



# Prevalence of sleep apnea in children and adolescents with attention-deficit hyperactivity disorder

Alireza Khalesi<sup>1</sup>; Fatemeh Moharreri<sup>2</sup>;  
Azam Sadat Heydari Yazdi<sup>3</sup>; Hamid Khalesi<sup>4</sup>; \*Maryam Nazari Noghabi<sup>5</sup>

<sup>1</sup>General physician, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>2</sup>Professor of child and adolescent psychiatry, Psychiatry and Behavioral Sciences Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>3</sup>Assistant professor of child and adolescent psychiatry, Psychiatry and Behavioral Sciences Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>4</sup>Pediatrics, Mashhad, Iran.

<sup>5</sup>Child and adolescent psychiatrist, Psychiatry and Behavioral Sciences Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

## Abstract

**Introduction:** Regarding the impact of sleep apnea on Attention-Deficit Hyperactivity Disorder (ADHD) manifestations in children and adolescents, the present study aimed to assess the prevalence of sleep apnea and sleep disturbances in children and adolescents with ADHD.

**Materials and Methods:** The statistical population of this descriptive-correlational study consisted of all children and adolescents with ADHD who were referred to a clinic of child and adolescent psychiatrist and clinic of children and adolescents psychiatry in Ibn-e-Sina Psychiatric Hospital in Mashhad City, Iran, in 2022-2023. Among them, 20 cases were selected using the convenient sampling method. The parents fulfilled the demographic checklist and Children's Sleep Habits Questionnaire (CSHQ). We measured Body Mass Index (BMI) and evaluated obstructive sleep apnea using Apnea Link device. The data were analyzed using descriptive indexes, the Mann-Whitney test, Spearman's coefficient, the Chi-square test, and the Pearson coefficient.

**Results:** Finally, 12 patients with a mean age of  $9.92 \pm 2.23$  years participated. The mean BMI was  $20.42 \pm 3.71$ . The mean score of the Children's Sleep Habits Questionnaire was 74.92. Also, 8 patients experienced different levels of obstructive sleep apnea. Only a significant correlation was seen between sleep disturbances and BMI ( $P = 0.007$ ). Also, the correlations between obstructive sleep apnea and demographic variables were insignificant ( $P > 0.05$ ).

**Conclusion:** It seems that sleep apnea and sleep disturbances are prevalent in children and adolescents with ADHD, so the clinical diagnosis of sleep problems plays an important role in treating ADHD symptoms.

**Keywords:** Attention-deficit hyperactivity disorder, Sleep apnea, Sleep disturbances

## Please cite this paper as:

Khalesi A, Moharreri F, Heydari Yazdi AS, Khalesi H, Nazari Noghabi M. Prevalence of sleep apnea in children and adolescents with attention-deficit hyperactivity disorder. *Journal of Fundamentals of Mental Health* 2024 Nov-Dec; 26(6): 351-355. DOI: 10.22038/JFMH.2024.83100.3179

## \*Corresponding Author:

Psychiatry and Behavioral Sciences Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.  
nazarinm1@mums.ac.ir

Received: Aug. 21, 2024

Accepted: Oct. 06, 2024



Copyright©2024 Mashhad University of Medical Sciences. This work is licensed under a Creative Commons Attribution-Noncommercial 4.0 International License <https://creativecommons.org/licenses/by-nc/4.0/deed.en>

## Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most prevalent neurodevelopmental disorders (1). Based on the recent meta-analysis, the prevalence rate of this disorder in children aged 3-12 years is 7.6%, while this rate is 5.6% in adolescents aged 12-18 years (2). This disorder is characterized by attention deficit, hyperactivity, and impulsivity (3). Also, ADHD children are prone to sleep disturbances (4), and sleep problems can exacerbate or mimic symptoms of ADHD (5). On the other hand, sleep disorders and ADHD have an interactional relationship, and treating one can impact on another disorder (6-8).

Obstructive Sleep Apnea (OSA) manifests during sleep and it is characterized by prolonged partial airway obstruction and/or intermittent complete obstruction that decreases ventilation during sleep. Some ADHD symptoms in children with OSA seem to present due to repeated hypoxic episodes. Also, it is indicated that sleep disturbances impact prefrontal executive functions such as memory, behavioral control, and attention (9). Regarding the impact of sleep disorders on the symptoms severity and treatment outcome of ADHD (10-12), the clinical diagnosis and evaluation of sleep problems in these patients are important.

