Research Square

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Sleep Disturbance in Preschool Children with Allergic diseases

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Abstract

Purpose

Sleep problems are very common in children with asthma, allergic rhinitis (AR), and atopic dermatitis (AD). This study investigates sleep disturbances in preschool children with atopy and evaluates the impact on their emotion and behavior.

Methods

Questionnaires were distributed to 19,086 preschool children 2 to 6 years old taking the public annual health examination. Symptoms of atopy, sleep problems, and behavior were assessed by the ISAAC questionnaire, the Child's Sleep Habits Questionnaire, and the Strengths and Difficulties Questionnaire, respectively.

Results

Of the 10,830 participants, symptoms of asthma, AR, and AD were reported in up to 25.9%, 52.9%, and 37.6%, respectively. Those with asthma, AR, and AD symptoms all had significantly higher scores in sleep onset delay, sleep anxiety, night waking, parasomnia, sleep-disordered breathing, and daytime sleepiness. Sleep problems were related to disease control. Children with asthma, AR, and AD also had significantly higher scores in hyperactivity, emotional symptoms, conduct problems, and peer problems. However, in children with AD without sleep problems, emotional symptoms score and conduct problems score were lower than those with sleep problems ($p < 0.01$), and were not significantly different from those without AD. Similarly, the emotional symptoms score in children with asthma without sleep problems was lower ($p < 0.01$) and not significantly different from those without asthma.

Conclusion

Preschool children with asthma, AR, and AD have more sleep problems and higher emotional and conduct problems scores which are related to their sleep problems. Therefore, evaluation and management of sleep disturbance in children with atopy is very important.

Introduction

Allergic diseases such as asthma, allergic rhinitis (AR), and atopic dermatitis (AD) are some of the most common chronic diseases in childhood. The prevalence of allergic diseases in children in Taiwan has greatly increased over time. From the year 1985 to 2011, the prevalence of asthma in children has increased from 5.08% to 17%; the prevalence of allergic rhinitis has increased from 7.84% to 47.8%; and the prevalence of atopic dermatitis has increased from 1.23% to 21%. [1, 2] Sleep disturbance is often reported in children with atopy. Nocturnal asthmatic symptoms such as cough and wheezing cause sleep disruptions and were associated with increased number of school absences and poorer school performance. [3, 4] Allergic rhinitis symptoms such as nasal congestion, sneezing, itchy eyes and nose, and rhinorrhea also contribute to sleep disturbances. The Pediatric Allergies in America Survey [5] found that 40% of AR patients reported that allergies affected their sleep. Studies have also found that nighttime symptoms of rhinitis were associated with chronic excessive daytime sleepiness and poor quality of life. [6] Moreover, patients with asthma or AR have increased risk of sleep-disordered breathing. [7] Sleep disturbance is also common in children with atopic dermatitis, including reduced sleep efficiency, longer sleep onset latency, and more sleep fragmentation, [8, 9] and the sleep disorders might also affect disease severity.[10]

Sleep is very important for both physical and mental health. In children, sleep disturbance can have many negative consequences, including impaired neurocognitive function, higher rates of behavioral problems, and changes in mood. [11, 12] While sleep disturbance is common in children with atopy, it has seldom been studied whether the sleep disturbance affect their emotion and behavior. It has been suggested that AD is associated with attention deficit hyperactivity disorder (ADHD) and emotional and conduct problems only when accompanied with sleep problems. [13, 14] This study aims to investigate sleep problems in children with atopy and whether it is associated with emotional and behavioral problems.

Methods

This is a cross-sectional study. The Taipei City Hospital Research Ethics Committee approved the study protocol. This study conformed to the principles of the Declaration of Helsinki.[15]

Participants

Questionnaires were sent to the parents of a random sample of children 2 to 6 years old who were taking the children's annual health examination provided by the Department of Health, Taipei City Government. We randomly selected 2 districts of Taipei City (Da'an and Songshan Districs) and distributed the questionnaires to the preschools and health centers where the health examinations were held. The questionnaires (including informed consent) were completed by caregivers and collected during the health examination.

