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THE RELATIONSHIP BETWEEN MACRONUTRIENTS, ANTHROPOMETRIC MEASUREMENTS AND BIOCHEMICAL PARAMETERS OF ADOLESCENTS WITH METABOLIC SYNDROME

METABOLİK SENDROMLU ERGENLERDE MAKRO BESİN ÖĞELERİ, ANTROPOMETRİK ÖLÇÜMLER VE BİYOKİMYASAL PARAMETRELER ARASINDAKİ İLİŞKİ

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Abstract

Background: With the increasing prevalence of obesity in adolescents, the prevalence of metabolic syndrome is increasing in our country.

Objective: To compare the nutritional status, anthropometric measurements and biochemical parameters of adolescents diagnosed with metabolic syndrome with their healthy peers.

Methods: The study included 40 adolescents with metabolic syndrome, 40 healthy adolescents aged 14-18 years living in Istanbul. A questionnaire including demographic information was applied. Body weight, height, and waist circumference were measured and a retrospective 24-hour dietary recal was taken by the researcher to determine their nutritional status. Glucose, insulin, triglyceride, total cholesterol, HDL cholesterol, AST, ALT, blood pressure values associated with metabolic syndrome were recorded from hospital records.

Results: Body weight, BMI, waist circumference measurements and biochemical parameters including glucose, insulin, triglycerides, total and HDL cholesterol, AST, ALT were found to be higher in adolescents with metabolic syndrome compared to their healthy peers ($p<0.01$). When food consumption records were examined, carbohydrate (%) and fiber (g) intakes of adolescents with metabolic syndrome were higher and fat (%) was lower ($p<0.01$). Positive correlation was found between fat (g) intake and BMI among anthropometric measurements and glucose among biochemical parameters ($p<0.05$). ALT and AST levels increased as the proportion of total energy coming from carbohydrate increased ($p<0.05$).

Conclusion: Adolescents with metabolic syndrome were found to consume higher amounts of energy, carbohydrates and fiber, but had a more adequate and balanced daily diet compared to their healthy peers. These findings emphasize the importance of early intervention strategies, especially for younger age groups.

Keywords: Metabolic syndrome, nutrition, insulin resistance, obesity

Özet

Giriş: Adölesanlarda obezite sıklığının artması ile birlikte ülkemizde metabolik sendrom prevelansında artış görülmektedir.

Amaç: Metabolik sendrom tanısı almış adölesanların beslenme durumlarını, antropometrik ölçümlerini ve biyokimyasal parametrelerini sağlıklı yaşıtları ike karşılaştırmaktır.

Yöntemler: Çalışmaya İstanbul ilinde yaşayan 14-18 yaş arası 40 metabolik sendromlu ve 40 sağlıklı adölesan dahil edildi. Demografik bilgileri içeren bir anket formu uygulandı. Vücut ağırlığı, boy uzunluğu, bel çevresi ölçüldü ve beslenme durumlarını belirlemek için araştırmacı tarafından geriye dönük 24 saatlik besin tüketim kaydı alındı. Hastane kayıtlarından, metabolik sendromla ilişkili glukoz, insülin, trigliserit, total kolesterol, HDL kolesterol, AST, ALT, kan basıncı değerleri kaydedildi.

Bulgular: Metabolik sendromlu adölesanlarda vücut ağırlığı, BKİ, bel çevresi ölçümleri ve glukoz, insülin, trigliserit, total ve HDL kolesterol, AST, ALT gibi biyokimyasal parametreler sağlıklı yaşıtlarına göre daha yüksek bulunmuştur ($p<0.01$). Besin tüketim kayıtları incelendiğinde metabolik sendromlu adölesanların karbonhidrat (%), lif (g) alımları sağlıklı yaşıtlarına göre daha yüksek, yağ (%) düşüktür ($p<0.01$). Yağ (g) alımı ile antropometrik ölçümlerden VKİ, biyokimyasal parametrelerden glukoz arasında pozitif korelasyon bulunmuştur ($p<0.05$). Toplam enerjinin karbonhidrattan gelen oranı arttıkça ALT, AST düzeyleri artmaktadır ($p<0.05$).

Sonuç: Metabolik sendromlu ergenlerin sağlıklı akranlarına kıyasla daha fazla miktarda enerji, karbonhidrat ve lif tükettiği, fakat daha yeterli ve dengeli bir günlük diyete sahip oldukları bulundu. Bu bulgular, özellikle daha genç yaş grupları için erken müdahale stratejilerinin önemini vurgulamaktadır.

