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Adenoid hypertrophy and nocturnal enuresis are associated with sleep disturbances

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Abstract

Objective: Adenoid hypertrophy and nocturnal enuresis, comorbidities that are quite prevalent among children, are both associated with sleep problems. However, limited research has specifically focused on sleep domains and their parameters. In the present study we thus aimed to investigate the impact of adenoid hypertrophy and nocturnal enuresis on sleep, both when the two disorders coexist and when they do not coexist.

Methods: We investigated 178 children (mean age: 7.24±1.02 years, range=6-9 years), 50 (28.1%) of whom had only adenoid hypertrophy, 39 (21.9%) of whom had only nocturnal enuresis, 35 (19.7%) of whom had coexistence of adenoid hypertrophy and nocturnal enuresis, and 54 (30.3%) of whom were healthy-control children. Psychiatric disorders were diagnosed by a semi-structured diagnosis interview and the diagnosis of adenoid hypertrophy was confirmed by flexible fiberoptic nasopharyngoscopy. Sleep habits and disturbances were assessed via the Children's Sleep Habits Questionnaire and Modified Epworth Sleepiness Scale.

Results: Our results showed that the comorbid condition was the most severe form in terms of both adenoid hypertrophy and enuresis. Regarding sleep difficulties, the "Sleep-Disordered Breathing", "Night Wakings", "Sleep Onset Delay" and "Sleep Duration" parameters were closely associated with adenoid hypertrophy and its severity, while "Bedtime Resistance", "Parasomnias" and "Sleep Anxiety" domains of sleep were strongly related to nocturnal enuresis.

Conclusion: Otorhinolaryngologists, child psychiatrists and pediatricians should be aware of the relationship between enuresis and adenoid hypertrophy, that both diseases are associated with impaired sleep patterns, and that children affected by the comorbidity of the two disorders experience more sleep disturbances.

Keywords: Adenoids, nocturnal enuresis, sleep disorders, children.

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Introduction

Obstructive sleep-disordered breathing, a complex, multifactorial syndrome, is characterized by frequent and repetitive episodes of upper airway obstruction during sleep. Adenoid hypertrophy, a condition frequently encountered in otolaryngology clinics in childhood, is one of the most common pathologies associated with upper airway obstruction and obstructive sleep-disordered breathing in the pediatric population.[1,2] Chronic and repetitive upper airway obstruction arising from adenoid hypertrophy can lead to sleep problems including mouth breathing, snoring, increased respiratory effort, sleep fragmentation and frequent awakenings, obstructive sleep apnea (OSA) or witnessed apnea, decreased rapid eye movement (REM) sleep, unrefreshing sleep, excessive daytime sleepiness, and enuresis.[1-3]

Enuresis, another common pediatric problem observed in general practice, is defined as intermittent urinary incontinence (whether involuntary or intentional) that is not consistent with a child's developmental age (over the age of 5 years). The three main types of enuresis consist of nocturnal (night-time) only, diurnal (daytime) only, and both nocturnal and diurnal. Nocturnal enuresis, also known as bedwetting, characterized by a failure to control urination and thereby urinary incontinence while sleeping [throughout this paper, the terms "enuresis" and "nocturnal enuresis" will be used interchangeably in most areas]. Enuresis is divided into two subtypes depending on the absence or presence of the previous dry period for longer than 6 months during sleep. Primary enuresis refers to children who have never had a dry period longer than 6 months during sleep, while secondary enuresis applies to children who have a return after a dry period of at least 6 months.[4,5] The etiology and causes of enuresis are multifaceted. Underlying problems include genetic, developmental, psychological, urinary, hormonal and sleep-related factors.[5] Accumulated evidence indicates that enuresis is closely related to obstructive sleep-disordered breathing and adenoid hypertrophy, and that concomitant enuresis is observed quite frequently in children with adenoid hypertrophy. Also, nocturnal enuresis has been associated with more negative consequences of adenoid hypertrophy such as sleep apnea syndrome.[6-9] Previous studies have documented that the prevalence of enuresis is 22-42% among children with adenoid hypertrophy and 8-47% among children with upper airway obstruction, with prominent improvement of enuresis after surgery.[6,9,10]

