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Differences in sleep quality and body mass index in asthmatic children and healthy control group

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Abstract
Introduction: Childhood asthma has become a serious public health problem. Obesity has been determined to be one of the risk factors of asthma.
Aim: We aimed to determine the difference in body mass index (BMI) and sleep quality in pediatric asthmatic individuals compared to their peers.
Method: Thirty children aged 8–17 years were followed up in the Pediatric Outpatient Clinic for asthma along with 30 healthy children. The BMI percentile values of the children were recorded. The Pittsburgh Sleep Quality Index was used to assess sleep quality.
Results: Each group in our study had 10 girls and 20 boys. The mean age was found to be 11.76 ± 2.69 years in asthma group and 11.33 ± 2.29 years in the healthy group. The asthma group were found to be more obese than the healthy group (P = 0.033). There was a significant difference between groups interested in a sport (P = 0.028) and sleep quality (P = 0.007).
Conclusion: It was observed that the asthma group had more obesity and poorer sleep quality than the healthy group. Further, it was determined that in the asthma group, the level of interest in any sport was less than that in the healthy group. We think that high obesity in the asthma group reduces the effect of corticosteroids, and the continuity of nighttime cough symptoms causes deterioration in sleep quality. We conclude that participation in sports activities should be encouraged to reduce the level of obesity in asthmatic children.
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Introduction

Allergic diseases and obesity in children have increased significantly in recent years.[1] Asthma is one of the most common diseases in children and is a serious public health problem worldwide.[2] Since the precise cause of the disease is not known, studies are required on immunological, genetic, environmental, and pharmacological factors.[3] Lifestyle differences, malnutrition, infections, allergies, exposure to cigarette smoke, socioeconomic level, rural and metropolitan life, and obesity are important risk factors for asthma.[4]

Asthma is a chronic inflammatory disease.[4] Obesity is associated with a low-intensity chronic inflammatory process known as metabolic inflammation using adipokines.[5] Obesity increases the possibility of developing asthma by affecting the airway functions of leptin mediators.[4] Obesity also obstructs the upper respiratory tract more easily by reducing lung capacity.[6] Obesity has been proven to affect the progression of asthma.[7] Conditions such as obesity and asthma are important in pediatric primary care because of their increasing comorbidity.[8]

The clinical symptoms of asthma are wheezing, shortness of breath, cough, and pain.[9] Asthma can affect sleep time and sleep quality in children. The presence of nighttime symptoms adversely affects sleep quality in asthmatic children. Children with frequent asthma symptoms reported more daytime fatigue/sleepiness than those with less frequent or no symptoms at all.[10] In patients with chronic allergic diseases, such as asthma, rhinitis, and atopic dermatitis, sleep disturbances can increase the severity of the condition, complicate treatment prescribed by doctor, and negatively affect the quality of life and mood.[11]

The perception of shortness of breath in asthmatic children reduces their participation in both physical and sports activities, and they are prevented from participating in sports activities, by both their families and teachers, because of the fear of having attack of asthma.[12] That's why asthmatic children lead a more sedentary life than their peers.[13] In this case, it leads to an increase in obesity.[14]

In our study, we aimed to determine difference between body mass index (BMI) and sleep quality in individuals with pediatric asthma compared to their peers.

Method

The study included 30 asthmatic children who were followed up in the Pediatric Health and Diseases Outpatient Clinic and 30 healthy non-asthmatic children similar in age and gender admitted to the hospital for general check-up. Children aged 8–17 years, who were diagnosed with asthma according to physical examination, laboratory findings, and clinical findings, and those who did not have respiratory problems and whose general health status was found to be good after the examination, were included in the study. Children with cardiovascular, orthopedic, or neurological problems; with mental retardation; unable to cooperate; or with physical disabilities were excluded from the study. Based on the anamnesis information received in the application, the number of individuals living in the family, number of children in the family, health insurance, place of residence, smoking exposure, heating process of the house, presence of dampness at living place, eating habits, number of meals per day, fast food nutritional status, sports activities, drugs used, and allergic condition were recorded. The BMI percentile values and respiratory function test results of the children were also recorded. The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality.

