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Obez Astımlı Çocuklarda Akdeniz Diyeti Uyumu, Solunum Fonksiyonları ve Beslenme Durumunun Değerlendirilmesi

Evaluation of Adherence to the Mediterranean Diet, Respiratory Functions and Nutritional Status in Obese Asthmatic Children

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ABSTRACT

This study aimed to evaluate Mediterranean diet adherence, respiratory functions, and nutritional status in obese children with asthma.

This study was conducted between July and September 2024 at Aydın Adnan Menderes University Hospital, Pediatric Allergy and Immunology Clinic. A total of 55 obese children aged 6-15 years with asthma who agreed to participate and whose parents provided written informed consent were included. A questionnaire covering sociodemographic characteristics, health information, and dietary habits was administered. Additionally, three-day food consumption records were collected. The KIDMED index was applied to assess adherence to the Mediterranean diet. Anthropometric measurements, body composition analysis, and spirometry tests for respiratory function were performed.

The mean age of the children was 10.03±0.25 years. The mean KIDMED score was 7.02±2.79, indicating moderate adherence to the Mediterranean diet. Among boys, lower adherence to the Mediterranean diet was associated with a more adverse body composition ($p<0.05$), whereas no significant difference was found in girls ($p>0.05$). No significant differences were observed between energy and nutrient intake, dietary antioxidant capacity, ORAC values, and KIDMED scores ($p>0.05$). A negative correlation was found between saturated fat and cholesterol intake and FVC, while a positive correlation was observed between FEV_1 and vitamin E intake ($p<0.05$). Additionally, FEV_1/FVC ratio showed a positive correlation with dietary fiber, insoluble fiber, vitamin E, phosphorus, iron, and zinc intake ($p<0.05$).

In conclusion, adherence to the Mediterranean diet was associated with favorable body composition and pulmonary function parameters in children. These findings suggest that integrating Mediterranean diet principles into pediatric asthma management strategies may offer additional benefits in improving respiratory outcomes.

Key words: Asthma, Mediterranean diet, Obesity

ÖZ

Bu çalışma obez astımlı çocuklarda Akdeniz diyeti uyumu, solunum fonksiyonları ve beslenme durumunu değerlendirmek amacıyla yapılmıştır.

Bu çalışma; Temmuz-Eylül 2024 tarihinde Aydın Adnan Menderes Üniversitesi Hastanesi Çocuk Alerji ve İmmünoloji Polikliniği'ne başvuran ve çalışmaya katılmayı kabul eden 6-15 yaş aralığındaki toplam 55 obez ve astımlı çocukla yürütülmüştür. Katılımcılara sosyodemografik özellikler, sağlık bilgileri, beslenme alışkanlıklarını içeren bir anket formu uygulanmış ve bunun yanı sıra üç günlük besin tüketim kayıtları alınmıştır. Katılımcılara Akdeniz Diyeti Kalite İndeksi (KIDMED) uygulanmış, antropometrik ölçüleri ve vücut bileşimi analizi yapılmış ve spirometre cihazıyla solunum fonksiyon testleri ölçülmüştür.

Çocukların yaş ortalamaları 10,03±0,25 yaştır. Çocukların ortalama KIDMED puanı 7,02±2,79 bulunmuştur ve çocukların Akdeniz diyetine orta uyum gösterdiği saptanmıştır. Erkek çocuklarda Akdeniz diyetine düşük uyumun, daha olumsuz bir vücut bileşimi ile ilişkili olduğu bulunmuştur ($p<0,05$), kız çocuklarda istatistiksel olarak anlamlı bir fark bulunmamıştır ($p>0,05$). Çalışmamızda enerji ve besin ögeleri, diyet antioksidan kapasitesi, ORAC değerleri ve KIDMED puanları arasında anlamlı farklılık saptanmamıştır ($p>0,05$). Doymuş yaş asidi ve kolesterol alımı ile FVC arasında negatif yönde, FEV_1 ve E vitamini arasında pozitif yönde, FEV_1/FVC oranı ve diyet posası, çözünmez diyet posası, E vitamini, fosfor, demir, çinko ve alımları arasında pozitif yönde anlamlı ilişki saptanmıştır ($p<0,05$).

Sonuç olarak, Akdeniz diyetine uyum, çocuklarda olumlu vücut bileşimi ve solunum fonksiyonu parametreleri ile ilişkilendirilmiştir. Bu bulgular, Akdeniz diyeti prensiplerinin çocukluk çağı astım yönetim stratejilerine entegre edilmesinin solunum sonuçlarını iyileştirmede ek faydalar sağlayabileceğini düşündürmektedir.

Anahtar kelimeler: Astım, Akdeniz diyeti, Obezite

Ethical approval was obtained from the Aydın Adnan Menderes University, Faculty of Health Sciences, Non-Interventional Ethics Committee (E-15189967-050.04-567626, 2024/35).

