant at the 0.05 level, **Correlation is significant at the 0 .01 level.
BMI: body mass index; HDL: high-density lipoprotein; LDL: low-density lipoprotein

Table 6. Different variables correlations for 10-16 age group children

10-16 Age	1	2	3	4	5	6	7	8	9	10	11
Waist circumference (n=411) 1	1.000										
Hip circumference (n=411) 2	.898**	1.000									
Blood glucose (n=410) 3	-.028	-.028	1.000								
Cholesterol (n=402) 4	.067	.068	.077	1.000							
Trigliceride (n=401) 5	.304**	.316**	.007	.084	1.000						
HDL_cholesterol (n=106) 6	-.034	-.031	-.030	.537**	-.291**	1.000					
LDL_cholesterol (n=122) 7	.066	.027	-.044	.812**	-.213*	.230*	1.000				
Sistolic BP (n=411) 8	.432**	.468**	.022	.022	.206**	.000	-.032	1.000			
Diastolic BP (n=411) 9	.253**	.307**	.001	.076	.171**	.015	-.041	.672**	1.000		
BMI (n=411) 10	.829**	.802**	-.052	.122*	.359**	-.028	.090	.373**	.278**	1.000	
Waist/Hip ratio (n=411) 11	.428**	-.011	-.013	.006	.030	-.014	.091	.012	-.063	.242**	1.000

*Correlation is significant at the 0.05 level,**Correlation is significant at the 0.01 level.
BMI: body mass index; HDL: high-density lipoprotein; LDL: low-density lipoprotein

found an average BMI value of 18.2±3.1 for boys and 18.6±3.1 for girls [11]. Our study's BMI values were 18.27±3.53. This value is lower than the values of Lissau's study and close to the average of Sur's study.

Recently, obesity has increasingly become a growing problem. The Health Behaviour in School-Aged Children Survey (HBSC) study shows that 24% of girls and 34% of boys in 13 years old children; and 31% of girls and 28% of boys in

15 years old children are overweight. Furthermore, obesity prevalence in ages 13 and 15 was found to be 5% in girls and 9% in boys [12]. Recently, the studies on this subject have become widespread in Turkey. Bundak et al. [13] indicated in their research that the percentage for 18 years old Turkish boys being overweight is 25% and the obesity rate is 4%. Also they indicated that in 14 years old Turkish girls, the percentage for being overweight was 15% and of obese was 1%. In Samsun in a survey of 4120 children the obesity rate was found to be 7.3% in girls and 4% in boys [14]. The prevalence rates of overweight and obesity in Van were 11.1% and 2.2%, respectively, and in Elazig 13.2% and 1.6%, respectively [15, 16]. In our study, the prevalence of overweight children was found in near eastern cities of Turkey. We consider that these high rates are associated with local eating habits and limited physical activity. In addition, it should not be forgotten that obesity has increased all over the world.

Giampietro's research, which consisted of 869 cases with an average age of 118±5 months, that children whose BMI values were found to be high and also have elevated systolic and diastolic BP rates [17]. 12265 cases between the ages of 2 and 17 took part in National Health and Nutrition Examination Survey (NHANES) III in the United States and 3611 children and adolescents took part in NHANES 1999-2000. Ford compared these two surveys and found that correlations between BMI percentiles and cardiovascular risk factors were similar in both studies. The strongest correlation is found between BMI and systolic BP; and between BMI and TG. The correlation between BMI and T-Chol was found to be rather weak [18]. Another study conducted by Sur indicated that BMI and T-Chol, LDL cholestherol, TG, LDL/HDL cholestherol were high and positively correlated for boys. And TG level was high, but HDL cholestherol level was low in obese girls [11]. Also, in our study a positive and strong correlation was found between BMI and WC, hip circumference, waist/hip ratio, systolic BP, diastolic BP, TG. Our study was closely related to other studies, because the prevalence of obesity and overweight was nearly in the same range with the others. High BMI or increasing BMI over time was associated with pronounced increase in risk of both incidents of high BP and cardiovasculer risk factor. In this study, high triglyceride level was shown most frequently, and accompanied by both high T-Chol level and low HDL cholesterol level. This dyslipidemic view worries us as atherosclerosis begins in childhood and have several risk factors associated with future lives. Ultimately, our findings of high BMI, BP and TG levels lead us to the diagnosis of MES.

