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Research Article

Mediterranean diet adherence, sleep disturbances, and quality of life in children with asthma: A cross-sectional study

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ABSTRACT

Objective: This study aimed to examine the association between adherence to the Mediterranean diet (MD), sleep disturbances, and quality of life (QoL) in children with asthma.

Methods: A cross-sectional study was conducted with 77 children aged 7–12 years diagnosed with physician-diagnosed, well-controlled asthma receiving low-dose controller therapy. Dietary intake was evaluated using three-day food records and the KIDMED index. Sleep quality and QoL were analyzed using the Sleep Disturbance Scale for Children (SDSC) and the Pediatric Asthma Quality of Life Questionnaire (PAQLQ), respectively. Correlation and regression analyses were performed.

Results: Moderate adherence to the MD was observed in 49.4% of participants. Greater adherence to MD was associated with fewer arousal-related sleep disturbances ($r = –0.283$, $p < 0.05$) and and lower total sleep disturbance scores ($r = −0.241$, $p < 0.05$).. A one-point increase in KIDMED score was associated with a 0.758-point decrease in SDSC score. Higher SDSC scores were significantly associated with lower PAQLQ scores ($r = −0.356$, $p < 0.01$).

Conclusions: Greater adherence to the Mediterranean diet may reduce sleep disturbances and enhance quality of life in asthmatic children, supporting its potential role in asthma management.

Keywords: asthma, mediterranean diet, sleep disorders, child, quality of life, nutritional status

INTRODUCTION

Asthma is the most common chronic respiratory disease in childhood and is characterized by persistent airway inflammation, recurrent wheezing, and coughing episodes.[1] The pathophysiology involves infiltration and activation of immune cells, including dendritic cells, eosinophils, neutrophils, lymphocytes, innate lymphoid cells, and mast cells, which contribute to airway narrowing and bronchial hyperresponsiveness.[2,3] In 2021, the Centers for Disease

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Control and Prevention reported a prevalence of asthma among children aged 5 to 14 years at 7.7%.[4] In addition to its respiratory symptoms, asthma has significant psychosocial implications, including alterations in personality traits, increased psychological distress, and reduced quality of life (QoL).[5]

Children with asthma tend to have lower QoL and health status compared to their healthy peers, participate less in physical activities, and experience higher rates of emotional and behavioral difficulties.[6,7] Assessing QoL in this population is essential to understanding the disease's impact on functional and psychosocial domains during daily life.

Nocturnal worsening of asthma symptoms is a common and clinically significant feature, often triggered by circadian variations in airway inflammation, hormonal levels, and airway reactivity. These physiological alterations lead to sleep disturbances characterized by coughing, wheezing, and dyspnea during the night, which degrade sleep quality. A reciprocal relationship has been proposed between asthma severity and sleep disorders, in which each may aggravate the other.[8,9]

The Mediterranean diet (MD) is a dietary pattern traditionally consumed in Mediterranean countries, emphasizing a high intake of fruits, vegetables, legumes, nuts, and whole grains, as well as olive oil; moderate intake of fish and poultry; and limited consumption of red meat, dairy products, and sweets. This dietary model constitutes a balanced composition of monounsaturated and polyunsaturated fatty acids, dietary fibre, antioxidants, and bioactive compounds associated with anti-inflammatory and antioxidant effects.[10]

Adherence to the MD may reduce airway inflammation and bronchial hyperresponsiveness by modulating oxidative stress and inflammatory pathways.[11,12] Additionally, components of the MD, such as omega-3 fatty acids, polyphenols, and tryptophan-rich foods, may support sleep regulation through their effects on melatonin and serotonin synthesis, gut microbiota modulation, and neuroendocrine function.[13]

This study was designed to investigate the association between adherence to the MD and both sleep quality and QoL in children aged 7 to 12 years diagnosed with asthma. This cross-sectional study assessed dietary intake, sleep disturbances, and QoL using validated measurement tools. We hypothesized that higher adherence to the Mediterranean Diet would be associated with better sleep quality and improved quality of life in children with asthma.