Questionnaires

Demographic data was obtained, including age, sex, body weight and body height, number of siblings, maternal age, and maternal education level. Sleep was examined by a modified Children's Sleep Habits Questionnaire (CSHQ)[16, 17], which includes questions about sleep habits, sleep duration, and evaluation for sleep problems including bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnia, sleep-disordered breathing, and daytime sleepiness [18]. To screen for allergic diseases, core symptoms of asthma, allergic rhinitis, and atopic dermatitis were evaluated by the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire[19, 20]. Physician-diagnosed asthma/ allergic rhinitis/ atopic dermatitis were defined as those who answered "yes" to the question "Has your child ever been diagnosed by a doctor to have asthma/ allergic rhinitis/ atopic dermatitis?". Children with symptoms of asthma was defined as those who answered "yes" to "Has your child ever had wheezing or whistling in the chest at any time in the past?". Children with symptoms of allergic rhinitis was defined as those who answered "yes" to "Has your child ever had a problem with sneezing, or a runny, or blocked nose when she/he DID NOT have a cold or the flu?". Children with symptoms of atopic dermatitis was defined as those who answered "yes" to "Has your child ever had an itchy rash, which was coming and going for at least six months?". Of those who answered "yes" to "Has your child had wheezing or whistling in the chest in the past 12 months?", those who answered "Never woken with wheezing" to the question "In the past 12 months, how often, on average, has your child's sleep been disturbed due to wheezing?" were defined as "Asthma with no sleep problems related to symptoms", and those who answered "Less than one night per week" and "One or more nights per week" to this question were defined as "Asthma with sleep problems related to symptoms." Of those who answered "yes" to " Has your child had this itchy rash at any time in the past 12 months?", those who answered "Never in the past 12 months" to the question "In the past 12 months, how often, on average, has your child been kept awake at night by this itchy rash?" were defined as "Eczema with no sleep problems related to symptoms," and those who answered "Less than one night per week" or "One or more nights per week" to this question were defined as "eczema with sleep problems related to symptoms." Behavioral evaluation was conducted by using the Strengths and Difficulties Questionnaire (SDQ)[21], which includes screening for emotional symptoms, conduct problems, hyperactivity, peer relationship problems, and prosocial behavior.

Statistical Analysis

The χ^2 test or the Student's t test was used to compare the data between the patients with allergic symptoms and those without allergic symptoms or between the patient subgroups. Missing data were excluded from the analysis. All statistical analyses were performed by using SPSS software (SPSS version 25, IBM Corp.). $P < 0.05$ defines statistical significance.

Results

We distributed 19,086 questionnaires, and 10,830 questionnaires were collected. Return rate of the questionnaires was 56.7%. A total of 10,464 questionnaires were valid for analysis, of which 48.6% were girls and 51.4% were boys. Mean age was 4.9 ± 1.1 years old.

Prevalence of Allergic Diseases

In our study population, 11.7% had physician-diagnosed asthma, 35.9% had physician-diagnosed allergic rhinitis, 21.9% had physician-diagnosed atopic dermatitis, and 14.7% had at least 2 overlapping diagnoses. (Fig. 1) Symptoms of allergic diseases was even more prevalent: Wheezing was present in 18.3%, dry cough at night apart from infection in 25.9%, allergic rhinitis symptoms apart from infection in 52.9%, and eczema ever in 37.6%.

Sleep Problems in Children with Allergic Diseases

In children with symptoms of asthma, allergic rhinitis, or atopic dermatitis, parents reported that the child's sleep was problematic in 55.2%, 54.1%, and 55.7%, respectively. The total sleep duration at nighttime was not significantly different in those with symptoms of asthma (wheezing ever) compared with those without symptoms of asthma (587.2 ± 45.1 vs 586.5 ± 45.8 minutes, p = 0.54). Nor was the total sleep duration at nighttime significantly different between those with and without allergic rhinitis symptoms (586.7 ± 44.7 vs 586.1 ± 46.5 minutes, p = 0.58) or between those with and without atopic dermatitis symptoms (587.5 ± 44.9 vs 586.4 ± 45.5 minutes, p = 0.92). However, results from the CSHQ showed that in children with symptoms of asthma, allergic rhinitis or atopic dermatitis all had significantly higher scores in sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnia, sleep-disordered breathing, daytime sleepiness, and total sleep disturbance score. Children with symptoms of allergic rhinitis and atopic dermatitis also had significantly higher scores on bedtime resistance. (Table 1)

Table 1
CSHQ scores in children with and without symptoms of asthma, allergic rhinitis, and atopic dermatitis