So the present study aimed to assess the prevalence rate of sleep apnea by ApneaLink device, sleep disturbances, and their relationships with demographic factors in children and adolescents with ADHD. According to the search, in Iran, we did not find a similar study with an emphasis on sleep apnea using this device. Also, most studies were reported the prevalence of sleep disturbances through questionnaires based on parents' opinions. Therefore, this study has novelty in our country.

## Materials and Methods

In this cross-sectional study, the statistical population included all children and adolescents referred to the child and adolescent psychiatry clinics and the specialized clinic of children and adolescents psychiatry in Ibn-e-Sina Psychiatric Hospital in Mashhad City, Iran, in 2022-2023. Among patients with ADHD diagnosis, we selected 20 cases using the convenient sampling method. The sample size was calculated according to a study conducted (13), and the formula. The inclusion criteria included age 6-15

years, having ADHD diagnosis, lack of comorbid psychiatric disorder, having no respiratory diseases such as asthma and adenotonsillar hypertrophy, and lack of taking medications impact on sleep habits or respiratory system. The exclusion criteria included major psychiatric problems in parents, experiencing acute stressful events in the past three months, and unwillingness to participate in patients or their parents. The parents fulfilled the demographic checklist and the Children's Sleep Habits Questionnaire (CSHQ). Then, we measured the patients' weight and height and calculated their Body Mass Index (BMI). We evaluated sleep apnea in patients through the ApneaLink device, installed overnight by a trained nurse at the patient's home. This installed device monitored the patient's sleep that night.

## Research instruments

*A) The Demographic Checklist:* It includes the history of psychiatric disorders in the family and children, the medications taken by children, and the children's age and gender.

*B) The Children's Sleep Habits Questionnaire (CSHQ):* This questionnaire was developed by Owens et al. in 2000. It includes eight subscales (sleep resistance, sleep onset delay, sleep duration, sleep anxiety, night awakenings, parasomnia, sleep-disordered breathing, and daytime sleepiness) and 45 questions. Some of the questions only have diagnostic or therapeutic aspects, so only 33 questions are scored based on the Likert system (1 to 3), and the total score is in a range of 33 to 99. The higher score indicates more disturbance in sleep habits (14). This tool has been used frequently in many studies in different countries and has acceptable psychometric properties (15-19). This questionnaire was validated in the Iranian population, with a Cronbach's alpha of 0.80 (20).

*C) ApneaLink Device:* The gold standard method for diagnosing obstructive sleep apnea in polysomnography, but its use is limited due to use conditions and cost (21). So, more individuals were using portable devices. Apnea Link, as a portable device for screening and treatment, has a positive correlation with polysomnography to diagnose sleep indexes such as the Apnea-Hypopnea Index (AHI) and Respiratory Disturbance Index (RDI) (22), so it can be used in clinical studies. We used this device in our study, by an experienced nurse who installed this device in a patient's home.

So, we assessed the prevalence of Obstructive Sleep Apnea (OSA) and the OSA severity in children and adolescents with ADHD.

The collected data was analyzed using descriptive indexes, the Mann-Whitney test, Spearman's rank correlation coefficient, the Chi-square test, and the Pearson coefficient.

## Results

In this descriptive-correlational study, we selected 20 ADHD children and adolescents. Finally, due to the lack of adherence to the use

of ApneaLink in 5 patients, incomplete questionnaires, and interrupted information in 3 patients, we evaluated 12 patients. Regarding demographic variables, the mean age of the participants was  $9.92 \pm 2.23$  years (7-13 years). Two patients were female, and ten patients were male. The body mass index was 16-27, with a mean of  $20.42 \pm 3.71$ .

Table 1 presents the descriptive statistics of the scores related to the Children's Sleep Habits Questionnaire (CSHQ) and the prevalence and severity of Obstructive Sleep Apnea (OSA) in children and adolescents with ADHD.