MATERIALS and METHODS

Study design and participants

This cross-sectional study was conducted between January 1 and March 31, 2023, at Prof. Dr. Cemil Taşcıoğlu City Hospital, İstanbul, Türkiye. The study population consisted of children aged 7–12 years with physician-diagnosed asthma, evaluated according to the Global Initiative for Asthma (GINA) guidelines.[14] Asthma status was evaluated at enrollment by the treating physician as part of routine clinical follow-up. Only children with well-controlled asthma receiving low-dose controller therapy were included, whereas those with partly controlled or uncontrolled asthma or requiring higher treatment steps were not included. Eligibility was based on clinical assessment consistent with GINA symptom control, including the absence of asthma-related nocturnal awakenings at enrollment. This approach is consistent with asthma managed at low treatment steps according to the GINA framework. Participants continued their prescribed asthma treatments in accordance with routine clinical practice, and no intervention or modification of medication use was undertaken as part of the study. Children with other chronic diseases or previously diagnosed psychiatric disorders were excluded. Eligible participants were recruited consecutively from children attending the Pediatric Allergy and Immunology outpatient clinic during the study period. A total of 96 children were assessed for eligibility. Nineteen children were excluded (did not meet the inclusion criteria, n=14; did not complete the study procedures, n=5), and the remaining 77 children were included in the final analysis.

Ethics approval was obtained from the Non-Interventional Scientific Research Ethics Committee of İstanbul Atlas University, and written informed consent was obtained from the legal guardians of all participants.

Data collection

Data were collected using a structured 26-item questionnaire covering sociodemographic characteristics, dietary habits, and physical activity. Anthropometric measurements (weight, height) were obtained by trained personnel using standardized procedures. Body Mass Index (BMI) was calculated using the WHO 2007 growth references for children aged 5–19 years.[15]

Measurement tools

Mediterranean diet quality index (KIDMED)

Adherence to the Mediterranean diet was assessed using the KIDMED index, a 16-item questionnaire developed by Serra-Majem et al.[16] The Turkish version was adapted and validated by Akar Şahingöz et al.[17] Scores range from 0 to 12, with ≥8 indicating high adherence, 4–7 moderate adherence, and ≤3 low adherence.

Sleep disturbance scale for children (SDSC)

Sleep quality was assessed using the SDSC, developed by Bruni et al.[18], which consists of 26 items across six subscales. The Turkish validation was performed by Ağca et al.[19] Each item is scored on a 5-point Likert scale; higher scores indicate greater sleep disturbances.

Pediatric asthma quality of life questionnaire (PAQLQ)

Quality of life was assessed using the PAQLQ, developed by Juniper et al.[20] and validated in Turkish by Bozkurt and Yıldız.[21] The scale consists of 23 items across three domains: Activity Limitations, Symptoms, and Emotional Function. Each item is scored on a 7-point scale, with higher scores indicating better quality of life.

Dietary intake assessment

Three-day dietary intake records (including one weekend and two weekdays) were obtained from each participant and analyzed using the Nutrition Information System (BeBiS) software.[22] Participants and their parents received standardized and structured training on how to complete the three-day dietary records, and written instructional materials were provided. To support accurate portion size estimation, the Food and Meal Photograph Catalogue: Measures and Portions developed by Rakıcıoğlu et al. was used as a visual reference during the completion and verification of the dietary records.[23] After completion of the dietary records, telephone interviews were conducted to assess and verify the accuracy of the recorded information. Daily energy and nutrient intake were evaluated and compared with reference values from the Turkish Nutrition Guideline (TÜBER) and the Dietary Reference Intakes (DRI).[24,25]

Statistical analysis

Descriptive statistics were expressed as mean±standard deviation (SD) for continuous variables and as frequency (%) for categorical variables. The Shapiro–Wilk test was used to assess normality. Independent samples t-test and chi-square test were used for group comparisons. Pearson correlation coefficients were calculated to examine relationships among KIDMED, SDSC, and PAQLQ scores. Indirect and total effects were estimated using bias-corrected bootstrap procedures to assess the association between dietary quality, sleep disturbances, and quality of life. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY). A two-sided p value <0.05 was considered statistically significant.

RESULTS

A total of 96 children were assessed for eligibility, and 77 children were included in the final analysis. Of the participants, 20 (26.0%) were girls and 57 (74.0%) were boys, with ages ranging from 7 to 12 years. According to body mass index classification, approximately half of the children were of normal weight, while a smaller proportion were classified as overweight or obese. The baseline demographic and clinical characteristics of the study population are presented in Table 1.

Dietary habits according to sex are summarized in Table 2. As shown in Table 2, meal skipping was common among both boys and girls, with breakfast being the most frequently skipped meal. Snack consumption was predominantly based on fruits and fruit juices in both sexes, whereas dairy-based snacks were less commonly consumed. When eating outside the home, fast food consumption was more frequent than homemade food consumption among both boys and girls.