Anahtar Kelimeler: Metabolik sendrom, beslenme, insülin direnci, obezite

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INTRODUCTION

Metabolic syndrome (MetS) is a systemic endocrinopathy characterized by conditions such as abdominal obesity, glucose intolerance, diabetes, dyslipidemia, hypertension, cardiovascular disease, and coronary heart disease. It is also referred to as "insulin resistance syndrome" or "syndrome X" (1).

Diagnostic criteria in MetS were determined by the USA National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP III) and the World Health Organization (WHO) (1). According to a comprehensive systematic review examining the prevalence of metabolic syndrome (MetS) in children and adolescents, the prevalence of MetS in adolescents worldwide was estimated at 4.8% (2). In studies conducted in Turkey, the frequency of MetS has been reported in the range of 20-40% for childhood and adolescence (3,4).

Obesity is one of the most important risk factors in the development of MetS in childhood and adolescence. While the prevalence of MetS is around 3-4% in the general population, this rate increases up to 28-30% in obese children (5,6). It has been reported that the most common metabolic disorders accompanying abdominal obesity in adolescents with MetS are high triglyceride levels and low high-density lipoprotein (HDL) levels (7,8).

The most important step in the treatment approach of MetS in children is the prevention of obesity. In addition, Mediterranean style eating habits increased physical activity, and adoption of a healthy fibre style are the main components of the treatment (9,10).

The aim of this study was to evaluate the nutritional status, anthropometric measurements and biochemical parameters of adolescents diagnosed with MetS in comparison with their healthy peers.

MATERIAL - METHODS

Study Design and Participants

The study was conducted with a total of 80 adolescents, 40 MetS patients (study group) and 40 healthy adolescents (control group), admitted to a university hospital in Istanbul, Turkey between April and June 2014. Sample size calculation was performed using the G*Power 3.1.9.2 program. In order to test whether there was a significant difference between two independent groups (adolescents with MetS and healthy controls), it was determined that at least 34 participants were required for each group as a result of the calculation based on the medium effect size (Cohen's d = 0.5), 95% confidence level (α = 0.05) and 80% test power (1-β = 0.80). Considering possible data losses, 40 participants were included in each group, thus the total sample size was determined as 80.

The mean age of the participants was 15.31±1.31 years, with an equal distribution of genders. The study group consisted of adolescents diagnosed with MetS and followed up in the pediatric endocrinology outpatient clinic, while the control group consisted of healthy adolescents admitted to the orthopedics clinic of the hospital. Patients who were taking medication for any reason, were on a diet, had a syndromic or endocrinologic disease and refused to participate in the study were excluded.

Data Collection and Evaluation

Demographic characteristics of the adolescents participating in the study and their families were obtained with a questionnaire form prepared beforehand. The questionnaire included age, gender, educational status, and health problems.

Body weight, height and waist circumference were measured by the researcher to determine the growth, development and risk factors associated with MetS in adolescents. A wall-mounted tape measure was used for height. Measurements were taken without shoes, with heels touching and recorded in centimeters (11). Body weight was measured without shoes using a Beurer brand digital scale with a capacity of 150 kg, sensitive to 100 g, and the values were recorded in kilograms Waist circumference was measured by the researcher using a non-elastic measuring tape while participants stood on a flat surface, wearing minimal clothing, in a position parallel to the floor. Body mass index was calculated by dividing body weight (kg) by the square of height (m^2) (11). The obtained data were entered into the WHO AntroPlus program body mass index (BMI for Age Z Score-BAZ) z-score values were calculated according to age. BMI values were evaluated with reference to WHO (World Health Organization) z-score classification (12). The values of Oztürk et al. were taken as reference in waist circumference percentiles (13). Waist circumference measurements, <5th percentile is classified as underweight, 5-85th percentile as normal, 85-95th percentile as being overweight, and 95th percentile as obese (14).