	Asthma	No Asthma	*P*-value	Allergic rhinitis	No allergic rhinitis	*P*-value	Atopic dermatitis	No atopic dermatitis	*P*-value
	(n = 1760)	(n = 7873)		(n = 5152)	(n = 4584)		(n = 1564)	(n = 8104)	
Bedtime resistance	11.71 ± 2.78	11.60 ± 2.75	0.14	11.71 ± 2.75	11.53 ± 2.77	< 0.01	11.85 ± 2.74	11.58 ± 2.76	< 0.001
Sleep onset delay	1.61 ± 0.68	1.57 ± 0.67	0.02	1.60 ± 0.68	1.54 ± 0.66	< 0.001	1.66 ± 0.70	1.56 ± 0.66	< 0.001
Sleep duration	4.25 ± 1.45	4.11 ± 1.38	< 0.001	4.21 ± 1.42	4.03 ± 1.35	< 0.001	4.31 ± 1.45	4.10 ± 1.38	< 0.001
Sleep anxiety	7.20 ± 2.00	7.04 ± 1.95	< 0.01	7.16 ± 1.97	6.95 ± 1.95	< 0.001	7.23 ± 1.94	7.03 ± 1.96	< 0.001
Night wakings	3.69 ± 1.05	3.60 ± 0.99	< 0.01	3.68 ± 1.04	3.54 ± 0.94	< 0.001	3.77 ± 0.11	3.58 ± 0.97	< 0.001
Parasomnias	7.59 ± 1.56	7.40 ± 1.50	< 0.001	7.59 ± 1.57	7.27 ± 1.43	< 0.001	7.59 ± 1.61	7.40 ± 1.49	< 0.001
Sleep disordered breathing	3.88 ± 1.21	3.47 ± 0.90	< 0.001	3.73 ± 1.10	3.34 ± 0.77	< 0.001	3.72 ± 1.13	3.51 ± 0.94	< 0.001
Daytime sleepiness	15.17 ± 2.84	14.88 ± 2.79	< 0.001	15.14 ± 2.81	14.72 ± 2.79	< 0.001	15.20 ± 2.84	14.89 ± 2.71	< 0.001
Total sleep disturbance score	50.48 ± 6.66	49.25 ± 6.23	< 0.001	50.31 ± 6.42	48.58 ± 6.10	< 0.001	50.70 ± 6.54	49.25 ± 6.26	< 0.001

In children with asthma, those with more than 4 wheezing attacks in the past 12 months had significantly higher scores in sleep anxiety, night waking, parasomnias, sleep disordered breathing, and daytime sleepiness compared with those who had 0–3 wheezing attacks in the past 12 months. (Table 2) Children with asthma who were well-controlled with no symptoms in the past 12 months did not have significantly different scores in the CSHQ compared with children without asthma, except for a higher sleep-disordered breathing score. (Table 3) Similarly, children with atopic dermatitis who were well-controlled with no symptoms in the past 12 months did not have significantly different scores in the CSHQ compared with children without atopic dermatitis, except in sleep-disordered breathing and parasomnia score. (Table 3)

Table 2
CSHQ scores in children with asthma of different severity

	Mild asthma †	Moderate to severe asthma‡	*P*-value
	(n = 973)	(n = 184)	
Bed time resistance	11.74 ± 2.74	12.11 ± 2.62	0.09
Sleep onset delay	1.62 ± 0.68	1.60 ± 0.69	0.71
Sleep duration	4.26 ± 1.43	4.33 ± 1.48	0.54
Sleep anxiety	7.15 ± 2.00	7.71 ± 1.91	< 0.001
Night waking	3.68 ± 1.02	3.93 ± 1.29	< 0.01
Parasomnia	7.58 ± 1.57	7.94 ± 1.76	< 0.01
Sleep disordered breathing	3.89 ± 1.23	4.28 ± 1.26	< 0.001
Daytime sleepiness	15.13 ± 2.81	15.64 ± 2.87	0.03
Total score	53.66 ± 6.03	55.79 ± 6.01	< 0.001
†Mild asthma: 0–3 wheezing attacks in the past 12 months			
‡Moderate to severe asthma: >4 wheezing attacks in the past 12 months			

Table 3
CSHQ scores in children with asthma/atopic dermatitis who had no symptoms in the past 12 months and in children without asthma/atopic dermatitis