The distribution of Mediterranean Diet adherence categories by sex is presented in Table 3. Overall, most participants demonstrated moderate adherence to the Mediterranean diet, and no statistically significant differences were observed between boys and girls in the distribution of KIDMED categories ($p > 0.05$).

Comparisons of the mean KIDMED, SDSC, and PAQLQ scores between genders are shown in Table 4. The mean KIDMED score was 5.49±2.84 for boys and 5.70±2.39 for girls. The mean SDSC total score was 40.49±9.13 for boys and 39.75±6.73 for girls. There were no statistically significant differences between genders in the mean total or subdimension scores of the KIDMED, SDSC, and PAQLQ scales ($p>0.05$).

Table 1. Baseline characteristics of the study population

	Boys (n=57)		Girls (n=20)		Total (n=77)	
	n	%	n	%	n	%
Age (years)						
7	24	42.10	9	45.00	33	42.90
8	11	19.30	2	10.00	13	16.90
9	5	8.80	2	10.00	7	9.10
10	7	12.30	1	5.00	8	10.40
BMI classification						
Underweight	10	17.50	4	20.00	14	18.20
Normal weight	28	49.10	13	65.00	41	53.20
Overweight	9	15.80	2	10.00	11	14.30
Obese	10	17.50	1	5.00	11	14.30
Gestational age						
≤37 weeks	10	17.50	3	15.00	13	16.90
≥38 weeks	47	82.50	17	85.00	64	83.10
Mode of delivery						
Vaginal	29	50.90	8	40.00	37	48.10
Cesarean section	28	49.10	12	60.00	40	51.90
Breastfeeding duration						
≤6 months	12	21.10	4	20.00	16	20.80
7–12 months	8	14.00	2	10.00	10	13.00
13–24 months	31	54.40	9	45.00	40	51.90
>24 months	6	10.50	5	25.00	11	14.30
Formula feeding in first year						
Yes	26	45.60	7	35.00	33	42.90
No	31	54.40	13	65.00	44	57.10
Food allergy						
Yes	4	7.00	1	5.00	5	6.50
No	53	93.00	19	95.00	72	93.50

BMI: Body Mass Index.

Correlations between the KIDMED, SDSC, and PAQLQ scores are presented in Table 5. Weak negative correlations were found between the total KIDMED score and both DOA (r=-0.283, p<0.05) and the total SDSC score (r=-0.241, p<0.05). SRBD scores were negatively correlated with total PAQLQ scores (r=-0.395, p<0.01), as well as the PAQLQ subscales of Symptoms (r=-0.255, p<0.05) and Emotional Function (r=-0.434, p<0.01). A weak negative correlation was observed between DOES scores from the SDSC and the Activity scores from the PAQLQ (r=-0.250, p<0.05). HSD scores from the SDSC showed negative correlations with both PAQLQ

Table 2. Distribution of dietary habits by gender

	Boys (n=57)		Girls (n=20)		Total (n=77)	
Dietary habits	n	%	n	%	n	%
Number of meals consumed daily						
2	4	7.00	0	0.00	4	5.20
3	9	15.80	9	45.00	18	23.40
4	28	49.10	7	35.00	35	45.50
≥5	16	28.10	4	20.00	20	26.00
Skipping daily meals						
Yes	19	33.30	7	35.00	26	33.80
No	38	66.70	13	65.00	51	66.20
Most frequently skipped meal						
Breakfast	9	47.40	3	42.90	12	15.60
Lunch	9	47.40	3	42.90	12	15.60
Dinner	1	5.30	1	14.30	2	2.60
Reason for skipping meals						
Waking up late in the morning	2	10.50	1	14.30	3	3.90
Coming home late from school	0	0.00	0	0.00	0	0.00
Insufficient time	1	5.30	2	28.60	3	3.90
Reluctance to eat	16	84.20	4	57.10	20	26.00
Nausea	1	5.30	0	0.00	1	1.30
Choices of snacks						
No snacks consumption	3	5.30	0	0.00	3	3.90
Grain-based foods	18	31.60	10	50.00	28	36.40
Packaged snacks	23	40.40	6	30.00	29	37.70
Dairy products	16	28.10	3	15.00	19	24.70
Fruits and fruit juices	35	61.40	16	80.00	51	66.20
Choices of meals outside home						
Fast food	38	66.70	12	60.00	50	64.90
Homemade food	19	33.30	8	40.00	27	35.10

Multiple responses were allowed for snack choices.