Regarding the relationship between nocturnal enuresis and adenoid hypertrophy, it has been emphasized that nocturnal enuresis may be a symptom, sign and result of adenoid hypertrophy [6-9], and that the relationship has been mainly linked to sleep pathologies and upper airway obstruction caused by adenoid hypertrophy. It is highlighted that upper airway obstruction and sleep apnea increase water and sodium excretion by increasing the nighttime release of atrial natriuretic peptide due to the stimulation of right atrial receptors originating from alterations of intrathoracic pressure, which in turn, can cause enuresis. Moreover, obstructive respiratory events including adenoid hypertrophy decrease arousal response, disturb urodynamics, increase bladder pressure by elevating intra-abdominal pressure, and these changes impair the secretion and diurnal rhythm of vasopressin (antidiuretic hormone), which regulates fluid balance. Also, large adenoids interrupt sleep architecture by blocking normal breathing and reduce normal brain and brain stem control of urinary function, which can lead to enuresis.[7,11,12]

On the other hand, enuresis itself is also associated with sleep problems, even though obstructive respiratory events and disturbed sleep patterns are quite common among children with nocturnal enuresis. The most common sleep pathologies include sleep deprivation triggered by sleep fragmentation, increased deep sleep, elevated sleep arousal thresholds (i.e., fewer arousals or deeper sleep), frequent cortical arousals, periodic limb movements, and daytime sleepiness.[13-21]

As a result, both enuresis and adenoid hypertrophy are characterized by sleep problems, but data on which of the two has a more disruptive effect on the sleep mechanism is limited. Also, it has not been adequately investigated which sleep parameters are more affected. In this study, we therefore aimed to examine the impact of adenoid hypertrophy and nocturnal enuresis on sleep both when the two disorders coexist and when they do not coexist.

Materials and Methods

Participants

This cross-sectional study was performed with 178 children composed of 108 males (60.7%) and 70 females (39.3%) aged 6-9 years (mean 7.24±1.02 years, range=6-9 years). To evaluate the sleep domains and their parameters, four different groups of participants who were matched for age, gender, sociocultural characteristics and educational

attainment were chosen: the adenoid hypertrophy group, the nocturnal enuresis group, the comorbid diagnosis group of nocturnal enuresis and adenoid hypertrophy, and the control group. The adenoid hypertrophy sample consisted of 50 children (30 males (60%), 20 females (40%), mean age: 7.06±1.07 years) diagnosed with adenoid hypertrophy but no additional disorders including other obstructive pathologies in the upper respiratory tract such as tonsillary hypertrophy. The nocturnal enuresis sample was recruited from children who presented to the Child and Adolescent Psychiatry Outpatient Clinic with the complaint of bedwetting. The sample included 39 children (24 males (61.5%), 15 females (38.5%), mean age: 7.26±1.04 years) diagnosed with nocturnal enuresis but no additional physical and psychiatric disorders including other types of enuresis. Only children with primary nocturnal enuresis were enrolled in the study. The comorbid sample consisted of 35 children (22 males (62.9%), 13 females (37.1%) mean age: 7.11±1.1 years] diagnosed with adenoid hypertrophy and nocturnal enuresis but no additional disorder. Children in the control group were randomly recruited from normal children who were admitted to the pediatric clinic of the hospital. The control sample included 54 children (32 males (59.3%), 22 females (40.7%), mean age: 7.48±0.8 years) developing typically with no clinical diagnosis. All children were un-medicated at the time of examinations.