Body Weight Percentile Value

There are age- and gender-specific charts in the pediatric age group. In our study, a growth chart specific to our country was preferred. We used the reference and percentage values for Turkish children accepted by Neyzi et al.[15] Patients whose BMI value for age was above the 95th percentile were considered "obese,". It is reported that children and adolescents are between 85 and 95 percentiles defined as overweight, and higher than 95 percentile defined as obese.

Respiratory Function Test

Respiratory function was tested with a portable spirometer (MiniSpir) according to the criteria of American Thoracic Society (ATS) and European Respiratory Society (ERS).[16] The patients were asked whether they had used any bronchodilator at least 8–12 h prior to the test. The respiratory function of the patients was tested with the ERS/Knudson program. While in the sitting position, the patient was first asked to breathe deeply and then quickly exhale through the spirometer. Nose clips were used during exhalation. Forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1), FEV_1/FVC, and 25–75% of FVC ($FEF_{25-75\%}$) were recorded. Pulmonary function test parameters were expressed as a percentage of the expected values according to age, height, body weight, and gender.

Pittsburgh Sleep Quality Scale

The PSQI was used to measure sleep quality. The Turkish validity and reliability of the questionnaire was developed by Ağargün et al.[17] There were 24 questions evaluating sleep quality and disorder over the past month. The total score ranged from 0 to 21, and a score of above 5 indicated poor sleep quality.

Statistical Analysis

The research data were evaluated using the SPSS 22.0 (SPSS, Chicago, IL, USA) computer program. Frequency distribution, arithmetic mean, and standard deviation (SD) values were recorded in the evaluation of demographic and clinical characteristics. Differences between groups with numerical and normal distributions were analyzed by independent samples T-test and One-Way ANOVA. Nonnumerical data analyzed by Chi-square test (Yates's correction for

continuity was done). The approval for the study was obtained from the Hatay Mustafa Kemal University Ethics Committee. The purpose of the study was explained to all the patients and their families, and their consent was obtained prior to participation in the study.

Results

There were 10 girls (33.3%) and 20 boys (66.7%) in each of the two groups in our study. The average age of the children in the asthmatic group was 11.76 ± 2.69 years and the average age of the healthy group was 11.33 ± 2.29 years. The asthmatic group comprised 22 (73.3%) patients with allergic asthma and 8 (26.7%) were having nonallergic asthma. The average body weight and height of asthmatic children were 48.43 ± 14.88 kg and 151.56 ± 13.84 cm, respectively, while the average body weight and height of healthy children were 40.26 ± 13.68 kg and 147.13 ± 13.17 cm, respectively. There was significant difference between the BMI of both groups (P = 0.013) (Table 1).

The FVC% and FEV_1% values of asthmatic children were 88.53 ± 16.62 and 86.06 ± 17.18, respectively, while the FVC% and FEV_1% values of healthy children were 98.63 ± 11.90 and 95.90 ± 13.32, respectively. There were significant differences between the FVC% (P = 0.009) and FEV_1% values (P =0.016) of both groups. It was found that there was no significant difference between the groups regarding FEV_1/FVC% values. Restrictive breathing with obstruction was detected in asthmatic children (Table 2).

In the asthmatic group, 73.3% of the children were considered allergic, while 26.7% were considered nonallergic. In the asthmatic group, the following proportion of drugs were used: 20% salbutamol, 10% montelukast, 3.3% fluticasone propionate, 30% salbutamol + montelukast, 3.3% salbutamol + fluticasone propionate, 13.3% salbutamol + montelukast + fluticasone propionate, 13.3% salbutamol + budesonide, and 6.7% salbutamol + montelukast + budesonide. It was determined that age at the time of diagnosis of children in the asthmatic group was 7.11 ± 4.31 years (Table 3).

In our study, according to BMI percentile values of the asthmatic and healthy groups, it was determined that asthmatic children were more obese than the healthy group (P = 0.033). In all, 40% children in the asthmatic group and 10% children in the healthy group had poor sleep quality. There was a significant difference between the groups in terms of sleep quality (P = 0.007) (Table 4).

Significant differences were found in PSQI (total), sleep duration, sleep disturbances values between the groups (P < 0.05) (Table 5).

We found that according to the BMI of asthma group, there was no difference in PSQI parameters (P > 0.05)

Table 1 Demographic information of the participants.