Table 3. KIDMED adherence categories by gender

	Boys, n (%)	Girls, n (%)	Chi-square	p
Low	14 (24.6)	5 (25)	0.013	0.993
Moderate	28 (49.1)	10 (50)		
High	15 (26.3)	5 (25)		

Chi-square test; KIDMED: Mediterranean Diet Quality Index; *significance at p<0.05.

Table 4. Mean KIDMED, SDSC, and PAQLQ scores by gender

	Boys (n=57)	Girls (n=20)	t	p
Scales	**Mean±SD**	**Mean±SD**		
KIDMED				
Total KIDMED	5.49±2.84	5.7±2.39	-0.294	0.770
SDSC				
DIMS	11.07±4.39	12.35±4.13	-1.139	0.258
SRBD	5.4±1.91	4.65±1.87	1.527	0.131
DOA	3.47±1.66	3.2±0.52	0.722	0.472
SWTD	8.95±3	8.95±2.72	-0.003	0.997
DOES	7.49±3.27	7.2±2.61	0.360	0.720
HSD	4.11±2.6	3.4±2.41	1.061	0.292
Total SDSC	40.49±9.13	39.75±6.73	0.332	0.741
PAQLQ				
Activity	31.05±5.04	31.5±4.32	-0.353	0.725
Symptoms	60.98±8.25	61.7±7.43	-0.343	0.732
Emotional Function	52.77±4.77	53.6±2.91	-0.729	0.468
Total PAQLQ	144.81±15.08	146.8±11.09	-0.541	0.590

Independent two-sample t-test; SD: standard deviation; KIDMED: Mediterranean Diet Quality Index; SDSC: Sleep Disturbance Scale for Children; DIMS: Disorders of Initiating and Maintaining Sleep; SRBD: Sleep-Related Breathing Disorders; DOA: Disorders of Arousal; SWTD: Sleep-Wake Transition Disorders; DOES: Disorders of Excessive Somnolence; HSD: Hyperhidrosis in Sleep Disorders; PAQLQ: Pediatric Asthma Quality of Life Questionnaire; *significance at p<0.05.

Symptoms (r=-0.276, p<0.05) and total PAQLQ scores (r=-0.232, p<0.05). Additionally, total SDSC scores correlated negatively with all PAQLQ subscales—Activity (r=-0.240, p<0.05), Symptoms (r=-0.296, p<0.01), and Emotional Function (r=-0.344, p<0.01)—as well as with total PAQLQ scores (r=-0.356, p<0.01).

Correlations between BMI and KIDMED, SDSC, and PAQLQ scores are presented in Table S. No statistically significant correlations were observed between BMI and any of these variables (all p > 0.05). Nutrient correlations with the KIDMED and SDSC scores are summarized in Table 6. The total KIDMED score was positively correlated with fat (g), fat (%), carotene, and calcium intake, and negatively correlated with carbohydrate intake (all p<0.05). The total SDSC score showed a negative correlation with calcium intake (p<0.05). No statistically significant correlations were found between total PAQLQ scores and nutrient intake (p>0.05).

The indirect and total effects are summarized in Table 7. As shown in Table 7, a one-unit increase in the KIDMED score was significantly associated with a decrease of 0.758 units in the SDSC score (β = −0.758, 95% CI: −1.406 to −0.017). In addition, higher SDSC scores were significantly associated with lower PAQLQ scores (β = −0.660, 95% CI: −0.991 to −0.258).

DISCUSSION

The present cross-sectional study, conducted among children aged 7–12 years with physician-diagnosed, well-controlled asthma receiving low-dose controller therapy, examined the associations between adherence to the Mediterranean diet (MD), sleep disturbances, and quality of life (QoL). Our findings showed that higher adherence to the MD was associated with fewer sleep disorder symptoms, while sleep disturbances were inversely related to QoL. No direct relationship was observed between MD adherence and overall QoL, suggesting that additional factors may influence this association in pediatric asthma.

In Türkiye, the prevalence of pediatric asthma among children aged 5–18 years is estimated at 7.4%, affecting nearly one in ten children.[26,27] Boys are more likely to develop asthma in preadolescence[28], and our study was consistent with this pattern. Similar trends have been reported in Finland, where asthma incidence rises from age 10 and is more common among boys.[29] The PIAMA study also demonstrated higher rates in boys compared with girls.[30] These differences may be linked to hormonal, genetic, and socioeconomic factors.