Children with any psychiatric disorders except primary nocturnal enuresis and any otolaryngological problems except adenoid hypertrophy were excluded from the study. Nocturnal enuresis dependent on the direct physiological effect of a substance (e.g. a diuretic, antipsychotic, or SSRI antidepressant) or a general medical condition (e.g. diabetes, a urological problem including urological anomalies and/or bladder instability, urinary tract infection, spina bifida or seizure disorder) were also exclusion criterion. We further excluded children with cystic fibrosis, asthma, known genetic or craniofacial anomalies, cerebral palsy, overweight (body mass index [BMI] ≥85th percentile) and obesity (BMI ≥95th percentile), any other underlying systemic disease and children who had undergone adenotonsillectomy.

Regarding sleep hygiene, the children of the parents who answered the following questions as "usually" or "always" were also not included in the study: heavy exercise during the day, excessive consumption of drinks or foods containing caffeine after 5 PM (e.g., chocolate, cola), watching TV, video or DVDs to help fall asleep, engaging in exciting or stimulating activities in the hour before bedtime (e.g., rough play, video games, sports).

Procedure

Each child and his/her parents were evaluated with a semi-structured psychiatric interview (Turkish version of the Schedule for Affective Disorders and Schizophrenia for School-Aged Children- Present and Lifetime Version, DSM-5-K-SADS-PL-DSM-5-T) to identify the presence of any current or past psychopathology.[22,23] Also, all children underwent a physical examination and a detailed otorhinolaryngological examination, and children who had mouth breathing during sleep, snoring or witnessed apnea were assessed by flexible fiberoptic nasopharyngoscopy to confirm the diagnosis of adenoid hypertrophy. The size of adenoid tissue was categorized between grades I and IV according to the percentage of adenoid tissue that occurred with blockage of the posterior choana in a sitting position and at rest: 0-25% (grade 1), 25-50% (grade 2), 50-75% (grade 3), 75-100% (grade 4).[24] Severe hypertrophy was considered grade 3 and above, while grade 2 and below were allocated as mild hypertrophy.

After a full verbal explanation of the study, for all participants who were accepted to participate in the study, a written and verbal informed consent was obtained from the parents of each child. This study was approved by the local Ethics Committee of the Medical Faculty of the Sivas Cumhuriyet University and performed in accordance with Good Clinical Practice procedures and the current revision of the Declaration of Helsinki (No: 2019-12/18, Date: 11.12.2019).

Data Collection Tools:

Demographic information form: Participants' socio-demographic characteristics (age, sex, place of residence, family characteristics, etc.) and clinical data (participants' health and disease status, individual and family history, features of nocturnal enuresis and adenoid hypertrophy, etc.) were obtained with a questionnaire designed by the researchers. This questionnaire was evaluated by the researchers during the examinations. We also recorded the body weight, height and body-mass index (BMI: body mass/height^2) of each child using standard techniques.

The Children's Sleep Habits Questionnaire (CSHQ): The CSHQ is one of the widely used sleep-screening instruments for childhood sleep habits and disturbances devel-

oped by Owens et al. [25] The questionnaire, a parent-rated questionnaire, is rated on a three-point Likert scale ("rarely": never or 1 time within the past week; "sometimes": 2–4 times within the past week; "usually": 5–7 times within the past week). It is comprised of 56 items (of which 33 are scored questions), 8 subscales and a CSHQ total score. The subscales concerning sleep domains include Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Wakings, Parasomnias, Sleep-Disordered Breathing, and Daytime Sleepiness. The Total Sleep Disturbances index score is obtained by summing the scores of all subscales, and ranges from 33 to 99. A total CSHQ score over 41 indicates the presence of clinically important sleep problems, with higher scores reflecting greater sleep disturbances. The Turkish validity and reliability study was performed by Perdahlı Fiş et al.[26]