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INTRODUCTION

Asthma is one of the most common chronic diseases of childhood, characterized by chronic inflammation of the airways and affecting many children worldwide. It is characterized by variable expiratory airflow narrowing with respiratory problems such as wheezing, difficulty breathing, a feeling of pressure in the chest, and/or cough. According to the World Health Organization (WHO), it is estimated that approximately 300 million people worldwide suffer from asthma today, and this number is expected to reach 400 million by 2025.[1]

In addition to genetic and environmental factors, dietary habits are also thought to play an important role in the development of asthma. In particular, it has been reported that Western-type dietary habits increase the prevalence of asthma in children, whereas the Mediterranean-type diet provides a protective effect.[2] Additionally, the impact of obesity on the development and severity of asthma is also highlighted; the prevalence of asthma has been observed to increase with increasing body mass index (BMI).[3] Many studies have been conducted to examine the role of diet, particularly breast milk, in the development of asthma. Studies have shown that children fed cow's milk or soy-based formulas have higher rates of wheezing compared to those fed breast milk.[4, 5] The Mediterranean diet is a healthy eating pattern that includes foods such as fresh fruits and vegetables, whole grains, legumes, olive oil and fish. The effects of this diet on childhood asthma and obesity have been examined in scientific studies.[6, 7] For example, in a study conducted with asthmatic children aged 7-12, it was determined that those who were high adherence to the Mediterranean diet had an increased quality of life and decreased sleep disorders.[6] In a systematic review published on this subject, it was stated that consumption of vitamins C, E and D, Mediterranean diet and fruit consumption reduce the risk of developing asthma.[7] However, high consumption of processed and ready-to-eat foods, decreased consumption of antioxidant-rich fruits and vegetables, increased omega-6 polyunsaturated fatty acids (especially through margarine and vegetable oils), and decreased omega-3 polyunsaturated fatty acids (especially from oily fish sources) have been evaluated as factors that may contribute to the increase in the frequency of asthma and atopic diseases. In addition, it has been determined that asthma symptoms and bronchial hypersensitivity are more common in individuals with inadequate consumption of micronutrients such as vitamins A, C, E, carotene, riboflavin, pyridoxine, zinc and magnesium.[4] In this context, examining the effects of nutritional status of asthmatic children on body composition and respiratory function tests is important for the management of the disease and the development of treatment strategies.[8] Although previous researches have investigated the relationship between dietary intake and respiratory outcomes in asthmatic children, there is a paucity of studies examining how adherence to dietary patterns like the Mediterranean diet influences pulmonary function specifically in obese asthmatic children. Furthermore, the combined impact of obesity-related metabolic alterations and diet quality on lung function remains poorly understood in this vulnerable group.

Therefore, this study was conducted to evaluate to adherence to the Mediterranean diet, respiratory functions and nutritional status in obese asthmatic children.

MATERIAL AND METHOD

Research Design and Participants

This cross-sectional study was conducted between July and September 2024 at the Pediatric Allergy and Immunology Clinic of Aydın Adnan Menderes University Hospital. A total of 55 obese children with asthma, aged 6–15 years, who met the inclusion criteria and whose parents provided written informed consent, were included in the study.

Inclusion criteria were: age between 6 and 15 years, physician-diagnosed asthma for at least three months, obesity defined as BMI at or above the 95th percentile, and clinically stable asthma (no exacerbations or medication changes in the past four weeks). Exclusion criteria included the presence of other respiratory diseases, recent unexplained weight change, use of systemic corticosteroids, acute asthma exacerbation, ongoing diet therapy or regular intake of probiotics or nutritional supplements.

Ethical Aspects of the Study

Before the study commenced, ethical approval was obtained from the Non-Interventional Research Ethics Committee of Aydın Adnan Menderes University, Faculty of Health Sciences (Approval No: E-15189967-050.04-567626, Date: 2024/35). Written informed consent was obtained from all participants and their parents.

Data Collection Tools and Procedure

Data on sociodemographic characteristics, dietary habits, anthropometric measurements and respiratory function collected from all participants. Additionally, three-day food intake records were obtained from the children with the assistance of their parents. The researcher provided instructions for accurate record-keeping. Detailed procedures are described in the following sections.

No significant differences were found in the sociodemographic characteristics, health information and nutritional habits (e.g., socioeconomic status, age, parental education, time to diagnosis of disease, meal consumption habits) across The Mediterranean Diet Quality Index (KIDMED) adherence groups (p>0.05). Therefore, potential bias due to sociodemographic variability was considered minimal in this study.

Dietary Assessment

The dietary intake records were analyzed using the Computer-Assisted Nutrition Program, Nutrition Information Systems (BeBiS 9.0).[9] Nutrient quantities and meal compositions were calculated with reference to the Standard Food Recipes and Food Photograph Catalogue. Based on the three-day dietary intake records, dietary antioxidant capacity (DAC) and oxygen radical absorbance capacity (ORAC) values were also estimated to evaluate the total antioxidant potential of participants' diets.[10, 11]

KIDMED was applied to children to measure their adherence to the Mediterranean diet. Developed by Serra-Majem et al. in 2004, KIDMED has been used by researchers, dietitians and educators for a long time to assess adherence to the Mediterranean diet in children and adolescents (2-14 years of age)[12]. A validity and reliability study for Türkiye was conducted by Şahingöz et al (The internal consistency reliability coefficient (KR-20) was calculated as 0.72).[13] This index includes 16 statements, 12 of which are positive and 4 of which are negative. Positive responses to statements regarding adherence to the diet were evaluated as +1 point, and positive responses to statements that assumed less adherence to the diet were evaluated as -1 point. Negative responses to statements were not scored (0 points). According to the total scores received by children from the index, adherence to the Mediterranean diet was divided into 3 categories and interpreted. These are; 1) Low adherence (0-3 points): very low nutritional quality; 2) Moderate adherence (4-7 points): improvement of the dietary model is necessary and 3) High adherence (8-12 points): optimal Mediterranean diet.

Anthropometric Measurements and Body Composition Analysis

Anthropometric measurements and body composition analyses were performed under standardized conditions. Body weight and composition were assessed using the InBody 270 body analyzer, and height was measured in the Frankfurt plane using a stadiometer. All measurements were conducted after a minimum of 8 hours of fasting to ensure consistency and accuracy.