Table 5. Correlations between KIDMED, SDSC, and PAQLQ scores

	KIDMED-Total	SDSC-DIMS	SDSC-SRBD	SDSC-DOA	SDSC-SWTD	SDSC-DOES	SDSC-HSD	SDSC-Total	PAQLQ-Activity	PAQLQ-Symptoms	PAQLQ-Emotional Function	PAQLQ-Total
KIDMED-Total	1.000	-0.201	0.011	-0.283*	-0.128	-0.131	-0.009	-0.241*	0.056	-0.157	-0.042	-0.083
SDSC-DIMS	-0.201	1.000	0.012	-0.003	0.104	0.348**	0.004	0.673**	-0.117	-0.006	-0.211	-0.109
SDSC-SRBD	0.011	0.012	1.000	0.097	0.113	0.023	0.288*	0.380**	-0.202	-0.434**	-0.255*	-0.395**
SDSC-DOA	-0.283*	-0.003	0.097	1.000	0.151	0.179	0.051	0.322**	0.046	0.001	-0.018	0.011
SDSC-SWTD	-0.128	0.104	0.113	0.151	1.000	0.120	0.079	0.512**	-0.135	-0.210	-0.124	-0.204
SDSC-DOES	-0.131	0.348**	0.023	0.179	0.120	1.000	-0.001	0.616**	-0.250*	-0.113	-0.189	-0.208
SDSC-HSD	-0.009	0.004	0.288*	0.051	0.079	-0.001	1.000	0.402**	-0.022	-0.276*	-0.220	-0.232*
SDSC-Total	-0.241*	0.673**	0.380**	0.322**	0.512**	0.616**	0.402**	1.000	-0.240*	-0.296**	-0.344**	-0.356**
PAQLQ-Activity	0.056	-0.117	-0.202	0.046	-0.135	-0.250*	-0.022	-0.240*	1.000	0.484**	0.409**	0.744**
PAQLQ-Symptoms	-0.157	-0.006	-0.434**	0.001	-0.210	-0.113	-0.276*	-0.296**	0.484**	1.000	0.542**	0.901**
PAQLQ-Emotional Function	-0.042	-0.211	-0.255*	-0.018	-0.124	-0.189	-0.220	-0.344**	0.409**	0.542**	1.000	0.757**
PAQLQ-Total	-0.083	-0.109	-0.395**	0.011	-0.204	-0.208	-0.232*	-0.356**	0.744**	0.901**	0.757**	1.000

Pearson correlation analysis; KIDMED: Mediterranean Diet Quality Index; SDSC: Sleep Disturbance Scale for Children; DIMS: Disorders of Initiating and Maintaining Sleep; SRBD: Sleep-Related Breathing Disorders; DOA: Disorders of Arousal; SWTD: Sleep-Wake Transition Disorders; DOES: Disorders of Excessive Somnolence; HSD: Hyperhidrosis in Sleep Disorders; PAQLQ: Pediatric Asthma Quality of Life Questionnaire; * significance at: $p<0.05$; **: $p<0.01$.

Table 6. Correlations between dietary intake and questionnaire scores

	KIDMED-Total	SDSC-Total	PAQLQ-Total
Energy (kcal)	0.029	-0.132	0.066
Protein (g)	-0.088	-0.112	0.118
Protein (%)	-0.156	0.051	0.085
Fat (g)	0.298**	-0.125	-0.016
Fat (%)	0.423**	-0.030	-0.167
Carbohydrates (g)	-0.125	-0.107	0.092
Carbohydrates (%)	-0.333**	-0.008	0.115
Fiber (g)	0.087	-0.059	0.011
Polyunsaturated fat (g)	0.170	0.028	-0.011
Cholesterol (mg)	0.059	-0.011	0.021
Vitamin A (µg)	0.089	0.103	-0.060
Carotene (mg)	0.288*	-0.111	-0.101
Vitamin E (eq.) (mg)	0.141	-0.006	-0.072
Vitamin B1 (mg)	0.129	0.022	0.023
Vitamin B2 (mg)	0.214	-0.073	-0.018
Vitamin B6 (mg)	0.109	0.079	-0.047
Folate, total (µg)	0.159	0.050	-0.064
Vitamin C (mg)	0.156	0.055	-0.050
Sodium (mg)	0.046	0.008	0.031
Potassium (mg)	0.118	-0.070	0.003
Calcium (mg)	0.244*	-0.288*	-0.002
Magnesium (mg)	0.115	-0.076	0.051
Phosphorus (mg)	0.108	-0.184	0.089
Iron (mg)	0.096	0.026	0.010
Zinc (mg)	0.092	-0.170	0.120