To determine nutritional status, 24-hour dietary recall were obtained. To ensure that food consumption records were reliable, detailed information was provided for adolescents and their families with replica samples and food catalogs. Dietary energy and nutrients derived from daily nutrition were analyzed using Nutrition Information System Package Program for Turkey (BEBIS 8.2.) specifically designed for Turkey (15). The values obtained were compared with the recommendations of the Turkish Food and Nutrition Guide (TUBER 2022). Reference values determined 14-18 years in TUBER 2022 were taken into consideration (16). For energy and nutrients, 67-133% of the recommended level is considered adequate, 67% and below is considered inadequate and 133% is considered excessive. This method has been used in many studies evaluating energy and nutrient intakes (17,18,19).

Biochemical parameters associated with MetS, including glucose, insulin, triglycerides (TG), total cholesterol, HDL cholesterol, and liver function tests such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST), blood pressure were obtained from hospital records of the last week for the study group. For the control group, these parameters were measured through blood samples.

Ethical statement

Bezmialem Vakif University Clinical Research Ethics Committee approved the study (approval date 28.01.2015 and numbered 71306642-050.01.04-, decision no: 2/15). The families of the participants were first explained the purpose of the study and informed about the research. A voluntary consent form was obtained from the families who wanted to participate in the study.

Data Analysis

IBM SPSS Statistics 22.0 programme was used. In addition to descriptive statistics for quantitative data, Student's t-test was used to compare normally distributed variables between two groups. Pearson correlation analysis was used to examine the relationships between normally distributed variables. Pearson correlation analysis was used to examine the relationships between normally distributed variables. The strength of the association based on the Pearson r coefficient can be interpreted as follows: 0.00–0.19 very weak, 0.20–0.39 weak, 0.40–0.59 moderate, 0.60–0.79 strong, and 0.80–1.00 very strong/excellent (20). The statistical significance level was accepted as $p < 0.05$, and $p < 0.01$ was considered as a high level of statistical significance.

RESULT

The demographic characteristics and anthropometric measurements of the adolescents participating in the study are presented in Table 1. Regardless of gender, anthropometric measurements were higher in adolescents with MetS compared to their healthy peers ($p <0.01$).

Table 1. Demographic characteristics and anthropometric measurements of adolescent

Features	Study group (n=40)		Control group (n=40)		t/p	
	Female Mean± SD (n=22)	**Male Mean± SD (n=18)**	**Female Mean± SD (n=18)**	**Male Mean± SD (n=22)**	**Female**	**Male**
Age (year)	14.7±0.8	15.5±1.2	15.2±1.2	15.7±1.6	-1.51/ 0.159	-0.45/ 0.631
Height (cm)	158.6±5.8	167.5±13.4	154.3±26.1	169.1±9.4	0.68/ 0.500	-0.43/ 0.663
Body weight (kg)	88.6±16.8	102,9±29.3	55.3±26.8	57.9±8.4	5.22/ <0.001**	6.52/ <0.001**
BMI (kg/m²)	35.4±5.7	35.1±6.2	19.4±2.4	20.3±2.3	11.55/ <0.001**	10.08/ <0.001**
WC (cm)	100.6±5.7	107.3±6.2	71.2±6.2	76.7±2.8	17.60/ <0.001**	21.65/ <0.001**

t: Independent Sample T-Test, BMI: Body Mass Index, WC: Waist Circumference, **p<0.01

The BMI Z score of the adolescents in the study group was mostly obese, while it was in the normal range in the control group. Similar results were observed in waist circumference percentile values (Table 2).

Table 2. Distribution of adolescents according to BMI Z score and waist circumference percentile

BMI Z score	Study group		Control group		Total	
	(n)	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Underweight (< -2 SD)	0	0	0	0	0	0
Normal (-2 SD -1 SD)	0	0	38	95	38	47.5
Overweight (≥1 SD – 2 SD)	2	5	1	2.5	3	3.75
Obese (≥2 SD)	38	95	1	2.5	39	48.75
WC percentile						
Under weight (<5)	0	0	0	0	0	0
Normal (5-85)	1	2.5	36	90.5	37	46.25
Overweight(≥85-95)	2	5	3	7.5	5	6.25
Obese (≥95)	37	92.5	1	2.5	38	47.5

BMI: Body Mass Index, WC: Waist Circumference.

Some biochemical measurements for adolescents are shown in Table 3. All biochemical measurements of the adolescents in the study group were statistically higher than those of the adolescents in the control group (p <0.01).