	Asthma with no symptoms in the past 12 months	No asthma	*P*-value	Atopic dermatitis with no symptoms in the past 12 months	No atopic dermatitis	*P*-value
	(n = 487)	(n = 7873)		(n = 243)	(n = 8104)	
Bed time resistance	11.48 ± 2.92	11.60 ± 2.75	0.35	11.81 ± 2.80	11.58 ± 2.76	0.21
Sleep onset delay	1.58 ± 0.67	1.56 ± 0.67	0.65	1.57 ± 0.67	1.56 ± 0.66	0.75
Sleep duration	4.17 ± 1.41	4.11 ± 1.38	0.32	4.27 ± 1.39	4.10 ± 1.38	0.08
Sleep anxiety	7.06 ± 2.03	7.04 ± 1.95	0.76	7.18 ± 1.81	7.03 ± 1.96	0.22
Night waking	3.59 ± 0.97	3.60 ± 0.99	0.84	3.59 ± 1.02	3.58 ± 0.97	0.94
Parasomnia	7.48 ± 1.47	7.40 ± 1.50	0.24	7.64 ± 1.67	7.40 ± 1.49	0.04
Sleep disordered breathing	3.68 ± 1.07	3.47 ± 0.90	< 0.001	3.69 ± 1.14	3.51 ± 0.94	0.02
Daytime sleepiness	15.10 ± 2.83	14.88 ± 2.79	0.11	15.25 ± 2.93	14.89 ± 2.80	0.05
Total score	49.46 ± 6.66	49.25 ± 6.23	0.5	50.60 ± 6.49	49.25 ± 6.26	0.003

Behavior Problems in Children with Allergic Diseases

Results from the SDQ evaluation showed that children with symptoms of asthma, allergic rhinitis, and atopic dermatitis all had significantly higher scores in hyperactivity, emotional symptoms, conduct problems, peer problems, and total difficulties score. Children with symptoms of allergic rhinitis also had a significantly lower prosocial score. (Table 4) However, in children with asthma without sleep problems, emotional symptoms score was significantly lower than those with sleep problems, and was not significantly different from those without asthma. (Fig. 2) In children with atopic dermatitis without sleep problems, emotional symptoms score and conduct problems score were significantly lower than those with sleep problems, and were not significantly different from those without atopic dermatitis. (Fig. 3)

Table 4
SDQ scores in children with and without symptoms of asthma, allergic rhinitis, and atopic dermatitis

	Asthma	No asthma	*P*-value	Allergic rhinitis	No allergic rhinitis	*P*-value	Atopic dermatitis	No atopic dermatitis	*P*-value
	(n = 1760)	(n = 7873)		(n = 5152)	(n = 4584)		(n = 1564)	(n = 8104)	
Hyperactivity	3.93 ± 2.42	3.70 ± 2.35	< 0.001	3.94 ± 2.39	3.53 ± 2.33	< 0.001	3.95 ± 2.47	3.71 ± 2.35	< 0.001
Emotional symptoms	2.13 ± 1.71	1.95 ± 1.61	< 0.001	2.16 ± 1.69	1.77 ± 1.52	< 0.001	2.20 ± 1.74	1.94 ± 1.60	< 0.001
Conduct problems	1.70 ± 1.44	1.60 ± 1.37	< 0.01	1.71 ± 1.41	1.53 ± 1.35	< 0.001	1.73 ± 1.37	1.61 ± 1.38	< 0.01
Peer problems	2.12 ± 1.58	2.03 ± 1.54	0.04	2.10 ± 1.56	1.98 ± 1.53	< 0.001	2.12 ± 1.57	2.03 ± 1.54	0.03
Prosocial	7.34 ± 1.99	7.32 ± 1.98	0.71	7.26 ± 1.98	7.39 ± 1.99	0.001	7.31 ± 2.05	7.33 ± 1.97	0.77
Total difficulties score	9.87 ± 4.85	9.27 ± 4.70	< 0.001	9.89 ± 4.74	8.79 ± 4.64	< 0.001	9.99 ± 4.75	9.27 ± 4.72	< 0.001

Discussion

The prevalence of allergic diseases has been rising in children worldwide.[22, 23] Our study found that the prevalence of physician-diagnosed asthma, allergic rhinitis, and atopic dermatitis in preschool children in Taiwan were 11.7%, 35.9%, and 21.9%, respectively, and up to 14.7% had at least 2 overlapping diagnoses. Symptoms of asthma such as wheezing or dry cough at night apart from infection were reported up to 25.9%, allergic rhinitis symptoms were reported in 52.9%, and eczema ever was reported in 37.6%. Compared with the report of prevalence of childhood allergic diseases in 2011 which showed 17% for asthma, 47.8% for allergic rhinitis, and 10.8% for eczema, we can see that the prevalence of allergic diseases in children in Taiwan is still rising in the past 10 years,[1, 2] and undiagnosed rates are still high.