Pearson correlation analysis; KIDMED: Mediterranean Diet Quality Index; SDSC: Sleep Disturbance Scale for Children; PAQLQ: Pediatric Asthma Quality of Life Questionnaire; * significance at: p<0.05; **: p<0.01.

Table 7. Indirect and total effects based on bootstrap estimates

				95% C.I.				
Type	**Effect**	**Estimate**	**SE**	**Lower**	**Upper**	**β**	**z**	**p**
Indirect	KIDMED ⇒ SDSC ⇒ PAQLQ	0.501	0.266	0.055	1.261	0.096	1.881	0.060
Component	KIDMED ⇒ SDSC	-0.758	0.348	-1.406	-0.017	-0.241	-2.182	0.029
	SDSC ⇒ PAQLQ	-0.660	0.178	-0.991	-0.258	-0.400	-3.707	<.001
Direct	KIDMED ⇒ PAQLQ	-0.930	0.560	-1.993	0.418	-0.179	-1.661	0.097
Total	KIDMED ⇒ PAQLQ	-0.429	0.594	-1.436	0.988	-0.083	-0.722	0.470

Bias-corrected bootstrap analysis; KIDMED: Mediterranean Diet Quality Index for children and adolescents; SDSC: Sleep Disturbance Scale for Children; PAQLQ: Pediatric Asthma Quality of Life Questionnaire; CI: confidence interval.

The MD is characterized by a high intake of vegetables, legumes, fruits, cereals, nuts, and olive oil, with moderate

consumption of fish and dairy, and limited intake of red meat.[31] Although MD adherence is generally associated with better health outcomes, several studies indicate that children in Mediterranean countries increasingly adopt Western dietary habits, resulting in suboptimal adherence.[32-34] A previous study found that each one-point increase in the KIDMED score was associated with reduced asthma symptoms.[35] In contrast, our results did not demonstrate a significant relationship between MD adherence and QoL, which may be explained by the sample size, disease severity, or other unmeasured environmental factors.

Asthma is well known to negatively impact QoL.[36-38] Case-control studies have reported significantly lower QoL in children with asthma compared with healthy peers.[39] While some studies and meta-analyses have shown a positive association between MD adherence and QoL[40], we did not observe such a correlation in our study population. This discrepancy may be due to the inclusion of only mild-to-moderate asthma cases and the potential influence of social and environmental factors.

In addition to the established links between dietary patterns and quality of life, evidence in the literature indicates an association between dietary habits and sleep quality.[41-43] Notably, a large population-based study reported that higher adherence to the Mediterranean diet was associated with better sleep duration and fewer sleep-related problems, supporting a potential role of diet quality in sleep regulation.[44] Consistent with these observations, our study found that children with higher scores on the SDSC awakening disorders subscale had lower adherence to the Mediterranean diet, indicating a potential relationship between overall diet quality and sleep disturbances. When other factors commonly discussed in relation to sleep disturbances are considered, obesity and body mass index (BMI) have been reported to be associated with obstructive sleep apnea and sleep fragmentation in children.[45] However, in the present study, no statistically significant association was observed between BMI and sleep disturbance scores. This finding may be related to the characteristics of the study sample and the limited number of obese participants; the use of a general approach to the assessment of sleep disturbances may also have influenced the observed results.

Beyond overall dietary patterns, specific nutrients may also be related to sleep-related outcomes. In our study, calcium intake was positively associated with better sleep outcomes, consistent with existing literature. Observational evidence indicates that higher dietary calcium intake is associated with fewer sleep-related difficulties, including shorter sleep latency and improved sleep maintenance, while lower serum calcium levels have been linked to disrupted sleep–wake regulation and altered rest–activity rhythms, even within the normal reference range.[46,47] Calcium may influence sleep through its role in sleep–wake regulatory and neuroendocrine pathways implicated in sleep quality.