Table 3. Biochemical parameters of adolescents

Parameters	Reference values	Study group (Mean±SD)	Control group (Mean±SD)	t/ p
Insulin (mIU/L)	5-12	40.25±25	12.09±2.43	7.09/ <0.001**
Glucose (mg/dl)	79-115	97.43±19.63	79.2±7.27	5.51/ <0.001**
Triglyceride (mg/dl)	0-200	172.38±103.45	85.92±22.72	5.16/ <0.001**
Total cholesterol (mg/dl)	120-200	188.85±36.86	130.92±27.84	7.93/ <0.001**
HDL cholesterol (mg/dl)	30-90	38.72±12.47	48.95±6.72	-4.57/ <0.001**
ALT (U/L)	14-54	35.63±23.21	20.37±5.36	4.05/ <0.001**
AST (U/L)	15-41	31.55±14.26	21.97±5.35	3.98/ <0.001**

t: Independent Sample T-Test, ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, HDL: High-density lipoprotein, **p<0.01

In Table 4, daily energy and macronutrient intakes of adolescents and percentages of meeting recommended nutrient intake. The average daily energy intake was higher in the study group (2103.8±605.7 kcal) compared to the control group (1807.6±541.4 kcal) (p>0.05). It was found that the amount of carbohydrate (g, %) and fiber (g) were consumed more among adolescents with MetS (p<0.01). In the control group, the ratio of total energy coming from fat was found to be higher than the study group (p<0.01).

Table 4. Daily energy and macronutrient intakes of adolescents and percentages of meeting recommended nutrient intake

		Study group		Control group		
Nutrition	**Recomended**	**Obtained (Mean±SD)**	**Recomended (%)**	**Obtained (Mean±SD)**	**Recomended(%)**	**t/ p**
Energy (kcal)	2139-3384	2103.8±605.7	76.1	1807.6±541.4	74.6	0.60/ 0.547
CHO (g)	130	257.4±85.8	169.9	184.3±69.2	141.8	3.29/ <0.001**
CHO (%)	45-60	49.9±6.7	-	41.6±8.3	-	3.29/ <0.001**
Fibre (g)	21-25	21.2±8.7	92.4	16.7±5.9	81.0	2.70/ 0.007**
Protein (g/kg)	1.04-1.11	0.8±0.3	99.4	1.3±0.5	120.9	1.22/ 0.224
Protein (%)	8-20	15.1±3.7	-	16.1±3.7	-	1.22/ 0.224
Fat (g)	-	83.4±29.5	-	85.1±28.6	-	0.57/ 0.567
Fat (%)	20-35	35.5±6.9	-	42.3±7.6	-	3.29/ <0.001**

t: Independent Sample T-Test, CHO: Carbohydrate, ** p<0.01

The correlation between energy and macronutrients and anthropometric measurements of adolescents is shown in Table 5. As the fat (g) intake increases in the study group, the BMI increases (p<0.05, r=0.328). There is a significant positive correlation between fiber (g) intake and BMI and waist circumference (p<0.05, r=0.372, p<0.01, r=0.410).

Table 5. Correlation between macronutrients and anthropometric measurements of adolescents (r)

Nutrient		**Study group**		**Control group**	
		BMI (kg/m²)	**WC (cm)**	**BMI (kg/m²)**	**WC (cm)**
Energy (kcal)	r	0.179	0.166	0.030	0.035
	p	0.269	0.306	0.854	0.830
CHO (g)	r	0.105	0.172	-0.070	0.080
	p	0.519	0.289	0.668	0.624
CHO (%)	r	-0.153	-0.050	-0.235	0.114
	p	0.346	0.759	0.144	0.484
Fibre (g)	r	0.372	0.410	0.127	-0.138
	p	0.018*	0.009**	0.435	0.396
Protein (g)	r	0.181	0.100	0.152	-0.008
	p	0.264	0.539	0.349	0.961
Protein (%)	r	0.100	-0.053	0.206	-0.014
	p	0.539	0.745	0.202	0.932
Fat (g)	r	0.328	0.266	0.087	-0.022
	p	0.039*	0.097	0.593	0.893
Fat (%)	r	0.191	0.114	0.139	-0.112
	p	0.238	0.484	0.392	0.491

BMI: Body Mass Index, WC: Waist Circumference, CHO: Carbohydrate. *p<0.05, **p<0.01, r: Pearson's Correlation

Table 6 shows the correlation between the energy and macronutrients taken daily by adolescents and their biochemical parameters. The blood glucose level, energy, fiber (g), and protein levels in the study group are at a weak level as they increase; as the fat intake (g) increases, it increases moderately (p<0.05).