	Asthma group X ± Std	Healthy group X ± Std	T	P
Age (years)	11.76 ± 2.69	11.33 ± 2.29	0.670	0.506
Weight (kg)	48.43 ± 14.88	40.26 ± 13.68	2.212	**0.031**
Height (cm)	151.56 ± 13.84	147.13 ± 13.17	1.271	0.209
BMI (kg/m^2)	20.68 ± 4.40	18.06 ± 3.47	2.554	**0.013**

Independent samples T-test P < 0.05.
X±Std: mean±Standard deviation

Table 2 Investigation of differences in respiratory function test results between the groups.

	Asthma group X ± Std	Healthy group X ± Std	T	P
FVC (L)	2.95 ± 0.78	2.70 ± 0.69	1.293	0.201
FVC (%)	88.53 ± 16.62	98.63 ± 11.90	−2.705	**0.009**
FEV_1 (L)	2.56 ± 0.67	2.34 ± 0.59	1.290	0.202
FEV_1 (%)	86.06 ± 17.18	95.90 ± 13.32	−2.477	**0.016**
FEV_1/FVC (L)	88.57 ± 1.82	89.45 ± 1.55	−2.003	0.050
FEV_1/FVC (%)	96.12 ± 11.33	96.10 ± 9.33	0.009	0.993
FEF_{25-75} (L)	2.94 ± 0.72	2.75 ± 0.61	1.098	0.277
FEF_{25-75} (%)	85.26 ± 24.01	90.03 ± 19.94	−0.836	0.406

Independent Samples T-test P < 0.05.
FVC: forced vital capacity
FEV_1: Volume that has been exhaled at the end of the first second of forced expiration
FEF_{25}:Forced expiratory flow
X±Std: mean±Standard deviation

Table 3 Asthma type, classification of asthma control, medication used, and age at diagnosis in asthma group.

		Asthma group	
		N	%
Allergic/nonallergic		22/8	73.3/26.7
Classification of asthma control (well-controlled/not well-controlled/very poorly controlled)		7/20/3	23.3/66.7/10
Drug used	Salbutamol	6	20
	Montelukast	3	10
	Flixiotide	1	3.3
	Salbutamol + montelukast	9	30
	Salbutamol + fluticasone propionate	1	3.3
	Salbutamol + montelukast + fluticasone propionate	4	13.3
	Salbutamol + budesonide	4	13.3
	Salbutamol + montelukast + budesonide	2	6.7
Age at diagnosis (year)		Asthma group X ± Std	
		7.11 ± 4.31	

X±Std: mean±Standard deviation

Table 4 Investigation of differences between BMI percentile values and sleep quality in groups.

BMI percentile	Asthma group		Healthy group		T	P
	N	%	N	%		
Poor (<5 percentile)	2	6.7	4	13.3	2.178	**0.033**
Ideal (5–85 percentile)	19	63.3	21	70.0		
Overweight (85–95 percentile)	2	6.7	5	16.7		
Obese (≥95 percentile)	7	23.3	0	0		
PSQI	N	%	N	%	T	P
Good sleep quality	18	60	27	90	2.812	**0.007**
Poor sleep quality	12	40	3	10		

BMI: body mass index; PSQI: Pittsburgh sleep quality index.
Independent samples T-test, P < 0.05.

Table 5 Investigation of differences in the sleep quality parameters of groups.

	Asthma group X ± Std	Healthy group X ± Std	T	P
PSQI (total)	4.26 ± 2.39	2.50 ± 1.40	**3.487**	**0.001**
Subjective sleep quality	0.83 ± 0.59	0.63 ± 0.49	1.425	0.159
Sleep latency	1.00 ± 1.20	0.53 ± 0.73	1.816	0.075
Sleep duration	0.26 ± 0.58	0.03 ± 0.18	**2.091**	**0.041**
Habitual sleep efficiency	0.06 ± 0.25	0.03 ± 0.18	0.584	0.561
Sleep disturbances	1.40 ± 0.72	0.93 ± 0.52	**2.866**	**0.006**
Use of sleep medication	0.06 ± 0.36	0.00 ± 0.00	1.000	0.321
Daytime dysfunction	0.66 ± 0.36	0.00 ± 0.00	1.703	0.094

PSQI: Pittsburgh sleep quality index.
Independent samples T-test P < 0.05.
X±Std: mean±Standard deviation

Table 6 Differrences between BMI and PSQI in asthma and healthy groups.