Despite the increasing number of studies conducted on MES in children, discussions continue about threshold values of the components for defining MES. So far, childhood disease researchers have used the ATP III and WHO criteria and they use values, which they acquire from their own groups for threshold values of measurements. In Cook's study conducted on the American population in NHANES III, 2430 adolescents between the ages of 12-19 were evaluated according to the ATP III criteria and the prevalence of MES was found to be 4.2% (6.1% in boys, 2.1% in girls). The prevalence of MES for obese adolescents was stated as 28.7% and as 6.8% for overweight adolescents [19]. Duncan, specifies in NHANES 1999-2000 (12-19 age, n=991) that the prevalence MES was elevated to 6.4% (boys: 9.1%, girls: 3.7%). Duncan observed a comparable prevalence of 32.1% in overweight adolescents, while 7.1% of those at risk of being overweight had MES. Also, the prevalence of MES in normal-weight adolescents was found to be less than 1% [20]. Studies conducted on prevalence of MES in obese children indicate varied numbers in European countries (in France 15.9%, in Italy 13.9%, in Spain 18%) [21-23]. Weiss's study, examining the correlation between obesity grades and the prevalence of MES, states a prevalence of 38.7% in moderate obese adolescents (VKI z score 2-2.5) and a prevalence of 49.7% in severely obese adolescents (VKI z score >2.5) [24]. In some studies, the highest rates of MES among overweight and obese children were observed in Turkey and the United States (around 40%) and the lowest rates in China, France and Italy (around 11.5%). In Europe, the prevalence of MES varies from 0.2% among 10 year olds in Estonia, Portugal, and Denmark [25] to 21% among 4-16 year olds in Germany in randomized controls [26]. In Turkey, Cizmecioğlu (2-18 age, n=131), Atabek (7-18 age, n=169) and Sen (n=352) found prevalences of 20%, 27.2% and 41.8%, respectively in their studies on obesity cases based on the WHO criteria [27, 28, 29]. Hatipoglu [9] observed MES at the rate of 4.7%. Bereket and Atay [30] found MES in 2.3% of Turkish schoolchildren aged between 10 19 years using the IDF criteria. This rate was 28% in obese children. And, another study found that the rate of MES was at 33% based on the IDF criteria [31]. New pathophysiological data imply that MS is a real disease and its prevalence is increasing worldwide [32]. Childhood obesity is increasing the likelihood of MES in children. We found metabolic syndrom at the rate of 6.3%, and the MES rate of obese children was 30.3% based on the IDF criteria. This finding is similar to other studies which demonstrated much higher prevalence rates of MES in children who were obese. Increasing prevalence of MS in children, indicates specific, genetic or environmental characteristics of the population. Culture, dietary behaviors and sport activity are known to vary significantly among the different regions of the country. We consider that these factors affect the prevalence of MES. The applicability of diagnostic criteria for MES in children should be questioned. This may account in part for the discrepancies in prevalence between different populations.

This study has strengths and limitations. An important strength is that it provides additional data in Mardin schoolchildren relating to MES, which was previously lacking. The major limitations are the small blood sample size and an ongoing debate on the accuracy of diagnosing the MES in children younger than 10 years old. In conclusion, our results indicate that the prevalence of MES had higher rates of MES in obese children than in non-obese children. Further studies are needed with larger blood sample sizes, including measurements of hormones, and biomarkers are known to be involved in pathogenesis and identification of MES in Mardin school children. Complications and co-morbidities of obesity have also started to arise in pediatric population, a warning that efforts should focus on the prevention of obesity during childhood.

Obesity is a disease that needs to be taken seriously because of its associated conditions and necessary precautions must be taken against it in order to protect the health and well-being of the population. Children and their families must be taught to be aware of this disease and its consequences through the press and in schools. A simply measurement of WC may be useful in clinical practice as a means of determining a child or adolescent's response to weight control measures.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Mardin Artuklu University, 07.02.2011/101.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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