**Table 1.** The mean score of the Children's Sleep Habits Questionnaire and the prevalence and severity of obstructive sleep apnea in ADHD children

Obstructive sleep apnea	Prevalence (%)	Children's sleep habits (Mean $\pm$ SD)
No	4 (33.3)	70.25 $\pm$ 11.29
Mild	3 (25.1)	79.33 $\pm$ 7.02
Moderate	4 (33.3)	76.75 $\pm$ 6.07
Severe	1 (8.3)	73.00 $\pm$ 1.10
Total	12 (100.0)	74.92 $\pm$ 8.28

As seen in Table 1, the mean score of 74.92 in the Children's Sleep Habits Questionnaire (the scores range from 33 to 99) indicates that most ADHD patients suffer from sleep disturbances; also, about two-thirds of the ADHD patients

had different levels of obstructive sleep apnea. In addition, we assessed the correlations between demographic variables and sleep disturbances. Table 2 presents these results.

**Table 2.** The correlations between demographic variables and sleep habits in ADHD children

Index	Age		Sex		BMI	
CSHQ	Coefficient	P	Coefficient	P	Coefficient	P
Coefficient	1.000	0.300	0.343*	0.606**	0.732	0.007*

\*Spearman's rank correlation coefficient

\*\*Mann-Whitney U

The results of Table 2 indicated that only a significant correlation between sleep disturbances and demographic variables was seen between body mass index and sleep disturbances ( $P=0.007$ ). Also, the correlations between obstructive sleep apnea and demographic characteristics such as BMI and age were insignificant (Pearson coefficient and Chi-square test:  $P=0.615$ ,  $P=0.345$ , respectively).

## Discussion

In this study, 12 children and adolescents with ADHD (2 girls and 10 boys with a mean age of  $9.92 \pm 2.23$  years) were evaluated through the Children's Sleep Habits Questionnaire and ApneaLink device to assess the prevalence of sleep apnea. The mean of BMI was  $20.42 \pm 3.71$ . This indicated that most ADHD children were in

a healthy weight range (23). The mean score of 74.92 in the Children's Sleep Habits Questionnaire and Obstructive Sleep Apnea (OSA) in 8 patients indicate that most ADHD patients suffer from sleep disturbances. Also, among demographic variables, only BMI has a positive and significant correlation with the Children's Sleep Habits Questionnaire score. In contrast, the correlations between obstructive sleep apnea, BMI, and age were insignificant.

The results of the present study about the high prevalence of obstructive sleep apnea in ADHD children are consistent with the previous studies. Alessandri-Bonetti et al., in a prospective study on 40 ADHD children in Rome, Italy, found that the prevalence rate of high-risk obstructive sleep apnea in ADHD children was 62.5% vs. 10% in healthy children (24). Also, we found the mean score of the Children's Sleep Habits

Questionnaire to be 74.92. Regarding the range of the scores in this questionnaire (33-99), higher scores than 41 indicate the presence of sleep disturbances in children (25). So, sleep disturbances were common in the patients of our study. In this line, Joseph et al. assessed 40 children with ADHD (aged 6-12 years) and 40 matched controls to compare sleep disturbances between these two groups using parent-reported questionnaires, sleep logs, and polysomnography. They found that 65% of children with ADHD suffered from one sleep disorder (based on subjective and objective instruments) compared to 17% of control participants (26). The present study found no significant relationship between OSA and body mass index. In contrast, only a significant relationship was seen between parent-reported sleep disturbances (the mean score of the Children's Sleep Habits Questionnaire) and body mass index. In contrast with our objective finding (OSA), Puzino et al. evaluated 421 adolescents (mean age of  $16.9 \pm 2.3$  years, 53.9% male) through polysomnography. Also, they conducted neurobehavioral and physical examinations. Among these adolescents, 208 cases were controlled. One hundred fifteen cases had OSA alone. Fifty-four adolescents had ADHD alone, and 44 of them had OSA + ADHD. The findings revealed that the ADHD + OSA group showed overweight/obesity (27). The difference between our findings and Puzino et al.'s study is probably related to different age groups, normal body mass index in our patients, and Puzino et al.'s larger sample size. Although ADHD symptoms worsen the quality of life in children and adolescents (28), studies suggest that sleep apnea treatment, such as adenotonsillectomy and Continuous Positive Airway Pressure (CPAP), is effective in treating

ADHD symptoms (29). So, it is important to assess sleep disorders in children and adolescents who have been diagnosed with ADHD. The present study has limitations, such as parents' lack of cooperation in using the ApneaLink device to assess OSA and the small sample size.