In addition, the positive association observed between fat intake and adherence to the Mediterranean diet in our study suggests that fat quality, rather than quantity alone, may be relevant to sleep-related outcomes. Omega-3 long-chain polyunsaturated fatty acids, which constitute a key component of the Mediterranean diet, have been reported to be associated with sleep quality and sleep efficiency. Given the anti-inflammatory properties of omega-3 fatty acids and the bidirectional relationship between inflammation and sleep regulation, these mechanisms may contribute to sleep-related outcomes.[48,49] In this context, the observed associations between fat intake and Mediterranean diet adherence in our study may reflect a potential link between dietary fat quality and sleep regulation; however, further studies are warranted to clarify these relationships.

Children with asthma often experience sleep-related anxiety[50], which has been linked to lower QoL.[51] In a study of 160 children with asthma, poor asthma control was associated with daytime sleepiness and impaired asthma-related QoL.[52] Our study found a weak but significant negative correlation between DOES scores and PAQLQ activity scores, suggesting that the absence of sleep disturbances may support better daily functioning. Previous studies have also shown that fewer sleep disturbances are associated with higher QoL and improved school performance.[53-55] Conversely, higher MD adherence has been linked to better sleep quality.[56] Our findings similarly suggest that MD adherence may play a role in reducing sleep disturbances, which in turn may positively influence QoL in children with asthma. To improve the clinical interpretability of our findings, the magnitude of the associations derived from the bootstrap-based analyses was summarized in the text. Accordingly, a one-unit increase in the KIDMED score was significantly associated with an average decrease of 0.758 units in the SDSC score. In addition, a one-unit increase in the SDSC score was associated with an average decrease of 0.660 units in the PAQLQ score. These estimates quantify the strength of the observed associations, suggesting that even modest improvements in adherence to the Mediterranean diet may be associated with measurable reductions in sleep disturbance burden, which in turn may

be related to improvements in asthma-related quality-of-life scores.

In conclusion, this cross-sectional study indicates that children with asthma generally exhibit moderate adherence to the Mediterranean diet and that greater adherence is associated with fewer sleep disturbance symptoms. Although no direct association was observed between Mediterranean diet adherence and overall quality of life, the findings suggest that dietary patterns may influence quality of life indirectly through their effects on sleep. These results underscore the potential role of the Mediterranean diet as part of a holistic approach to managing sleep-related problems in pediatric asthma. Further longitudinal and interventional studies are needed to confirm these relationships and to better define their clinical implications.

Study limitations

This study has several limitations that should be considered when interpreting the findings. The cross-sectional design does not allow causal conclusions regarding the associations between Mediterranean diet adherence, sleep disturbances, and quality of life. Although the study population consisted of children with well-controlled asthma, asthma control was not analyzed as a separate variable, which limits the assessment of potential differences across varying control levels. In addition, the potential effects of asthma medications on sleep outcomes were not examined, and other factors that may influence both dietary habits and sleep quality in children, including passive smoking exposure and socioeconomic status, were beyond the scope of this study. Moreover, unmeasured comorbidities—such as allergic rhinitis, suspected obstructive sleep apnea/adenoid hypertrophy, and obesity-related influences—may also have affected sleep outcomes. Despite the measures taken to improve data accuracy, dietary intake assessment may still be subject to recall-related limitations. Finally, as the study was conducted at a single center, the generalizability of the findings may be limited.

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Author contributions

Conception and design: M.G.T., H.Y.Ö.; Data acquisition: M.G.T., F.D., D.Ö.; Data analysis: M.G.T., H.Y.Ö.; Data interpretation: M.G.T., H.Y.Ö.; Drafting of the manuscript: M.G.T., H.Y.Ö.; Critical revision of the manuscript: H.Y.Ö., F.D., D.Ö. All authors reviewed the results, approved the final version of the manuscript, and agreed to be accountable for all aspects of this study.

Ethical approval

This study was approved by the Non-Interventional Scientific Research Ethics Committee of Istanbul Atlas University (Date: 15.06.2022, Decision/Protocol No: E-22686390-050.99-10853). Informed consent was obtained from all participants involved in this study.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that this study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Generative AI statement

The authors declare that during the preparation of this study, the following AI-assisted technology was used: Generative AI. Extent of Use: Generative AI was used only for grammar editing. The authors confirm that they have critically reviewed and edited any AI-generated content and take full responsibility for the integrity, accuracy, and originality of the publication. The authors certify that the original human contribution is maintained and that AI-assisted tools are not listed or cited as authors.

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