The Modified Epworth Sleepiness Scale (mESS): The mESS is a widely used inventory to assess the general level of daytime sleepiness in children. The scale is completed by children or their parents depending on the age of the child, and consists of 8 items evaluating the likelihood of falling asleep during commonly encountered situations.[27] Children or caregivers rate the likelihood of falling asleep in these eight different daily life situations/activities on a four-point Likert scale: no chance (0 points); slight chance (1 point); moderate chance (2 points); or high chance (3 points). The mean mESS score ranges from 0 to 24, a higher score indicates greater sleepiness. A mESS score over 10 suggests "excessive daytime sleepiness" and may represent the presence of underlying sleep disorders. The scale's Turkish psychometric properties were studied by Izci et al.[28]

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY, USA). Normality was tested by a one-sample Kolmogorov-Smirnov test. Numerical and categorical data are given as mean ± standard deviation (SD), median (min-max), number (n) and percentage (%) as appropriate. Comparisons of groups were performed using chi-square test for categorical variables, and Kruskal-Wallis test and Mann–Whitney U test for continuous variables. Post hoc nonparametric Dunn's (Bonferroni) and nonparametric Tukey HSD method were used to determine which groups in our sample differed. A p value of <0.05 was accepted as statistically significant.

Results

Sociodemographic characteristics of participants

The study population consisted of 178 children between 6 and 9 years of age (mean age: 7.24±1.02 years), 50 (28.1%) of whom had only adenoid hypertrophy, 39 (21.9%) of whom had only nocturnal enuresis, 35 (19.7%) of whom had coexistence of adenoid hypertrophy and nocturnal enuresis, and 54 (30.3%) of whom were healthy-control children. The four groups did not differ significantly in terms of age, gender, level of parental education, family income level, place of residence or the number of people per bedroom (p>0.05). On the other hand, the positive family history of enuresis differed between the groups. Children in the nocturnal enuresis group had a significantly higher family history of enuresis compared to other diagnostic groups and controls (p<0.001). Family history for enuresis of children in the comorbid group also showed a tendency to be higher than those of the only adenoid hypertrophy group and the control group, but the difference was not statistically significant. Furthermore, the four groups differed significantly in the mean scores of BMI (p=0.001); the scores of children in the adenoid hypertrophy group and the comorbid group were similar but significantly lower than those in the nocturnal enuresis group and the control group. The baseline demographic characteristics of the four groups are shown in Table 1.

Clinical features of participants

Regarding the clinical features of enuresis, the amount of urine incontinence (bed-wetting vs. panties/pajamas wetting), and the number of bedwetting incidents overnight (1 vs. 2 and above) did not differ between the enuresis group and the comorbid group. In contrast, the frequency of enuresis within a week was significantly higher in the comorbid group than in the enuresis group (4.06 ± 1.39 vs. 2.87 ± 1.15, p <0.001). With regard to the size of the adenoid tissue, we found that the rate of severe hypertrophy was higher in children in the comorbid group than children with only adenoid hypertrophy (p=0.032). Clinical features of participants are presented in Table 2.

Assessment/Evaluation of sleep habits and daytime sleepiness

The mean scores of the Children's Sleep Habits Question-

Table 1. Sociodemographic characteristics of participants.