	BMI			
	Asthma group		Healthy group	
	F	P	F	P
PSQI (Total)	0.950	0.431	0.132	0.877
Subjective sleep quality	0.400	0.754	2.206	0.130
Sleep latency	0.135	0.938	0.109	0.897
Sleep duration	0.919	0.446	0.203	0.818
Habitual sleep efficiency	0.374	0.773	0.203	0.818
Sleep disturbances	1.734	0.185	0.099	0.906
Use of sleep medication	8.089	**0.001**	-	-
Daytime dysfunction	1.963	0.144	0.054	0.948

BMI: body mass index; PSQI: Pittsburgh sleep quality index.
One way ANOVA test P < 0.05.

(Table 6). PSQI sleep disturbance parameters are related to night symptoms (P = 0.185).

We further found that there was no difference between classification of asthma control and sleep quality parameters (P > 0.05) (Table 7).

We evaluated a number of individuals and children in a family in both groups. There was no significant difference between the two groups (P > 0.05). It was found that asthmatic children had higher health insurance costs compared to children of healthy group (P = 0.028). There was no significant difference between the groups in terms of the place of residence, smoking exposure, heating process of the house, and presence of humidity in the house (P > 0.05) (Table 8).

In our study, no significant difference was found between the groups in terms of eating habits, number of meals per day, and fast food nutritional status (P > 0.05). It was observed that 53.3% of asthmatic children were interested in any sports activity, while 80% of children of healthy group were interested in a sports activity. There was a significant difference between the groups (P = 0.028) (Table 9).

When the sports activities of interest in both groups were examined, children in the asthmatic group reported the following proportion: 1 (3.3%) badminton, 2 (6.7%) basketball, 4 (13.3%) football, 3 (10%) handball, 2 (6.7%) gymnastics, 1 (3.3%) running, 1 (3.3%) archery, 1 (3.3%) taekwondo, and 1 (3.3%) swimming. On the other hand, children in the healthy group reported the following proportions: 1 (3.3%) cycling, 13 (43.3%) football, 1 (3.3%) wrestling, 1 (3.3%) handball, 1 (3.3%) karate, 1 (3.3%) kickboxing, 1 (3.3%) running, 3 (10%) volleyball, and 2 (6.7%) tennis (Figure 1).

Table 7 Diferrences between classification of asthma control and PSQI.

	Classification of Asthma Control (well-controlled/not well-controlled/very poorly controlled)	
	F	P
PSQI (Total)	1.466	0.249
Subjective sleep quality	0.926	0.408
Sleep latency	0.649	0.531
Sleep duration	1.523	0.236
Habitual sleep efficiency	0.500	0.612
Sleep disturbances	1.525	0.236
Use of sleep medication	0.237	0.791
Daytime dysfunction	1.046	0.365

PSQI: Pittsburgh sleep quality index.
One-way ANOVA Test P < 0.05.

Discussion

It was observed in our study that the asthma group had more obesity than the healthy group, and had poorer sleep quality. It was also determined that the level of interest of asthmatic children in any sports was less than that in the healthy group.

Childhood asthma is an inflammatory disease. Its exact cause is not fully known, as it is caused by various risk factors.[18] Among risk factors, it has been determined that obesity increases the risk of asthma, and obese children have a higher severity of allergic diseases than children with normal body weight.[19] The healthy body weight status in children is affected by environmental factors, drug use, genetic status, and sleep quality.[20] It is known that obesity negatively affects sleep quality, and an increase in adipose tissue is associated with airway inflammation, which causes airway obstruction.[8] Obesity leads to the severity of asthma by reducing the effectiveness of traditional corticosteroids.[21] In this study, the aim was to determine difference in BMI and sleep quality in children with pediatric asthma compared to their healthy non-asthmatic peers. It was observed that asthmatic children had more obesity compared to the healthy group. It was also determined that the level of interest of asthmatic children in any sports was less than that in the healthy group. In a study conducted by Peters-Golden et al.[22] on the use of leukotriene antagonist

Table 8 Examination of differences in environmental factors between groups and the presence of sports activity of interest.