### Conclusion

Based on the findings, the high score of the Children's Sleep Habits Questionnaire and the presence of obstructive sleep apnea in most patients indicate the high prevalence of sleep disturbances in children and adolescents with attention-deficit and hyperactivity disorder. Only a significant correlation between sleep disturbances and demographic variables was seen between body mass index and sleep disturbances.

### Acknowledgments

The authors thank all participants and their parents.

### Conflict of Interests

The authors declare no conflict of interest.

### Funding

Mashhad University of Medical Sciences

### Ethical Considerations

This study was approved by the Vice Chancellor of Mashhad University of Medical Sciences. All patients and their parents participated in this study voluntarily.

### Authors' Contributions

Study design: Fatemeh Moharreri; Conducting study: Alireza Khalesi, Azam Sadat Heydari, Fatemeh Moharreri, Maryam Nazari, and Hamid Khalesi; Manuscript preparation: Maryam Nazari and Alireza Khalesi; Final revision: Maryam Nazari and Alireza Khalesi.

### References

1. GBD 2019 Mental Disorders Collaborators. Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990-2019: A systematic analysis for the global burden of disease study 2019. *Lancet Psychiatry* 2022; 9: 137-50.
2. Salari N, Ghasemi H, Abdoli N, Rahmani A, Shiri MH, Hashemian AH, et al. The global prevalence of ADHD in children and adolescents: A systematic review and meta-analysis. *Ital J Pediatr* 2023; 49: 48.
3. Drechsler R, Brem S, Brandeis D, Grünblatt E, Berger G, Walitza S. ADHD: Current concepts and treatments in children and adolescents. *Neuropediatrics* 2020; 51: 315-35.
4. Yin H, Yang D, Yang L, Wu G. Relationship between sleep disorders and attention-deficit-hyperactivity disorder in children. *Front Pediatr* 2022; 10: 919572.
5. Ivanov I, Miraglia B, Prodanova D, Newcorn JH. Sleep Disordered Breathing and Risk for ADHD: Review of supportive evidence and proposed underlying mechanisms. *J Atten Disord* 2024; 28(5): 686-98.