The following parameters were recorded: body fat percentage (%), body fat mass (kg), lean body mass (kg), total body water (L), and skeletal muscle mass (kg). Waist circumference was measured using a non-elastic measuring tape, and waist-to-height ratio was calculated accordingly.

Body mass index (BMI) was calculated by dividing body weight (kg) by the square of height (m^2). In accordance with the WHO Child Growth Standards, BMI-for-age percentiles were used to evaluate anthropometric status. Obesity was defined as a BMI at or above the 95th percentile for the child's age and sex.[14]

Measurement of Pulmonary Function Parameters

In the clinical evaluation of respiratory diseases, pulmonary function tests (PFT) are one of the commonly used laboratory methods. PFT is an objective application that allows the evaluation of air exchange, gas diffusion and mechanical properties of the respiratory system. The analysis of test results is carried out by taking into account factors such as gender, age, height, weight and ethnicity.[15, 16]

Basic parameters such as forced vital capacity (FVC), volume of air exhaled in the first second of forced expiration (FEV_1), FEV_1/FVC ratio are measured with a simple spirometry device. These values are compared with reference data of healthy individuals of the same gender, age, height and ethnic group and percentage values are determined.[17, 18] While values above 80% are considered normal, values between 60-80% indicate mild impairment, and values below 60% indicate severe respiratory dysfunction.[19]

Statistical Analysis

The data obtained from the study were evaluated using SPSS 22.0 (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY: IBM Corp.) program for statistical analysis. The Shapiro-Wilk test was used to examine the conformity of the data to normal distribution. The homogeneity of variances was evaluated separately for boys and girls using Levene's test. In the comparison of more than one group, if the data were normally distributed, one-way analysis of variance (One-Way ANOVA) was applied, and if they were not normally distributed, the Kruskal Wallis test was used as a post hoc test to determine the differences between the groups. Effect sizes (η^2) were calculated from one-way ANOVA or Kruskal Wallis results as the ratio of the between-group sum of squares to the total sum of squares. Interpretation of η^2 was based on Cohen's thresholds: 0.01 (small), 0.06 (medium), and 0.14 (large). The relationship between the variables was examined with Pearson correlation analysis in cases where the data showed a normal distribution, and with Spearman correlation analysis in cases where they did not show a normal distribution. The level of statistical significance was accepted as $p<0.05$.

Given the relatively small overall sample size (n=55), post-hoc power analyses were conducted to evaluate the study's capacity to detect meaningful differences. When all participants were analyzed together, a post-hoc power analysis based on the BMI variable revealed an estimated power of 0.78 for detecting moderate effect sizes (f=0.25) at a significance level of 0.05. This indicates an adequate ability to detect moderate group differences in body composition across Mediterranean diet adherence categories. Additionally, among male participants only (n=33), the BMI variable exhibited a large effect size (η^2=0.42; f=0.86), resulting in an estimated statistical power of 0.99. This demonstrates excellent sensitivity to detect meaningful differences within this subgroup. Despite these positive findings, the statistical power for subgroup analyses, particularly among female participants, remained limited due to the smaller sample size (n=22), which should be considered when interpreting the results.

RESULTS AND DISCUSSION

This study was completed with a total of 55 children, 33 of whom were boys (60%) and 22 of whom were girls (40%). The mean age of these children was 10.03±0.25 years. Table 1 shows the distribution of children's body compositions according to adherence to the Mediterranean diet and gender. Accordingly; while no statistically significant difference was found between girls' adherence to the Mediterranean diet and body composition; in boys with low adherence to the Mediterranean diet, body weight, BMI, body fat mass, waist circumference and waist/height ratio were found to be statistically higher compared to those with moderate and optimal adherence ($p<0.05$). As shown in Table 1, these findings suggest that poor adherence to a Mediterranean dietary pattern may contribute to increased adiposity and central obesity in obese asthmatic boys. In contrast, no statistically significant differences were observed in girls across the KIDMED adherence groups, possibly due to smaller sample size or gender-specific physiological differences. Among boys, most body composition variables demonstrated large effect sizes, notably in body fat mass ($\eta^2=0.450$) and waist-to-height ratio ($\eta^2=0.352$), indicating substantial differences between KIDMED adherence groups. Moderate to large effect sizes were also observed for body weight ($\eta^2=0.333$) and BMI ($\eta^2=0.421$). In contrast, among girls, η^2 values were predominantly small, reflecting minimal differences across adherence groups (e.g., body fat mass $\eta^2=0.047$, skeletal muscle mass $\eta^2=0.092$).