Table 6. Correlation between macronutrients and biochemical parameters of adolescents (r)

Nutrients		Study group							Control group						
		FBG (mg/dL)	FI (mu/L)	Total-C (mg/dL)	HDL-C (mg/dL)	TG (mg/dL)	ALT (U/L)	AST (U/L)	FBG (mg/dL)	FI (mu/L)	Total-C (mg/dL)	HDL-C (mg/dL)	TG (mg/dL)	ALT (U/L)	AST (U/L)
Energy (kcal)	r	0.381*	-0.085	-0.037	-0.18	-0.173	0.220	0.227	0.087	0.134	0.195	-0.116	0.016	-0.302	-0.086
	p	0.015	0.602	0.820	0.11	0.285	0.173	0.159	0.594	0.409	0.228	0.476	0.922	0.058	0.597
CHO (g)	r	0.265	0.055	0.005	-0.072	-0.187	0.220	0.262	0.186	0.030	-0.027	-0.098	-0.037	-0.300	-0.119
	p	0.098	0.736	0.976	0.604	0.248	0.144	0.102	0.250	0.854	0.868	0.547	0.821	0.060	0.465
CHO (%)	r	-0.203	0.258	0.116	-0.205	-0.062	0.381*	0.332*	0.099	-0.058	-0.391*	-0.015	-0.190	-0.141	-0.191
	p	0.209	0.108	0.476	0.205	0.704	0.015	0.036	0.547	0.722	0.013	0.520	0.240	0.385	0.238
Fibre (g)	r	0.360*	0.099	0.039	0.055	-0.025	0.207	0.249	-0.013	-0.194	0.228	-0.114	-0.041	-0.218	-0.103
	p	0.023	0.054	0.811	0.736	0.878	0.200	0.121	0.936	0.230	0.157	0.484	0.802	0.176	0.527
Protein (g)	r	0.376*	0.075	-0.043	-0.022	-0.158	0.135	0.124	0.095	0.040	0.365*	0.057	-0.091	-0.055	0.075
	p	0.017	0.645	0.792	0.893	0.330	0.406	0.446	0.559	0.724	0.021	0.610	0.576	0.736	0.645
Protein (%)	r	0.266	0.109	-0.109	0.250	0.067	-0.101	-0.037	-0.015	-0.012	0.269	0.197	-0.182	0.339*	0.273
	p	0.097	0.503	0.503	0.090	0.681	0.535	0.820	0.927	0.941	0.093	0.223	0.261	0.032	0.088
Fat (g)	r	0.470*	0.258	0.070	-0.122	-0.005	0.051	0.156	-0.029	0.059	0.254	-0.155	0.121	-0.265	0.105
	p	0.002	0.108	0.668	0.453	0.975	0.755	0.336	0.859	0.717	0.114	0.339	0.457	0.098	0.519
Fat (%)	r	0.069	-0.333*	0.006	-0.146	-0.005	-0.122	-0.174	-0.138	0.056	0.291	-0.069	0.292	0.062	0.020
	p	0.672	0.036	0.971	0.368	0.976	0.248	0.283	0.396	0.731	0.068	0.672	0.067	0.704	0.902

FBG: Fasting Blood Sugar, FI: Fasting Insulin Total C: Total cholestrol HDL-C: High-density lipoprotein cholestrol, TG: Triglyceride, ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, CHO: Carbohydrate. *p<0.05, r: Pearson’s Correlation

DISCUSSION

By examining the dietary habits of adolescents diagnosed with MetS, this study sheds light on a point rarely addressed in the existing. While previous studies generally emphasized the relationship between MetS and unhealthy diet, this study showed that individuals may have a more balanced diet after MetS diagnosis. This fills an important gap in the literature in terms of evaluating the impact of health interventions and counseling services after diagnosis. In addition, the findings of the study provide valuable information for preventive public health strategies by revealing the potential of preventive health practices in creating behavioral change during adolescence.