Sleep disturbance has been reported in more than half of the children with symptoms of asthma, allergic rhinitis, or atopic dermatitis in our study. In concordance with previous studies, sleep duration was not significantly different in children with allergic diseases compared with those without allergic diseases.[8, 24] However, children with allergic diseases had significantly more problems in almost every aspect of the CSHQ. (Table 1) Previous studies have also reported that sleep disturbance is common in children with allergic diseases and were mostly attributed to nocturnal symptoms.[3, 6, 8, 10] However in our study we examined the type of sleep problems encountered, and we found that children with allergic diseases not only had significantly more night awakenings and daytime sleepiness, but also more problems with bedtime

resistance, sleep onset delay, sleep anxiety, and parasomnias.(Table 1) This could probably be due to acquired sleep habits, for example, worsening cough, itch, or stuffy nose at night usually results in more parental attention, either at sleep onset or during night awakenings, and could lead to limit-setting behavioral insomnia in childhood or sleep anxiety. Disrupted sleep could lead to an irregular sleep schedule (such as sleeping-in if the child had more awakenings the previous night) and could contribute to parasomnias. Therefore, sleep hygiene education, such as having a consistent bedtime routine and keeping a fixed sleep schedule is important for children with allergic diseases and behavioral interventions should be offered if needed.[25] Parents should also be educated about awareness of behavioral insomnia in childhood in order to avoid more sleep problems than those directly caused by allergic symptoms.

Sleep disordered breathing score is also significantly higher in children with either asthma, allergic rhinitis, or atopic dermatitis. (Table 1) In previous studies, sleep disordered breathing has been found to be associated with asthma and also asthma severity in children, but causal relationship has not been established.[26, 27] Allergic rhinitis has been found to be one of the most important risk factors for habitual snoring in children,[28, 29] and is also associated with increased risk of obstructive sleep apnea (OSA).[24, 30] In a study by Nosetti et al, allergic rhinitis was found in 35% of children with children with primary snoring, and 6% with OSA. It was suggested that nasal inflammation has a role in primary snoring and OSA.[31] Studies have also found that allergic rhinitis severity was significantly associated with OSA severity in children.[30] Chng et al found that habitual snoring was significantly associated with atopic dermatitis (OR 1.8; 95% CI 1.28–2.54),[28] and a large population based cohort study found that after adjusting for age, sex, urbanization level, and comorbidities, children with atopic dermatitis had a higher risk of OSA (OR 1.86). Atopic dermatitis and OSA are both chronic systemic inflammatory diseases and it was postulated that they share similar immunopathologic pathways. [32] It is important to evaluate for the presence of habitual snoring or OSA symptoms in children with allergic diseases in order to offer prompt diagnosis and management of possible sleep disordered breathing.

Our study found that in children with well-controlled asthma who had no symptoms in the past 12 months, the CSHQ score for problems with bedtime resistance, sleep onset delay, sleep anxiety, night waking, and daytime sleepiness were not significantly different from those without asthma. However, the score for sleep disordered breathing was still significantly higher than those without asthma. (Table 3) Similar results were found in children with atopic dermatitis who had no symptoms in the past 12 months. Most CSHQ scores became not significantly different from those without atopic dermatitis, except for the score for sleep-disordered breathing. (Table 3) This indicates that control of allergic symptoms is crucial for improving sleep in children with allergic diseases, and has benefit on both symptom-related sleep disturbance and also sleep problems which might be induced by acquired sleep habits. However, association with sleep disordered breathing might be more related to the pathogenesis of allergic diseases and does not seem to improve with symptom control.