Table 1. Body Composition Parameters by KIDMED Adherence and Gender

	Boys				Girls			
	KIDMED classification				KIDMED classification			
Variable	**Low adherence (n=3) ($\bar{x}$ ± SS)**	**Moderate adherence (n=17) ($\bar{x}$ ± SS)**	**Optimal adherence (n=13) ($\bar{x}$ ± SS)**	**p η^2**	**Low adherence (n=4) ($\bar{x}$ ± SS)**	**Moderate adherence (n=8) ($\bar{x}$ ± SS)**	**Optimal adherence (n=10) ($\bar{x}$ ± SS)**	**p η^2**
Body weight (kg)	92.93±8.08	53.15±17.32^{a}	55.42±16.81^{a}	**0.002** **0.333**	60.75±19.80	49.43±21.22	57.18±8.71	0.459 0.079
Height (cm)	167.83±0.29^{a}	144.41±15.41^{b}	149.69±13.52^{a,b}	**0.041‡** **0.192**	148.50±7.51	138.50±9.81	146.00±7.02	0.095 0.219
BMI (kg/m^2)	33.00±2.77	24.71±3.30^{a}	24.14±2.69^{a}	**<0.001** **0.421**	27.00±6.24	24.93±6.42	26.75±3.18	0.706 0.036
Body fat percentage (%)	44.57±1.27^{a}	40.35±4.75^{a,b}	37.18±2.55^{b}	**0.010‡** **0.265**	42.65±6.06	42.08±4.49	41.28±6.32	0.909 0.010
Body fat mass (kg)	41.50±4.68	21.65±7.98^{a}	20.37±5.34^{a}	**<0.001‡** **0.450**	26.80±12.12	21.38±11.43	23.75±5.62	0.635 0.047
Lean body mass (kg)	33.95±7.68^{a}	28.05±10.00^{b}	33.43±5.79^{a,b}	**0.017** **0.237**	33.95±7.68	28.05±10.00	33.43±5.79	0.306 0.117
Body water (L)	37.67±2.48^{a}	23.03±7.26^{b}	25.68±8.56^{a,b}	**0.016** **0.240**	24.80±5.66	20.55±7.35	24.52±4.21	0.308 0.117
Skeletal muscle mass (kg)	28.50±1.91^{a}	16.19±6.10^{b}	18.72±6.88^{a,b}	**0.013** **0.250**	18.10±4.62	14.55±6.04	16.97±3.20	0.398 0.092
Waist circumference (cm)	108.67±9.24	83.06±9.88^{a}	82.15±9.57^{a}	**0.001** **0.395**	87.50±15.59	80.25±13.65	83.18±6.63	0.572 0.057
Waist/height ratio	0.59±0.08	0.58±0.06^{a}	0.57±0.05^{a}	**0.002** **0.352**	0.59±0.08	0.58±0.06	0.57±0.05	0.948 0.000

BMI: Body mass index, KIDMED: Mediterranean diet quality index.
One Way ANOVA test was used in the analysis of the test. Bonferroni test was used to evaluate the difference between the groups.
‡ Kruskal Wallis test was applied for parameters that did not show normal distribution.
^{a,b}: There is no significant difference in groups with the same letters according to pairwise comparisons ($p>0.05$). η^2=Effect size.

Table 2 shows the average daily energy and nutrient intakes, dietary antioxidant capacities and ORAC values of children according to their adherence to the Mediterranean diet and gender. Accordingly, no statistically significant difference was found between the daily energy and nutrient intakes, dietary antioxidant capacities and ORAC values of children and their adherence to the Mediterranean diet. Table 2 illustrates that although trends indicated lower energy intake with higher adherence to the Mediterranean diet, these differences did not reach statistical significance. This may reflect modest dietary variations that were insufficient to elicit measurable changes in antioxidant capacity or nutrient profiles within the study population. The effect sizes (η^2) for nutrient intake and antioxidant capacity variables were calculated based on one-way ANOVA and Kruskal Wallis results. The η^2 values for boys ranged predominantly from small to moderate, with a few parameters approaching moderate effect sizes (e.g., energy intake η^2=0.0525, soluble fiber intake η^2=0.0658). In girls, most variables demonstrated small effect sizes (e.g., protein intake η^2=0.0088, calcium intake η^2=0.0090), with no parameters reaching the threshold for a large effect.

Table 2. Daily Energy, Nutrient Intake, and Antioxidant Capacity by KIDMED Adherence and Gender