		Asthma group		Healthy group		T	P
		N	%	N	%		
Number of individuals in the family	2	0	0	1	3.3	−0.799	0.427*
	3	2	6.7	1	3.3		
	4	8	26.7	2	6.7		
	5	10	33.3	13	43.3		
	6	6	20.0	11	36.7		
	7	4	13.3	1	3.3		
	8	0	0	1	3.3		
Number of children in the family	1	4	13.3	2	6.7	−1.688	0.097*
	2	6	20.0	3	10		
	3	13	43.3	12	40.0		
	4	5	16.7	11	36.7		
	5	2	6.7	1	3.3		
	6	0	0	1	3.3		
						χ^2	P
Health insurance	Yes	24	80.0	16	53.3	4.800	**0.028****
	No	6	20.0	14	46.7		
Place of residence	Center	11	36.7	7	23.3	2.593	0.274**
	Village	14	46.7	13	43.3		
	Town	5	16.7	10	33.3		
Smoking exposure	Yes	5	16.7	8	26.7	0.884	0.347**
	No	25	83.3	22	73.3		
Heating process of the house	Coal stove	19	63.3	14	46.7	3.267	0.071**
	Electric stove	2	6.7	1	3.3		
	Sawdust stove	2	6.7	8	26.7		
	Central heating	7	23.3	7	23.3		
Presence of dampness at living place	Yes	10	33.3	10	33.3	0.00	1.000**
	No	20	66.7	20	66.7		

***Independent samples T-test**
****Chi-square test**
$P < 0.05$.

montelukast, found that the response to inhaled corticosteroids decreases with the increase in BMI. We are of the opinion that high obesity in asthmatic children reduces the effect of corticosteroids, and consequently the continuity of nighttime cough symptoms causes deterioration in sleep quality. We opine that participation in sports activities must be encouraged in order to reduce the levels of obesity in asthmatic children.

Lang et al. have found in their study that more than 26% of asthmatic children were obese.[23] It was found in our study that 23.3% of asthmatic children were obese and 6.7% were overweight, which is in line with the literature. It was found that there was a significant difference between the asthmatic and healthy groups ($P < 0.05$).

The prevalence of childhood asthma and obesity is high in families with low socioeconomic status.[24] Worldwide, obesity and asthma, as well as the deaths and costs associated with these diseases, create a serious burden on the community.[25] In our study, a higher rate of social security was found in asthmatic children compared to healthy children. In the studies conducted, household dust, presence of dampness at living place, cockroach feces, and exposure to tobacco smoke, which are among the environmental factors that pose a risk of asthma in children from low socioeconomic status, are higher than in children from high socioeconomic status.[26] Low income also affects nutritional status and increases the chances of obesity. No significant difference was found by our study between the place of residence of the asthmatic group compared to the healthy group, as well as their nutritional status, presence of dampness at living place, and heating process of the house ($P > 0.05$). Kırmızıbekmez et al. found that 42.7% of

Table 9 Investigation of differences between nutritional status of groups and existence of interested sports activity.

		Asthma group		Healthy group		T	P
		N	%	N	%		
Number of meals per day	1	1	3.3	0	0	0.713	0.479**
	2	5	16.7	10	33.3		
	3	23	76.7	19	63.3		
	4	1	3.3	1	3.3		
						χ^2	P
Fast food nutrition status	Never	3	10.0	7	23.3	3.393	0.065**
	Rarely	14	46.7	15	50.0		
	Sometimes	9	30.0	7	23.3		
	Often	4	13.3	1	3.3		
Sports of interest	Yes	16	53.3	24	80	4.800	**0.028****
	No	14	46.7	6	20		