	Adenoid Hypertrophy (n=50)	Enuresis Nocturna (n=39)	Adenoid Hypertrophy and Enuresis Nocturna (n=35)	Control (n=54)	p-value*
Age (mean age ± SD)	7.06±1.07	7.26±1.04	7.11±1.10	7.48±0.88	0.113
Gender (n, %)					
Male	30 (60)	24 (61.5)	22 (62.9)	32 (59.3)	0.987
Female	20 (40)	15 (38.5)	13 (37.1)	22 (40.7)	
Place of residence (n, %)					
Urban	34 (68)	25 (64.1)	21 (60)	35 (64.8)	0.901
Rural	16 (32)	14 (35.9)	14 (40)	19 (35.2)	
Family Income Level (n, %)†					
Minimum wage/less than minimum wage	15 (30)	18 (46.2)	11 (31.4)	25 (46.3)	0.204
Above the minimum wage	35 (70)	21 (53.8)	24 (68.6)	29 (53.7)	
Level of education of the mother (n, %)					
Primary education and lower	14 (28)	13 (33.3)	12 (34.3)	20 (37)	0.804
Upper primary education	36 (72)	26 (66.7)	23 (65.7)	34 (63)	
Level of education of the father (n, %)					
Primary education and lower	16 (32)	13 (33.3)	11 (31.4)	15 (27.8)	0.943
Upper primary education	34 (68)	26 (66.7)	24 (68.9)	39 (72.2)	
Family history of Enuresis Nocturna (n, %)					
Yes	12 (24)	28 (71.8)	11 (31.4)	11 (20.4)	<0.001
No	38 (76)	11 (28.2)	24 (68.6)	43 (79.6)	
Number of people per bedroom (n, %)					
Alone	22 (44)	18 (46.2)	16 (45.7)	21 (38.9)	
1+	19 (38)	15 (38.5)	9 (25.7)	20 (37)	0.745
2+	9 (18)	6 (15.4)	10 (28.6)	13 (24.1)	
Body Mass Index (mean±SD)	18.55±0.81	19.12±1.11	18.42±0.68	19.20±1.19	0.001

* Chi-square test for categorical variables and Kruskal Wallis Test for continuous variables were used to test group differences.
† The level of income was determined by the minimum wage value on the date of the study.

naire and the Modified Epworth Sleepiness Scale of the participants are given in Table 3. Overall, the mean scores on all subscales of the Children's Sleep Habits Questionnaire and the mean scores of the Modified Epworth Sleepiness Scale were significantly different between the groups. Specifically, when analyzing sleep habits, the mean scores of children in the nocturnal enuresis group and the comorbid group on the "Bedtime Resistance" and "Parasomnias" subscales were significantly higher in comparison with children in the adenoid hypertrophy group and controls, and the scores of those in the adenoid hypertrophy group were significantly higher compared to the control group ($p<0.001$). In regard to the mean scores on the "Sleep Duration" and "Night Wakings" subscales, the differences between the groups were statistically significant ($p<0.001$); the mean scores of those in the adenoid hypertrophy group and the comorbid group were significantly higher than those of the other two groups, and the mean scores were similar in the nocturnal enuresis group and the control group. The mean scores of children in the adenoid hypertrophy group and the comorbid group on the "Sleep Onset Delay" and "Sleep-Disordered Breathing" subscales were significantly higher than those of the nocturnal enuresis group and the control group, and the scores of those

Table 2. Clinical features of participants

	Adenoid Hypertrophy (n=50)	Enuresis Nocturna (n=39)	Adenoid Hypertrophy and Enuresis Nocturna (n=35)	p-value*
Enuresis nocturna amount (n, %)				
Panties/pajamas get wet	-	7 (17.9)	12 (34.3)	0.108
Bed gets wet	-	32 (82.1)	23 (65.7)	
Frequency of enuresis (mean-nights (per week) ± SD)	-	2.87±1.15	4.06±1.39	<0.001
Number of bedwettings overnight (n, %)				
1+	-	32 (82.1)	23 (65.7)	0.108
2+	-	7 (17.9)	12 (34.3)	
Size of adenoid tissue (n, %)				
Mild hypertrophy	37 (74)	-	18 (51.4)	0.032
Severe hypertrophy	13 (26)	-	17 (48.6)	

* Chi-square test for categorical variables and Mann-Whitney U Test for continuous variables were used to test group differences.

Table 3. Mean scores of the Children's Sleep Habits Questionnaire and Modified Epworth Sleepiness Scale by diagnostic groups.