	Boys				**Girls**			
	KIDMED classification				**KIDMED classification**			
Variable	**Low adherence (n=3) ($\bar{x}$ ± SS)**	**Moderate adherence (n=17) ($\bar{x}$ ± SS)**	**Optimal adherence (n=13) ($\bar{x}$ ± SS)**	**p η^2**	**Low adherence (n=4) ($\bar{x}$±SS)**	**Moderate adherence (n=8) ($\bar{x}$±SS)**	**Optimal adherence (n=10) ($\bar{x}$±SS)**	**p η^2**
Energy (kcal)‡	1951.98±815.35	1807.61±392.28	1664.34±293.22	0.674‡ 0.053	1664.45±167.74	1520.05±208.49	1445.12±337.48	0.602 0.089
Carbohydrate (TE%)	45.33±13.05	38.82±7.58	39.31±7.24	0.361‡ 0.066	41.75±8.73	41.25±9.69	41.30±7.21	0.995 0.001
Carbohydrate (g)	231.91±165.08	177.30±73.32	161.19±43.44	0.337‡ 0.070	173.06±54.56	155.34±47.55	148.04±52.72	0.715 0.035
Protein (TE %)	17.00±4.36	17.94±2.28	17.69±2.72	0.846 0.011	15.75±2.22	15.63±3.42	16.10±1.60	0.919‡ 0.009
Protein (g)	74.62±9.35	78.45±14.23	70.85±12.43	0.311 0.075	63.88±4.15	58.79±14.88	56.10±10.90	0.549 0.061
Fat (TE %)	37.67±8.74	43.29±6.85	42.92±4.72	0.360 0.066	42.25±6.99	42.38±7.23	42.50±5.78	0.998 0.000
Fat (g)	77.79±13.14	85.45±10.54	79.86±14.23	0.378 0.063	77.79±7.61	72.17±12.52	68.37±16.16	0.518 0.067
Dietary fiber (g)	17.44±2.27	19.25±3.69	17.84±3.40	0.479 0.048	20.18±4.46	17.54±6.19	15.80±5.28	0.415 0.088
Soluble fiber (g)	5.33±1.17	5.31±1.15	5.25±0.93	0.989 0.001	5.87±0.99	5.04±1.65	4.68±1.13	0.338 0.108
Insoluble fiber (g)	11.54±0.77	13.15±2.96	12.35±2.82	0.571 0.037	13.81±4.15	11.89±5.09	10.77±4.30	0.538 0.063
SFA (g)	29.46±5.53	28.92±6.18	27.45±6.07	0.770 0.017	24.12±2.30	23.35±7.30	23.79±4.06	0.970 0.003
MUFA (g)	26.83±1.57	31.63±5.65	30.34±5.92	0.385 0.062	31.36±7.58	27.68±6.31	26.89±7.97	0.591 0.054
PUFA (g)	14.52±6.23	17.33±4.88	16.15±6.51	0.685 0.025	17.17±4.66	15.94±3.82	13.01±6.49	0.345‡ 0.106
Cholesterol (mg)	452.96±108.77	420.77±140.48	366.47±154.35	0.493 0.046	241.71±96.76	269.19±106.45	247.89±86.26	0.859 0.016
n-6 fatty acid (g)	12.04±5.92	14.05±4.90	13.63±6.35	0.848 0.011	13.74±4.74	13.18±3.51	10.05±5.05	0.247 0.137
n-3 fatty acid (g)‡	1.71±0.31	2.27±0.95	2.14±1.14	0.321 0.027	2.22±0.44	1.58±0.72	1.63±1.02	0.327 0.083
Vitamin A (mcg)	743.82±195.40	1010.16±478.21	1177.62±699.40	0.454 0.051	1077.99±527.73	864.51±538.99	970.20±720.10	0.852 0.017
Vitamin E (mg)	13.30±4.36	14.49±5.54	15.48±5.82	0.795 0.015	15.84±5.52	15.37±3.59	11.14±4.44	0.086 0.228
Vitamin K (mcg)	112.67±90.55	143.19±99.58	140.12±88.58	0.876 0.009	106.32±64.98	143.76±106.07	120.80±67.12	0.735 0.032
Vitamin C (mg)	69.81±14.50	83.31±45.84	105.04±45.88	0.303 0.077	120.60±67.64	132.09±92.20	79.59±41.19	0.265 0.130
Vitamin B_{12} (mcg)	3.61±0.50	4.72±1.63	4.89±1.13	0.366 0.065	3.62±0.79	3.31±1.67	3.97±1.36	0.619 0.049
Sodium (mg)	2532.97±1366.97	3357.83±1440.65	2967.96±1184.57	0.535 0.041	2933.43±631.93	2717.94±758.03	2581.72±516.21	0.645 0.045
Potasium (mg)	2256.39±495.71	2360.34±328.23	2418.40±359.60	0.758 0.018	2588.33±533.48	2208.53±769.24	2003.79±549.96	0.320 0.113
Calcium (mg)	591.99±173.68	677.30±94.03	692.53±143.76	0.448 0.052	701.73±153.57	666.51±289.35	651.45±124.59	0.918‡ 0.001
Phosphorus (mg)	1089.86±125.55	1208.73±138.35	1138.54±167.68	0.293 0.102	1091.27±166.60	1018.19±320.80	973.15±228.18	0.743 0.020

Table 2. (Continued) Daily Energy, Nutrient Intake, and Antioxidant Capacity by KIDMED Adherence and Gender

Variable	Boys: Low adherence (n=3) ($\bar{x}$ ± SS)	Boys: Moderate adherence (n=17) ($\bar{x}$ ± SS)	Boys: Optimal adherence (n=13) ($\bar{x}$ ± SS)	p η²	Girls: Low adherence (n=4) ($\bar{x}$±SS)	Girls: Moderate adherence (n=8) ($\bar{x}$±SS)	Girls: Optimal adherence (n=10) ($\bar{x}$±SS)	p η²
Magnesium (mg)	234.64±49.14	274.72±43.08	259.58±47.53	0.328 0.072	273.51±57.88	238.42±73.14	214.69±65.83	0.349 0.105
Iron (mg)	9.15±2.89	11.17±2.41	9.58±2.51	0.168 0.112	9.97±0.65	8.21±2.11	7.99±2.63	0.327 0.111
Zinc (mg)	8.20±2.34	10.05±1.66	9.19±2.02	0.211 0.099	7.88±1.33	7.06±2.19	7.93±2.02	0.267 0.130
DAC‡	16.76±25.57	3.31±5.86	8.40±12.19	0.314‡ 0.128	2.65±1.25	2.24±1.41	2.02±0.99	0.494‡ 0.040
ORAC	3588.73±1392.73	3229.52±2509.37	3401.86±2964.65	0.969 0.002	5946.37±3133.82	4828.52±3127.06	3696.02±2415.01	0.390 0.095

KIDMED: Mediterranean diet quality index, TE: Total energy, SFA: Saturated fatty acid, MUFA: Monounsaturated fatty acid, PUFA: Polyunsaturated fatty acid, DAC: Dietary antioxidant capacity, ORAC: Oxygen radical absorbance capacity
One Way ANOVA test was applied for parameters showing normal distribution.
‡ Kruskal Wallis test was applied for parameters that did not show normal distribution. η²=Effect size.

The means of children's respiratory function tests according to their adherence to the Mediterranean diet and gender are given in Table 3. Accordingly, no statistically significant difference was found between the FVC, FEV_1 and FEV_1/FVC values obtained from the respiratory function test of children and their adherence to the Mediterranean diet ($p>0.05$). Based on eta squared (η^2) values, the effect sizes for spirometry parameters varied between genders. According to Table 3, although no significant differences were detected, effect size values suggested moderate variability, particularly in girls, where a large effect size was observed for FVC. These findings imply that while dietary patterns may have a role in respiratory function, the current sample size might have been insufficient to detect significant differences.