6. Claudio Arias-Mera C, Paillama-Raimán D, Lucero-González N, Leiva-Bianchi M, Avello-Sáez D. Relation between sleep disorders and attention deficit disorder with hyperactivity in children and adolescents: A systematic review. *Res Dev Disabil* 2023; 137: 104500.
7. Craig SG, Weiss MD, Hudec, KL, Gibbins C. The functional impact of sleep disorders in children with ADHD. *J Atten Disord* 2020; 24(4): 499-508.
8. Weiss MD, Craig SG, Davies G, Schibuk L, Stein M. New research on the complex interaction of sleep and ADHD. *Curr Sleep Med Rep* 2015, 1(2): 114-21.
9. Chang SJ, Chae KY. Obstructive sleep apnea syndrome in children: Epidemiology, pathophysiology, diagnosis, and sequelae. *Korean J Pediatr* 2010; 53: 863-71.
10. Escobar L, Rodriguez Héctor L, Castellanos JE. Attention-deficit/hyperactivity disorder symptoms can be reduced by effectively treating obstructive sleep apnea with oral appliances: A hypothesis. *Dent Hypotheses* 2021; 12: 99-103.
11. Awadalla TO, Igwe O, Okeafor CU, Attarian HP. Improvement of attention deficit disorder symptoms after treatment of obstructive sleep apnea in an adult: A case report and mini review. *J Clin Sleep Med* 2024; 20(5): 825-7.
12. Perez A, Kimberly H. Adenotonsillectomy as a treatment for sleep-disordered breathing in children with ADHD. *J Am Acad Physician Assist* 2020; 33(10): 34-39.
13. Bhattacharjee R, Benjafield A, Blase A, Dever G, Celso J, Nation J, et al. The accuracy of a portable sleep monitor to diagnose obstructive sleep apnea in adolescent patients. *J Clin Sleep Med* 2021; 17(7): 1379-87.
14. Owens JA, Spirito A, McGuinn M. The Children's Sleep Habits Questionnaire (CSHQ): Psychometric properties of a survey instrument for school-aged children. *Sleep* 2000; 23(8): 1043-51.
15. Gios TS, Owens J, Mecca TP, Uchida RR, Belisario Filho JF, Lowenthal R. Translation and adaptation into Brazilian Portuguese and investigation of the psychometric properties of the Children's Sleep Habits Questionnaire (CSHQ-BR). *Sleep Med* 2022; 100: 550-57.
16. Ishii R, Obara H, Nagamitsu S, Matsuoka M, Suda M, Yuge K, et al. The Japanese version of the children's sleep habits questionnaire (CSHQ-J): A validation study and influencing factors. *Brain Dev* 2022; 44(9): 595-604.
17. Awadhiya S, Dwivedi R. Evaluation of prevalence of sleep disorders among children aged 4-10 years using Children's Sleep Habit Questionnaire (CSHQ). *J Cardiovasc Dis Res* 2022; 13(2): 1259-64.
18. Borrelli M, Scala I, Festa P, Bruzzese D, Michelotti A, Cantone E, et al. Linguistic adaptation and psychometric evaluation of Italian version of children's sleep habits questionnaire. *Ital J Pediatr* 2021; 47: 1-5.
19. Chehri A, Taheri P, Khazaie H, Jalali A, Ahmadi A, Mohammadi R. The relationship between parents' sleep quality and sleep hygiene and preschool children's sleep habits. *Sleep Sci* 2022; 15(03): 272-8.
20. Fallahzadeh H, Etesam F, Asgarian FS. Validity and reliability related to the Persian version of the Children's Sleep Habits Questionnaire. *Sleep Biol Rhythms* 2015; 13(3): 271-8.
21. Khor YH, Khung SW, Ruehland WR, Jiao Y, Lew J, Munsif M, et al. Portable evaluation of obstructive sleep apnea in adults: A systematic review. *Sleep Med Rev* 2023; 68: 101743.
22. Yun YB, Bae WY, Kim S, Kim YG, Park SH. The usefulness of ApneaLink™ as a screening test for diagnosis of obstructive sleep apnea. *Sleep Med Res* 2022; 13(2): 103-7.
23. Di Angelantonio E, Bhupathiraju S, Wormser D, Gao P, Kaptoge S, Berrington de Gonzalez A, et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *Lancet* 2016; 388 (10046): 776-86.
24. Alessandri-Bonetti A, Guglielmi F, Deledda G, Sangalli L, Brogna C, Gallenzi P. Malocclusions, sleep bruxism, and obstructive sleep apnea risk in pediatric ADHD patients: A prospective study. *J Atten Disord* 2024; 28(6): 1017-23.
25. Ozgoli G, Sheykhan Z, Soleimani F, Nasiri M, Mirzaie S, Kavousi F, et al. [A study of effective factors on sleep disorders in 4-6 years old children in Tehran city, Iran]. *Journal of Qom University of Medical Sciences* 2015; 9(5): 50-60. (Persian)
26. Joseph AA, Gupta A, Hazari N, Kalaivani M, Pandey RM, Sagar R, et al. A cross-sectional comparative study of sleep disturbances in children with ADHD and matched controls. *Brain Sci* 2022; 12: 1158.
27. Puzino K, Bourcstein E, Calhoun SL, He F, Vgontzas AN, Liao D, et al. Behavioral, neurocognitive, polysomnographic and cardiometabolic profiles associated with obstructive sleep apnea in adolescents with ADHD. *J Child Psychol Psychiatr* 2022; 63: 544-52.
28. Csábi E, Gaál V, Hallgató E, Schulcz RA, Katona G, Benedek P. Increased behavioral problems in children with sleep-disordered breathing. *Ital J Pediatr* 2022; 48: 173.
29. Urbano GL, Tablizo BJ, Moufarrej Y, Tablizo MA, Chen ML, Witmans M. The Link between pediatric Obstructive Sleep Apnea (OSA) and Attention Deficit Hyperactivity Disorder (ADHD). *Children* 2021; 8: 824.