	Adenoid Hypertrophy (n=50)	Enuresis Nocturna (n=39)	Adenoid Hypertrophy and Enuresis Nocturna (n=35)	Control Group (n=54)	p-value*
Children's Sleep Habits Questionnaire					
Bedtime Resistance	8.38±0.94	9.0±8.85	9.0±1.69	7.30±1.02	<0.001
Sleep Onset Delay	2.08±0.66	1.79±0.61	2.46±0.56	1.54±0.69	<0.001
Sleep Duration	6.14±1.10	3.79±0.80	6.74±1.54	3.76±1.13	<0.001
Sleep Anxiety	4.98±1.02	7.03±1.13	7.09±1.85	5.06±0.89	<0.001
Night Wakings	5.48±1.23	3.69±0.73	5.66±1.28	3.33±0.72	<0.001
Parasomnias	8.84±1.03	10.79±0.76	10.86±1.24	8.15±1.07	<0.001
Sleep Disordered Breathing	5.68±1.09	3.28±0.56	6.34±1.30	3.33±0.54	<0.001
Daytime Sleepiness	12.56±1.48	12.41±1.75	15.23±2.35	10.44±2.26	<0.001
Total Sleep Disturbances index score	51.68±3.39	51.49±3.70	61.60±6.39	43.35±5.95	<0.001
Modified Epworth Sleepiness Scale (mESS)	10.68±1.75	9.49±2.07	12.77±3.37	4.52±3.57	<0.001

* Kruskal Wallis Test was used to test group differences.

in the nocturnal enuresis group were significantly higher than the control group (p<0.001). The mean scores of children in the nocturnal enuresis and the comorbid group on the "Sleep Anxiety" subscale were significantly higher than those of the other two groups, and the results were similar in the adenoid hypertrophy group and the control group (p<0.001). As for the mean scores of the "Daytime Sleepiness" subscale, the Total Sleep Disturbances index and the total score of the Modified Epworth Sleepiness Scale, the differences between the groups were also statistically significant (p<0.001); the mean scores of those in the comorbid group were significantly higher compared to the rest, and the mean scores were similar in the nocturnal enuresis group and the adenoid hypertrophy group but significantly higher than those in the control group (Table 3).

Discussion

Nocturnal enuresis and adenoid hypertrophy, both of which are related to sleep problems, are common health problems among children, and their comorbidity is quite prevalent. In this study, we specifically investigated the sleep habits and patterns among children with adenoid hypertrophy and nocturnal enuresis both when the two disorders coexisted and when they did not coexist. Our findings lead us to suggest that children with enuresis and adenoid hypertrophy may suffer from additional complications related to a variety of sleep disturbances. Moreover, we found noteworthy differences in sleep domains between adenoid hypertrophy, nocturnal enuresis and comorbid diagnosis of nocturnal enuresis and adenoid hypertrophy.

First, our study revealed that children in the comorbid group had a more severe form of adenoid hypertrophy compared to children with adenoid hypertrophy only, and a higher frequency of enuresis than in children with enuresis only. This is in agreement with reports by studies suggesting that enuresis is more prevalent in children with severe adenoid hypertrophy, and strongly associated with the severity of adenoid hypertrophy [6,29,30], however, there are studies that do not confirm this relationship or do not report any relationship.[31] Heterogeneity in study settings and methodological differences of data sources, case definitions, and included age ranges may contribute to this great variability. Second, the results of the present study indicated that most of the sleep domains are more heavily affected by the comorbidity of adenoid hypertrophy and nocturnal enuresis rather than each being a single diagnosis. Our result reflecting that comorbidity is a more severe form in terms of both adenoid hypertrophy and enuresis provides a solid explanation for this finding. Since both adenoid hypertrophy and nocturnal enuresis are related to impaired sleep patterns, sleep disturbances are likely to be overrepresented among children who have a comorbidity of both diseases.