Table 3. Pulmonary Function Parameters by KIDMED Adherence and Gender

Variable	Boys: Low adherence (n=3) ($\bar{x}$ ± SS)	Boys: Moderate adherence (n=17) ($\bar{x}$ ± SS)	Boys: Optimal adherence (n=13) ($\bar{x}$ ± SS)	p η²	Girls: Low adherence (n=4) $\bar{x}$±SS	Girls: Moderate adherence (n=8) $\bar{x}$±SS	Girls: Optimal adherence (n=10) $\bar{x}$±SS	p η²
FVC‡	98.33±2.89	103.71±17.68	103.38±8.90	0.828 0.013	94.50±2.89	100.75±9.56	105.60±13.48	0.245 0.138
FEV_1	96.67±1.15	100.59±15.50	93.69±10.57	0.373 0.064	88.50±14.43	99.50±10.18	98.20±15.74	0.409 0.090
FEV_1/FVC	97.00±3.46	92.59±8.75	90.15±7.41	0.386 0.062	92.50±10.97	97.63±3.78	92.40±4.22	0.541‡ 0.063

KIDMED: Mediterranean diet quality index.
One Way ANOVA test was applied for parameters showing normal distribution.
‡ Kruskal Wallis test was applied for parameters that did not show normal distribution. η²=Effect size.

The relationship between children's respiratory function tests and energy and nutrient intake is given in Table 4. Significant relationships were found between certain nutrient intakes and respiratory function parameters. As presented in Table 4, significant correlations were identified: FVC values were negatively associated with saturated fat and cholesterol intake ($p<0.05$), while FEV_1 showed a positive correlation with vitamin E intake. Additionally, FEV_1/FVC ratio was positively correlated with dietary fiber, insoluble fiber, vitamin E, phosphorus, iron, zinc, and magnesium intake, and negatively correlated with n-6 fatty acids and vitamin B_{12} intake. These findings support the potential beneficial role of a nutrient-rich, antioxidant-dense diet in improving pulmonary function among obese asthmatic children.

Table 4. Correlation Between Dietary Intake and Pulmonary Function Parameters in Children

	FVC‡		FEV1		FEV_1/FVC	
Nutrients	**r**	**p**	**r**	**p**	**r**	**p**
Energy (kcal)‡	0.169	0.217	0.015	0.916	-0.216	0.114
Carbohydrate (TE%)	0.029	0.833	0.115	0.402	0.054	0.697
Carbohydrate (g)‡	0.173	0.205	0.104	0.449	-0.055	0.693
Protein (TE %)	0.245	0.071	0.054	0.694	-0.114	0.407
Protein (g)	0.155	0.258	0.086	0.533	-0.174	0.204
Fat (TE %)	-0.105	0.445	-0.170	0.215	-0.036	0.796
Fat (g)	-0.072	0.603	-0.103	0.456	-0.192	0.159
Dietary fiber (g)	0.042	0.763	0.194	0.156	0.295	**0.029**
Soluble fiber (g)	0.074	0.593	0.039	0.775	0.147	0.284
Insoluble fiber (g)	0.017	0.904	0.248	0.068	0.306	**0.023**
SFA (g)	-0.273	**0.044**	-0.078	0.573	-0.069	0.617
MUFA (g)	0.053	0.699	0.162	0.236	0.162	0.238
PUFA (g)	-0.110	0.426	-0.189	0.167	-0.220	0.106
Cholesterol (mg)	-0.266	**0.049**	-0.228	0.095	-0.100	0.468
n-6 fatty acid (g)	-0.085	0.538	-0.251	0.064	-0.270	**0.046**
n-3 fatty acid (g)‡	0.036	0.792	0.015	0.915	-0.090	0.515
Vitamin A (mcg)	-0.124	0.369	-0.132	0.338	-0.002	0.989
Vitamin E (mg)	-0.094	0.493	0.299	**0.027**	0.336	**0.012**
Vitamin K (mcg)	0.113	0.410	-0.030	0.826	-0.030	0.829
Vitamin C (mg)	-0.157	0.252	-0.215	0.116	-0.165	0.229
Vitamin B12 (mcg)	0.088	0.523	-0.193	0.159	-0.279	**0.039**
Sodium (mg)	0.008	0.955	-0.099	0.471	-0.219	0.108
Potasium (mg)	-0.051	0.713	-0.148	0.281	-0.192	0.160
Calcium (mg)	0.137	0.320	-0.020	0.884	-0.153	0.266
Phosphorus (mg)	0.210	0.125	-0.077	0.578	0.284	**0.036**
Magnesium (mg)	0.053	0.701	-0.214	0.116	0.346	**0.010**
Iron (mg)	0.052	0.706	0.174	0.204	0.335	**0.012**
Zinc (mg)	0.116	0.400	0.219	0.107	0.397	**0.003**
DAC‡	-0.188	0.169	-0.083	0.549	0.100	0.467
ORAC	-0.193	0.157	-0.149	0.277	0.024	0.862

TE: Total energy, SFA: Saturated fatty acid, MUFA: Monounsaturated fatty acid, PUFA: Polyunsaturated fatty acid, DAC: Dietary antioxidant capacity, ORAC: Oxygen radical absorbance capacity
If both variables are normally distributed, correlation coefficients and statistical significances for relationships between variables were calculated with the "Pearson test".
‡If at least one variable is not normally distributed, correlation coefficients and statistical significances for relationships between variables were calculated with the "Spearman test".