From the results of the SDQ questionnaire, we found that children with either asthma, allergic rhinitis, or atopic dermatitis all had significantly higher scores for hyperactivity, emotional symptoms, conduct problems, peer problems, and total difficulties score than those without asthma, allergic rhinitis, or atopic dermatitis. (Table 4) In previous literature, behavioral problems were also found to be more pronounced in children and adolescents with asthma, including conduct disorder, attention deficit hyperactivity disorder (ADHD), and having internalizing symptoms such as being withdrawn or depressed.[33–35] Allergic rhinitis symptoms in children were found to be associated with conduct problems and emotional symptoms.[36] Association of atopic dermatitis and behavior problems was also demonstrated in previous literature, including higher internal behavior scale scores and anxiety/depression scale scores, more emotional and conduct problems, and more symptoms of hyperactivity/inattention.[37, 38] A meta-analysis showed that children with ADHD were more likely to have asthma (OR 1.8, 95% CI 1.57–2.07), allergic rhinitis (OR 1.59, 95% CI 1.13–2.23), and atopic dermatitis (OR 1.43, 95% CI 1.09–1.88).[39] Wu et al. found that the risk of having psychosocial problems were increasingly higher in children with one, two, and more than two allergic diseases.[40]

The reason for the association between allergic diseases and behavioral problems is unclear and could be multifactorial. In previous literature, it was postulated that behavioral difficulties in children with allergic diseases were due to social implications, side effects of allergy medication, or negatively affected brain development.[37] Some studies have also suggested that disturbed sleep might play a role. Manjunath et al. found that sleep disturbance was a predictor of behavioral problems in children and adolescents with AD.[41] Schmitt et al. found that infant eczema with concurrent sleep problems predicted emotional problems (OR 2.63, 95%CI 1.20–5.76) and conduct problems (OR 3.03, 95%CI 1.01–9.12) at 10 years old.[13] In our study, we have shown that sleep problems are highly prevalent in children with allergic diseases. Further analysis showed that children with asthma who had sleep problems had significantly higher emotional symptoms score than children without asthma, but emotional symptoms score in children with asthma who had no sleep problems were significantly lower than those with sleep problems, and was not significantly different from those without asthma. (Fig. 2) Similarly, children with atopic dermatitis who had sleep problems had significantly higher emotional symptoms score and conduct problems score than children without atopic dermatitis, but emotional symptoms score and conduct problems score in children with atopic dermatitis who had no sleep problems were significantly lower than those with sleep problems, and was not significantly different from those without atopic dermatitis. (Fig. 3) Our study results suggest that sleep disturbance might play an important role in the behavioral problems in children with allergic diseases. Therefore, it is important to recognize sleep problems in children with allergy and offer timely management. We suggest assessing for presence of sleep disturbance when evaluating children with asthma, allergic rhinitis, and atopic dermatitis. For children with allergic disease who have sleep disturbance, we suggest that it is crucial to achieve optimal control of nighttime symptoms and it is also important to offer sleep hygiene education.

This is a cross-sectional study and therefore could only demonstrate association between factors rather than causal relationship. This is also a questionnaire-based study and therefore could be prone to have recall bias. Further prospective studies with objective measurements of sleep are needed to clarify the relationship between sleep disturbance and emotional or conduct problems in children with asthma, allergic rhinitis, or atopic dermatitis.

Sleep problems are highly prevalent in preschool children with asthma, allergic rhinitis, and atopic dermatitis, including more night awakenings, daytime sleepiness, bedtime resistance, sleep onset delay, sleep anxiety, parasomnias, and sleep disordered breathing. Children with allergic diseases also have significantly higher emotional and conduct problems scores, which might be related to their sleep problems. We suggest routine evaluation of sleep disturbance and symptoms of sleep disordered breathing in children with asthma, allergic rhinitis, and atopic dermatitis, and we stress the importance of optimal control of nighttime symptoms and offering sleep hygiene education and avoiding acquired problematic sleep habits in those with sleep problems.

Abbreviations

AD, atopic dermatitis; ADHD, attention deficit hyperactivity disorder; AR, allergic rhinitis; CSHQ, Children's Sleep Habits Questionnaire; ISAAC, International Study of Asthma and Allergies in Childhood; SDQ, Strengths and Difficulties Questionnaire

Declarations

Conflict of Interest

The authors have no relevant conflicts of interest.

Consent to Participate Declaration: not applicable

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics Approval

This study was performed in line with the principles of the Declaration of Helsinki. The Taipei City Hospital Research Ethics Committee approved the study protocol.