Adenoid hypertrophy can lead to secondary mouth breathing, snoring and impaired sleep integrity by creating an obstruction in the upper respiratory tract and disrupting nasal breathing.[1-3] The mechanism underlying sleep problems is that adenoid hypertrophy, especially OSA, affects the integrity of both REM and non-REM sleep stages and causes frequent awakening episodes by means of snoring, episodic oxyhemoglobin desaturation and hypercapnia.[1,32] Interrupted sleep architecture and frequent waking from sleep give rise to unrefreshing and inefficient sleep, inadequate time of sleeping, poor sleep quality, and hence waking up in the morning without rest, and excessive daytime sleepiness.[1-3,32] On the other hand, nocturnal enuresis, a predominantly non-REM sleep phenomenon [15-17], also results in similar sleep problems, however, the relationship between enuresis and sleep disturbances is bidirectional. In general, immaturity of the sleep mechanism, elevated arousal thresholds (i.e., fewer arousals or deeper sleep), poor arousability, and increased deep sleep lead to nocturnal enuresis, while enuresis induces sleep fragmentation, frequent cortical arousals, sleep deprivation, and daytime sleepiness.[13-21,33] Further, as coping mechanisms with enuresis nocturna, parents' adoption of strategies related to waking the child to prevent bedwetting, or taking the child to the toilet while sleeping can provoke frequent nighttime awakening and fragmented sleep, thereby daytime sleepiness and poor sleep quality.[18]

More specifically, regarding the effects of enuresis, adenoid hypertrophy and the comorbidity of the two on domains of sleep, not surprisingly our findings demonstrated that sleep-related breathing disturbances are highest in the comorbid group and that the children with adenoid hypertrophy had more of these problems than children with enuresis. Conversely, children with enuresis did not differ from the control group in this sleep domain. Given that adenoid hypertrophy is the most common cause of upper respiratory obstruction and obstructive sleep-disordered breathing in pediatric patients this finding is not surprising. Adenoid hypertrophy may impair this sleep domain more than enuresis by causing nasal obstruction, snoring and sleep apnea, and also this impairment is correlated

with the severity of adenoid hypertrophy. We found that the 'Sleep Duration' and 'Night Wakings' dimensions of sleep were similar in the adenoid hypertrophy group and comorbid group, but were significantly more negatively affected compared to the enuresis and control groups. The two domains of sleep were similar in children with nocturnal enuresis and the controls. Short sleep time, frequent night awakenings, and sleep fragmentation may originate from snoring, snorts and gasps, apnea and mouth breathing during sleep since both upper respiratory tract obstruction and snoring are associated with cortical arousal, which triggers an autonomic activation and increased respiratory effort against a closed airway. It is evident that these two factors lead to short sleep time, disrupted sleeping-waking rhythm and intermittent awakenings.[34,35] On the other hand, although it did not differ from the control group in terms of sleep time and non-spontaneous awakenings in our study, in fact, nocturnal enuresis is related to sleep fragmentation and frequent cortical arousals.[16,18,19,21,33] Some authors have noted that children with enuresis display frequent nighttime awakenings, shorter periods of continuous sleep, and greater sleep fragmentation than controls.[15,18,20] Inconsistent results may be due to nocturnal enuresis being clinically heterogeneous.

Other domains of sleep, "Bedtime Resistance", "Sleep Anxiety" and "Parasomnias" were mostly observed in the comorbid group and the nocturnal enuresis group, which suggests that these dimensions are associated with enuresis. However, one of the items of the "parasomnias" subscale in the questionnaire that we used to evaluate sleep habits is related to bedwetting, which may explain the high dimension seen in this domain. Also, the other item of this subscale, "restless and moves a lot, in particular, periodic limb movements", is a frequently reported problem in enuretic children.[14,15,18] The "Bedtime Resistance" domain of sleep mostly evaluates the need to sleep with others (falling asleep in the bed of his/her parents or sibling, being afraid to sleep alone, and the need for parent(s) in the room to sleep) and problems of sleep initiation, which are more affected by the psychological state. These results coincide with those of other reports showing that children with enuresis need more time to fall asleep and are more afraid of going to bed compared to healthy controls, and studies have also indicated that enuretic children feel more tired prior to bedtime, and in the morning.[15,18] Again, the need for parent(s) in the room to sleep, being afraid of sleeping in the dark, being afraid of sleeping alone and trouble sleeping away constitute the "Sleep Anxiety" domain of sleep, which is more closely related to psychological factors and status. The high rate of sleep anxiety in enuretic children may be related to these children having difficulty sleeping outside their homes (with relatives, or on a trip), which is assessed with an item in the "Sleep Anxiety" subscale. Also, one of the sources of sleep disturbance in enuretic children is the fear or anxiety of bedwetting again at night, although we did not evaluate this in this study.[20]