In this study, the mean KIDMED score of the children was found to be 7.02±2.79 and it was determined that the children showed moderate adherence with the Mediterranean diet. The Mediterranean diet is a nutritional model known to be effective in controlling inflammatory respiratory diseases such as asthma. It has been stated in the literature that high adherence to the Mediterranean diet can alleviate asthma symptoms with its anti-inflammatory effects, improve respiratory functions and contribute to body weight control.[20, 21] Results associated with better respiratory function and inflammation control have been reported in children with high KIDMED scores.[22, 23] However, these positive effects may not be strong enough at moderate adherence levels. Moderate adherence indicates that children's diets are not rich enough in the essential food groups typical of the Mediterranean diet, such as vegetables, fruits, whole grains, and healthy fats. Optimizing children's dietary habits in particular may have positive effects on both asthma control and body composition.

Some studies have reported that low adherence to the Mediterranean diet is associated with increased energy density and poor food quality, which may increase negative outcomes such as obesity, abdominal fat and inflammation.[24, 25] Similar to the results of this study, Calcaterra et al. also showed that high adherence to the Mediterranean diet was associated with lower body weight, fat mass and waist circumference in obese children.[26] It has been reported that abdominal obesity is associated with chronic inflammation and that this may worsen inflammatory diseases such as asthma, but the Mediterranean diet may contribute to the improvement of respiratory functions and the relief of asthma symptoms by suppressing the inflammatory process.[22] The Mediterranean diet may help with weight management because it is rich in fiber and low-energy density foods. In the present study, significant differences in body composition parameters according to Mediterranean diet adherence were observed among boys, whereas no statistically significant differences were detected among girls (Table 1). This discrepancy may be explained by gender-specific physiological and behavioral factors. Boys generally exhibit greater variability in body mass and fat distribution, which may enhance the detectability of diet-related effects. In contrast, the hormonal changes associated with puberty and possible reporting biases in dietary assessment among girls could obscure potential associations.[3, 26] Therefore, while the findings suggest that Mediterranean diet adherence might have a stronger influence on body composition in boys during childhood, further studies with larger and gender-balanced samples are warranted to validate these results.

Energy intake was highest in the low adherence group (1951.98±815.35 kcal) in boys, while it decreased in the optimal adherence group (1664.34±293.22 kcal). Similarly, in girls, energy intake was highest in the low adherence group (1664.45±167.74 kcal) and lower in the optimal adherence group (1445.12±337.48 kcal), but this difference was not statistically significant ($p>0.05$) (Table 2). Literature supports that adherence to the Mediterranean diet contributes to energy balance. It has been reported that the Mediterranean diet provides moderate energy restriction with high consumption of plant foods that are rich in fiber and low in energy density.[27] Peng et al. also found a negative linear relationship between the energy density of the diet and KIDMED scores in their study.[28] Based on this information, it can be said that adherence to the Mediterranean diet keeps energy balance more under control.

In our study, no significant difference was found between macro and micronutrients, dietary antioxidant capacity, ORAC values and KIDMED scores ($p>0.05$) (Table 2). However, previous literature highlights the critical role of diet quality in respiratory health outcomes. Mechanistically, fruits, vegetables, and nuts-key components of the Mediterranean diet-are rich in antioxidants and anti-inflammatory nutrients. Antioxidants such as vitamins A, C, and E can scavenge reactive oxygen species (ROS) and mitigate oxidative stress, a known driver of airway inflammation in asthma.[29] A systematic review and meta-analysis concluded that lower dietary intake of vitamins A and C was associated with a higher likelihood of asthma and wheezing symptoms.[30]

Dietary fiber, another hallmark of Mediterranean diet, also plays a crucial role in modulating inflammation. Higher intakes of total and vegetable-derived fiber has been associated with reduced systemic inflammation and lower all-cause mortality rates.[31] Fermentation of dietary fiber by gut microbiota produces short-chain fatty acids (SCFAs), such as butyrate, which exert immunomodulatory effects and reduce airway inflammation.[32] SCFAs modulate host immunity via mechanisms including G protein-coupled receptor activation and histone deacetylase inhibition, thereby potentially reducing the risk of allergic asthma.[33]

In contrast, Western dietary patterns characterized by high saturated fat intake have been linked to increased airway inflammation.[34] Arachidonic acid (AA), a type of n-6 polyunsaturated fatty acid, serves as a key substrate for the synthesis of pro-inflammatory eicosanoids. In their study, Rutting et al. found that AA stimulation increases the secretion of inflammatory mediators such as IL-6 and CXCL8. Their findings suggest that diets high in n-6 PUFAs may promote airway inflammation through both cyclooxygenase (COX)-dependent and independent mechanisms. Also, reducing saturated fat intake has been associated with lower neutrophilic inflammation and improved asthma control.[35] Furthermore, consumption of high-fat meals has been shown to elevate sputum neutrophil counts and activate inflammatory gene pathways, including TLR4 signaling.[36] In patients with severe asthma, higher fat and lower fiber intake correlate with increased eosinophilic airway inflammation, while greater consumption of fruits, vegetables, and antioxidants contributes to reduced airway inflammation.[37] High intake of fruits and vegetables has also been found to inversely correlate with IL-8 protein concentrations in nasal lavage fluid of asthmatic children.[38] Moreover, a systematic review conducted by the European Academy of Allergy and Clinical Immunology (EAACI) recommended increased fruit and vegetable intake to mitigate asthma risk, particularly in pediatric populations.[39]

Fish consumption is very common in the Mediterranean diet and is an important component in asthma control due to its anti-inflammatory effect.[40] A study in the UK found that increased consumption of n-6 fatty acids and decreased consumption of n-3 fatty acids in children were associated with increased rates of asthma.[41] Further supporting this, another study revealed that higher dietary intake of docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), and total n-3 fatty acids correlated with a lower prevalence of asthma in children. Omega-3 fatty acids, particularly EPA and DHA, exert their anti-inflammatory effects by competing with arachidonic acid for cyclooxygenase and lipoxygenase enzymes, thereby reducing the synthesis of pro-inflammatory eicosanoids.[42]

Taken together, these findings suggest that the adoption of a Mediterranean dietary pattern-characterized by high consumption of fruits, vegetables, fiber, antioxidants, and omega-3 fatty acids-may offer a promising non-pharmacological strategy to support asthma management and improve respiratory health outcomes in children.