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Figures

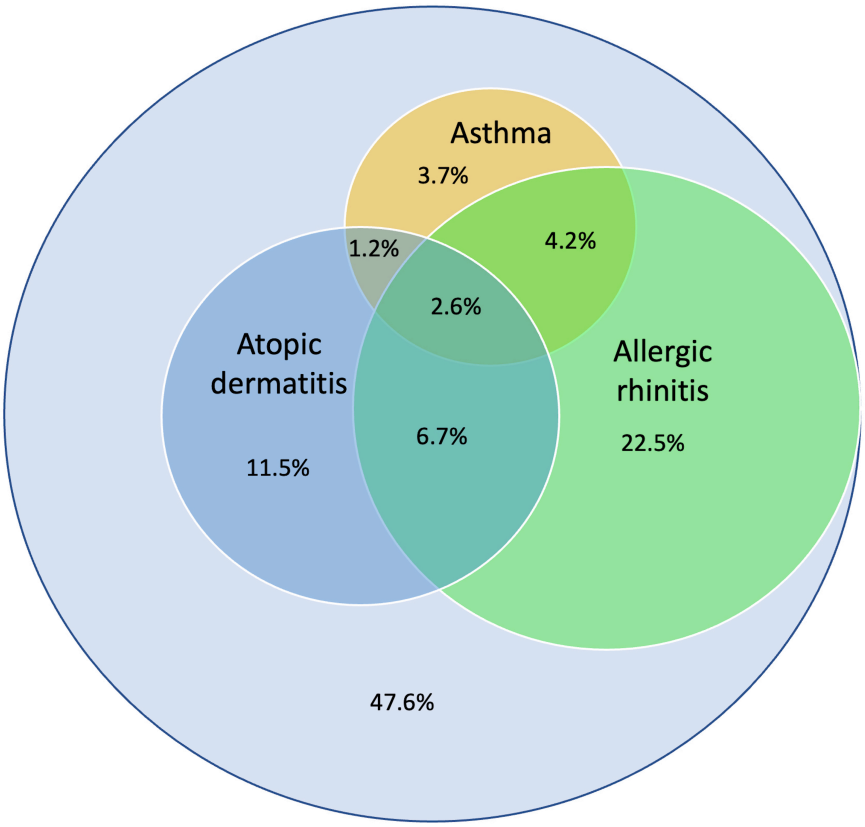


Figure 1. Prevalence of physician-diagnosed asthma, allergic rhinitis, and atopic dermatitis in preschool children
The prevalence of physician-diagnosed asthma, allergic rhinitis, and atopic dermatitis were 11.7, 35.9%, and 21.9%, respectively, and 14.7% had at least 2 overlapping diagnoses.

Figure 1

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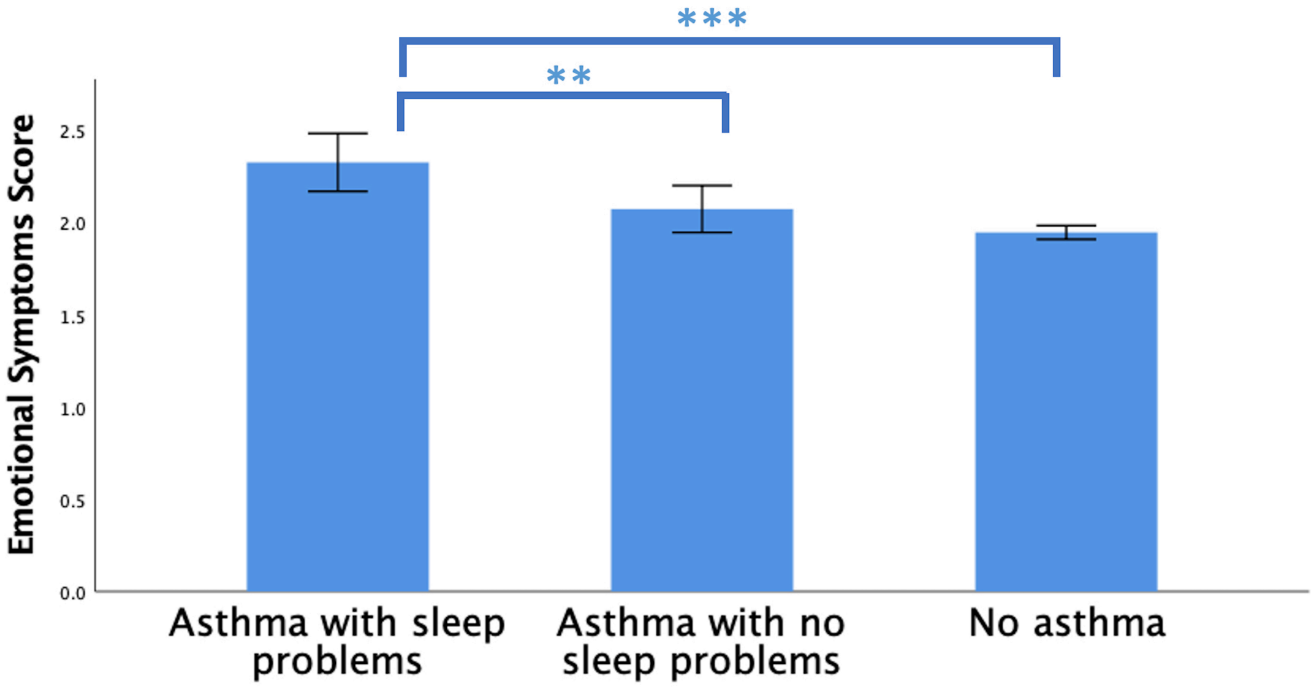