Increasing physical activity, consuming a healthy and balanced diet, and preventing obesity play important roles in the treatment of MetS. As part of general nutritional guidelines, it is recommended to reduce the intake of saturated fats, trans fats, salt, sugary drinks, fast food, and high-energy foods. Conversely, increasing the consumption of vegetables, fruits, whole grains, low-fat dairy products, and fish is encouraged (21). In our study, it was found that MetS adolescents had a more adequate and balanced diet in their daily energy and macronutrient intake compared to those without MetS (Table 4). Although this finding may seem surprising at first glance, it is consistent with some recent studies in the literature (22,23). In an analysis conducted in Korea between 2008 and 2017, it was reported that despite the increase in the prevalence of MetS, certain improvements in dietary habits were observed and these changes may affect risk factors (22). In particular, high adherence to balanced dietary patterns such as the Mediterranean diet has been reported to have protective effects on MetS components such as BMI, waist circumference and insulin resistance (23). These findings support the results obtained in our study and suggest that a more balanced diet profile may emerge with increased health awareness and improved nutritional behaviors in individuals after the diagnosis of MetS.

In a study examining the relationship between dietary habits and MetS, it was found that there was a relationship between abdominal obesity and high protein, cholesterol, saturated fat, sodium, fiber, vitamin, and mineral intake in adolescents (24). In our study, a positive correlation was found between fiber (g) intake and waist circumference and BMI values in adolescents with MetS ($p<0.01$, $p<0.05$). A similar relationship was observed between fat (g) intake and BMI ($p<0.05$). No such relationship was found in the control group. These findings suggest that focusing only on a single nutrient is not enough; the source of nutrients, portion sizes and overall dietary pattern should be considered.

Although the effects of nutrition on health are well known, determining the effect of dietary pattern on biochemical findings is an important indicator in determining the risk of chronic diseases. The relationship between carbohydrate intake and insulin sensitivity is still controversial. While simple carbohydrates have a negative effect on glucose metabolism, starches and polysaccharides may have a positive effect (25). In our study, a positive correlation was observed between energy derived from carbohydrates and biochemical parameters AST and ALT in adolescents with MetS ($p<0.05$). However, no correlation was found with insulin sensitivity ($p=0.258$). These results suggest that carbohydrate consumption may have a significant effect on liver function in adolescents, but the relationship with insulin sensitivity is shaped by more individual factors. This suggests that not only macronutrient ratios but also nutrient quality and individual metabolic differences should be considered in the assessment of metabolic disorders.

Limitations

When interpreting the results, there are several limitations of this study that should be considered. First, dietary intake was assessed using the 24-hour dietary recall method. Although practical, this method is prone to recall bias because participants may not accurately remember all the foods they consumed in the past. Second, the study had a limited sample size, which reduced the generalizability of the findings. Furthermore, potential confounding variables such as physical activity level or socioeconomic factors were not included in the study. Finally, the cross-sectional design of the study precludes establishing causal relationships.

This study fills an important gap in the literature by examining the relationships between dietary patterns and biochemical and anthropometric parameters in adolescents with MetS. Furthermore, its simultaneous assessment of both dietary components and clinical parameters contributes to a comprehensive interpretation of the findings.

CONCLUSION AND RECOMMENDATIONS

Adolescents with MetS were found to have an adequate and balanced daily diet, consuming higher amounts of energy, carbohydrates (%, g) and fiber (g) compared to their healthy peers. A positive correlation was observed between fat intake (g) and BMI from anthropometric measurements, as well as between fat intake and glucose levels from biochemical parameters. However, no significant relationship was found between macronutrient intake and triglyceride, HDL, or total cholesterol levels.

These findings emphasize the importance of early intervention strategies, especially for younger age groups, in both clinical practice and public health policies. However, the cross-sectional design of the study limits the establishment of cause-and-effect relationships, and the sample size limits generalizability. Therefore, further studies with a longitudinal design and larger sample groups are needed to provide stronger support for the findings. Furthermore, evaluating physical activity, sleep patterns, and lifestyle factors alongside dietary habits will contribute to a more comprehensive understanding of the multidimensional factors that play a role in the development of metabolic syndrome.

Author Contribution

E.G.D.: Planning the Research, Collecting Data, Writing the Research; M.G.D: Planning the Study, Writing the Study, Critical Revision

Conflict of Interest

The authors declare that they have no conflict of interest.

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Ethical Approval

The study was approved by Bezmialem Vakıf University Scientific Research Ethics Committee (7130642-050.01.04-). A voluntary consent form was obtained from the families of the patients who agreed to participate in the study.

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