In the present study, significant associations were observed between various nutrients and pulmonary function parameters. Specifically, FVC values showed a negative correlation with SFA and cholesterol intake, whereas FEV_1 was positively associated with vitamin E intake. Additionally, the FEV_1/FVC ratio was positively correlated with dietary fiber, insoluble fiber, vitamin E, phosphorus, iron, zinc, and magnesium intake, while it was negatively associated with n-6 fatty acids and vitamin B_{12} intake (Table 4). These findings align with previous evidence suggesting the potential role of specific dietary components in respiratory health.

In support of our findings, a randomized controlled trial in asthmatic children demonstrated that supplementation with fruit and vegetable concentrates, fish oil, and probiotics led to significant improvements in FEV_1 compared to placebo groups, highlighting the potential benefits of antioxidant and omega-3-rich interventions.[43] Similarly, a randomized controlled trial investigating vitamin E supplementation (50 mg/day) reported significant increases in FEV_1 and FEV_1/FVC ratio in the intervention group, corroborating our findings regarding the positive association between vitamin E and lung function.[44]

Contradictory results have also been reported in the literature. For instance, a meta-analysis concluded that n-3 fatty acid supplementation generally had no significant impact on pulmonary function except in exercise-induced asthma; however, it should be noted that included studies had small sample sizes, limiting the robustness of conclusions.[45] Additionally, cross-sectional studies examining adherence to the Mediterranean diet found no significant effect on FEV_1 values, suggesting that overall dietary patterns may influence lung function differently compared to individual nutrient effects.[38, 42]

Longitudinal data from the Avon Longitudinal Study of Parents and Children (ALSPAC) showed that higher intake of preformed vitamin A, but not β-carotene, in mid-childhood was associated with better lung function and lower incident asthma risk at adolescence.[46] Moreover, a cross-sectional study with 3204 children found that adherence to a plant-based dietary pattern rich in total and soluble fiber and pyridoxine intake was positively associated with better pulmonary function.[47] These findings, in combination with the current study, emphasize that specific nutrients such as fiber, vitamins, and minerals may play a beneficial role in preserving lung function, while excess intake of saturated fats and cholesterol could have detrimental effects.

Although this study did not demonstrate a significant association between Mediterranean diet adherence and respiratory function parameters, the overall nutritional quality promoted by this diet may contribute indirectly to better asthma management. Further longitudinal studies are needed to clarify this relationship.

CONCLUSION AND RECOMMENDATIONS

This study evaluated the adherence to the Mediterranean diet and its associations with body composition and respiratory function in obese asthmatic children. Although no statistically significant differences were observed in respiratory function parameters across different levels of Mediterranean diet adherence, significant associations were identified between adherence and body composition metrics among boys. These findings suggest that greater adherence to a Mediterranean dietary pattern may positively influence body composition during childhood, particularly in boys. However, due to the cross-sectional nature of the study, causal relationships cannot be inferred. Furthermore, despite the absence of statistically significant findings regarding nutrient intakes and respiratory outcomes, the observed correlations highlight the potential role of dietary quality in asthma management.

Future studies should be conducted with larger, more gender-balanced samples to confirm and expand upon these findings. Longitudinal and intervention-based research designs are recommended to better assess causality between dietary patterns and respiratory health outcomes in obese children with asthma. Moreover, detailed evaluation of specific nutrient intakes and objective dietary assessment methods could provide deeper insights into the relationships between diet and asthma pathophysiology.

Clinically, promoting adherence to Mediterranean dietary principles—emphasizing fruits, vegetables, fiber, antioxidant-rich foods, and healthy fats—may serve as a supportive strategy in the comprehensive management of pediatric asthma, alongside conventional medical treatments. To strengthen practical implementation, school-based nutrition programs and family-centered interventions could be designed to promote Mediterranean-style eating patterns among children. Integrating nutrition education into school curricula and providing parents with guidance on healthy meal planning may help improve dietary adherence and support overall asthma management.

Limitations of the Study

One of the main limitations of this study is the relatively small sample size in the female subgroup, which may have reduced the statistical power to detect significant differences, particularly in gender-based comparisons. The cross-sectional nature of the study also precludes any causal inferences between Mediterranean diet adherence and respiratory outcomes.

Another limitation stems from the use of self-reported three-day dietary intake records. Although participants and their parents were carefully instructed on how to record food intake and portion sizes, this method is inherently subject to recall bias and social desirability bias. Younger children may have had difficulty accurately reporting food items or quantities, while parents might have unintentionally misreported or underreported foods perceived as unhealthy. These biases may have led to misclassification of dietary adherence levels or inaccuracies in nutrient intake estimates.

To mitigate these limitations, standard portion size visuals (Food Photograph Catalogue) and structured guidance were provided, and inconsistencies in the food records were clarified during follow-up interviews. However, these measures do not eliminate the potential for residual bias, which should be considered when interpreting the findings.

Conflicts of Interest

There is no conflict of interest among the authors regarding the publication of this article.

Authors' Contributions

Ş.Ç.; research, conceptualization, data collection, formal analysis, methodology, writing – review, editing. **N.A.T.;** research, formal analysis, methodology, review, editing, supervision. **All authors have read and approved the published version of the article.**

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