Figure 2. SDQ emotional symptoms score in children with asthma with and without sleep problems and in children without asthma.
Children with asthma who had sleep problems had significantly higher emotional symptoms score than children without asthma, but emotional symptoms score in children with asthma who had no sleep problems were significantly lower than those with sleep problems, and was not significantly different from those without asthma. SDQ, Strengths and Difficulties Questionnaire. **p<0.01; ***p<0.001

Figure 2

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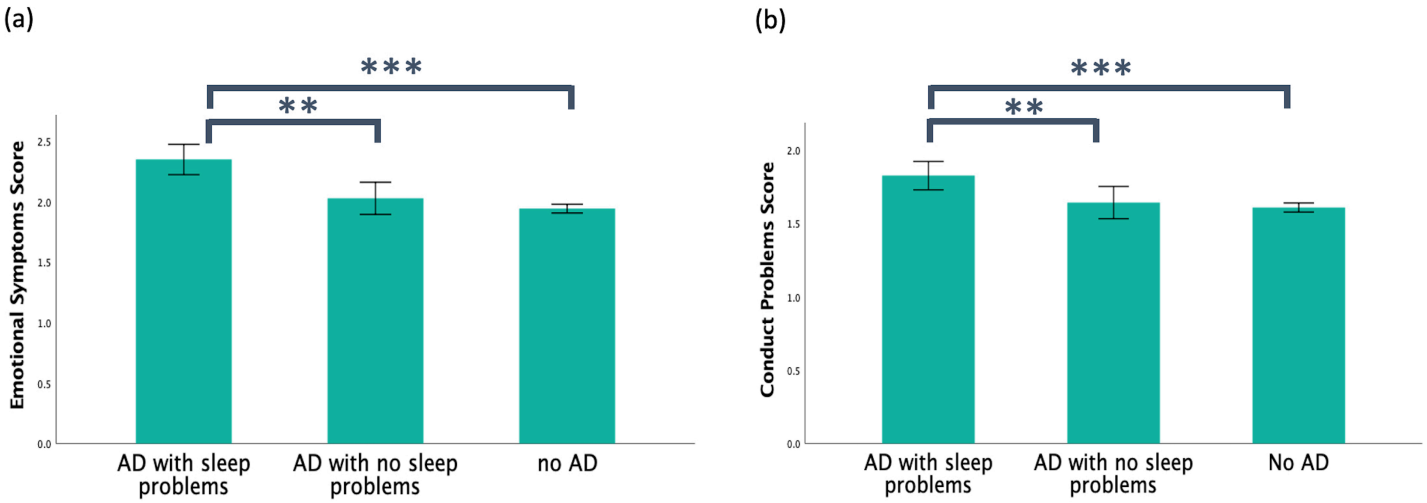


Figure 3. (a) SDQ emotional symptoms score in children with atopic dermatitis with and without sleep problems and in children without atopic dermatitis.
Children with atopic dermatitis who had sleep problems had significantly higher emotional symptoms score than children without atopic dermatitis, but emotional symptoms score in children with atopic dermatitis who had no sleep problems were significantly lower than those with sleep problems, and was not significantly different from those without atopic dermatitis. **(b) SDQ conduct problems score in children with atopic dermatitis with and without sleep problems and in children without atopic dermatitis.** Children with atopic dermatitis who had sleep problems had significantly higher conduct problems score than children without atopic dermatitis, but conduct problems score in children with atopic dermatitis who had no sleep problems were significantly lower than those with sleep problems, and was not significantly different from those without atopic dermatitis. AD, atopic dermatitis. SDQ, Strengths and Difficulties Questionnaire. **p<0.01; ***p<0.001

Figure 3

See image above for figure legend