Finally, regarding the "Daytime Sleepiness" domain and Total Sleep Disturbances index score of the Sleep Habits Questionnaire, and the total score of the Modified Epworth Sleepiness Scale, we found that children in the comorbid group experienced more daytime sleepiness, falling asleep at inappropriate times and general sleep disturbances compared to the rest. In both total scores and daytime sleepiness, children in the adenoid hypertrophy group and nocturnal enuresis group were similar but significantly higher than those in the control group. This is perhaps not surprising since the comorbid condition is a more severe form. On the other hand, our result, a similar level of daytime sleepiness between adenoid hypertrophy and enuresis, shows that the effects of both adenoid hypertrophy and enuresis are not limited to nighttime. Since daytime sleepiness and sleep deprivation due to sleep fragmentation are associated with difficulty in staying awake in quiet settings (e.g., class) and focusing attention, children who have difficulty keeping awake during the daytime are likely to experience mood and emotional changes, and learning and attention problems.[36,37] Daytime sleepiness and difficulty staying awake during the daytime or inadequate effective duration of wakefulness may be the consequences of low efficiency of sleep, frequent sleep fragmentation, and hence an unrefreshed feeling after an overnight sleep and a worse sleep quality.[13,20,21] Consistent with our results, previous studies have also highlighted the presence of a relationship between remarkably increased sleep fragmentation and excessive/clear daytime sleepiness in enuretic children.[21]

The strengths of this study are the assessment of the different types of sleep problems separately, with a relatively larger sample size, and the use of structured interview techniques in the psychiatric diagnosis process. However, our study has some limitations. First, the cross-sectional design of the study prevents generalization of the results and determination of definitive causality. Second, our measurements did not include polysomnography, which is the ideal method in this field. Finally, sleep evaluation

was not repeated after treatment for enuresis and adenoid hypertrophy. Prospective studies conducted with advanced tests in a sleep laboratory would be substantially valuable and appropriate to achieve more conclusive results.

Conclusion

In conclusion, the results of the present study lend support to the data that children with adenoid hypertrophy and enuresis have a potential increase in the risk of developing sleep problems. Specifically, the "Sleep-Disordered Breathing", "Night Wakings", "Sleep Onset Delay" and "Sleep Duration" parameters are closely associated with adenoid hypertrophy and its severity, while the "Bedtime Resistance", "Parasomnias" and "Sleep Anxiety" domains of sleep are strongly related to nocturnal enuresis. On the other hand, the "Daytime Sleepiness" parameter and "Total Sleep Disturbances index", which reflect general sleep disturbances, are equally affected by adenoid hypertrophy and enuresis. Taken together, these findings suggest that both adenoid hypertrophy and enuresis may play a role in a wide range of sleep disturbances and their maintenance, and in particular, children with comorbid adenoid hypertrophy and enuresis are vulnerable to greater sleep problems. Parents, otorhinolaryngologists, child psychiatrists and pediatricians should be aware of the relationship between enuresis and adenoid hypertrophy, that both diseases are associated with impaired sleep patterns, and that children affected by comorbidity of the two disorders experience more sleep disturbances. It also would be advisable to screen children with adenoid hypertrophy in terms of enuresis, and vice versa.

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