***Independent samples T-test
****Chi-square test
P < 0.05.

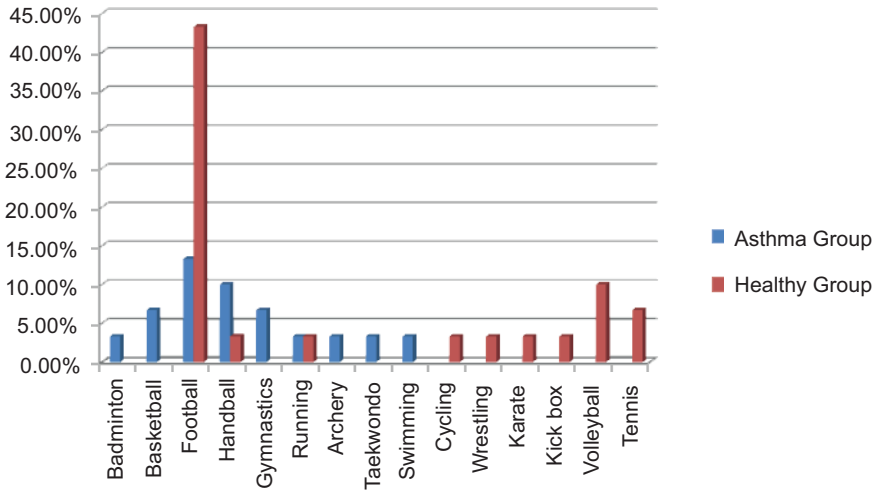

Figure 1 Sports of interest in both groups.

children were exposed to smoking in 82 cases diagnosed with asthma and/or allergic rhinitis.[27] It was determined in our study that cigarette exposure of asthmatic children was 16.7%, with no significant difference between them and the healthy group.

Effects of a sedentary lifestyle on the development of obesity have been expressed as an important factor in many studies. Owing to the anxiety of asthmatic children experiencing shortness of breath and the fear of having an attack by both families and teachers, the participation of asthmatic children in physical and sports activities was restricted, directing them toward a sedentary lifestyle.[12] Meyer et al. found in a study comprising 254 teachers in 46 schools of children of different ages that only 60% of asthmatic children attended physical education classes; 40% of asthmatic children were found to have limited participation—sometimes or no participation.[28]

In a study conducted by Sawyer et al., 31% of asthmatic children did not participate in sports because of asthma, 21% did not ride a bicycle, 20% did not swim, and 18% stated that they did not participate in activities in the school's half-break time.[29] In our study, children in the asthmatic group were interested in the following proportion of sports: 3.3% badminton, 6.7% basketball, 13.3% football, 10% handball, 6.7% gymnastics, 3.3% running, 3.3% archery, and 3.3% taekwondo, while children in the healthy group were interested in the following proportion of sports: 3.3% swimming, 3.3% cycling, 43.3% football, 3.3% wrestling,

3.3% handball, 3.3% karate, 3.3% kickboxing, 3.3% running, 10% volleyball, and 6.7% tennis.

Glazebrook et al. studied 112 children with and without asthma and found that asthmatic children reported less physical activity than children without asthma.[30] Our study established that children in the asthma group were less interested in sports than those in the healthy group, and 46.7% of asthmatic children did not participate in any sports.

Excessive fat tissue has a negative effect on lung function. In our study, in spite of routine medication follow-up, the respiratory function tests of children in the asthmatic group were found to be lower compared to the healthy group.

Increase in visceral fat tissue in obesity causes the release of inflammatory cytokines that disrupt the sleep and wakefulness cycles, causing deterioration in sleep quality. Nighttime symptoms, such as cough, wheezing, and shortness of breath, in asthmatic patients also impair sleep quality. Stores and colleagues investigated both subjective and objective sleep patterns in children with and without asthma, and found that asthmatic children had worse sleep in both polysomnography tests and questionnaires compared to the control group.[31] Our study also found a significant difference in the sleep patterns of the asthmatic and healthy groups (P = 0.007), and concluded that the sleep quality of asthmatic children was worse than that of healthy children.

Conclusion

Our study observed that the asthmatic group had more obesity and poorer quality of sleep than the healthy group. It also determined that the interest level of asthmatic group in any sports was less than that of the healthy group. We are of the opinion that high obesity in asthmatic children reduces the effect of corticosteroids, and consequently the continuity of nighttime cough symptoms causes deterioration in sleep quality. We opine that participation in sports activities must be encouraged in order to reduce obesity in asthmatic children.

However, there are contradictions in literature regarding the participation of asthmatic children in sports activities. The present study has concluded that participation of asthmatic children in sports activities must be encouraged and increased to reduce BMI. Participation in sports activities is thought to increase the general health status and quality of sleep, and supports medical treatment.

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