Association between primary nocturnal enuresis and habitual snoring in children with obstructive sleep apnoea-hypopnoea syndrome

Afroditi V. Sakellaropoulou[1], Maria N. Hatzistilianou[1], Maria N. Emporiadou[1], Victor T. Aivazis[2], John Goudakos[3], Konstantinos Markou[3], Fanni Athanasiadou-Piperopoulou[1]

[1]2nd Paediatric Department, Aristotle University of Thessaloniki, AHEPA Hospital, Greece
[2]1st Paediatric Department, Hippokration General Hospital, Thessaloniki, Greece
[3]Department of Otolaryngology, AHEPA University Hospital, Thessaloniki, Greece

Submitted: 23 June 2011
Accepted: 27 December 2011

Arch Med Sci 2012; 8, 3: 521-527
DOI: 10.5114/aoms.2012.28809

Corresponding author:
Afroditi Sakellaropoulou MD, PhD
2nd Paediatric Department
Aristotle University
AHEPA Hospital
18 Salaminos
Brilissia 15235
Athens, Greece
Phone: 00306972881018
E-mail: wx@otenet.gr

Abstract

Introduction: Nocturnal enuresis (NE) and obstructive sleep apnoea-hypopnoea syndrome (OSAHS) are common problems during childhood, and population studies have reported a significant correlation between them. This study aimed to assess whether habitual snoring, mouth breathing and daytime sleepiness are associated with increased incidence of NE in children with OSAHS.
Material and methods: Polysomnography was performed in 42 children (66.7% males), 3.5-14.5 years old, who were evaluated for sleep-disordered breathing (SDB).
Results: Fourteen out of 42 children (33.3%) presented mild, 16 out of 42 (38.1%) moderate and 12 out of 42 (28.6%) severe degree of OSAHS. Apnea hypopnea index (AHI) ranged between 1.30-94.20 (10.54 ±15.67) events per hour of sleep. Nocturnal enuresis was reported in 7/42 (16.7%) of them. The main observed symptoms were snoring (90.5%), restless sleep (81%), mouth breathing (71.4%), nasal congestion (76.2%), and difficulty in arousal (52.4%). A statistically significant association was found between NE and mouth breathing (p = 0.014) or nasal congestion (p = 0.005). Children with OSAHS and NE had a higher arousal index (8.14 ±8.05) compared with OSAHS children without NE (4.61 ±7.95) (p = 0.19, z = –1.28). Snorers had higher levels of AHI (11.02 ±16.37) compared with non-snorers (6.05 ±4.81) (p = 0.33, z = –0.96), and habitually snorers (23/42, 54.76%) were at greater risk of having NE (4/23) than were non-snorers (0/4, p = 0.36). However, the prevalence of enuresis was not related to the severity of OSAHS, expressed as AHI (p = 0.70).
Conclusions: Mouth breathing, nasal congestion and high threshold of arousal during sleep should be more carefully evaluated in cases of children with NE who do not respond to standard treatment and present SDB.

Key words: nocturnal enuresis, sleep apnoea syndrome.

Introduction

Nocturnal enuresis (NE) or bedwetting and sleep-disordered breathing (SDB) are common problems during childhood [1, 2]. The prevalence of enuresis (at least one night per week) has been reported to be 1.6% to 15%, depending on the subject's age and ethnic and cultural characteristics [2-5].

Sleep research has documented that nocturia and bedwetting are symptoms of obstructive sleep apnoea (OSA) in adults, and that bedwetting is

predictive of OSA in children [6, 7]. Moreover, nocturnal polyuria is considered a cardiovascular response to negative pressure breathing (inspiration against a closed glottis), which is characteristic of OSA [8]. The association between these two conditions in paediatric subjects is supported by the decrease or complete resolution of bedwetting after successful treatment of SDB with adenotonsillectomy or the use of intranasal corticosteroids [4, 6, 9].

Moreover, patients with untreated obstructive sleep apnoea syndrome (OSAS) excrete large amounts of sodium and urine overnight, probably because of increased secretion of atrial natriuretic peptide which is caused by the stimulation of right atrial receptors exposed to the exaggerated intra-thoracic pressure swings which accompany narrowing and obstruction of the upper airway. The natriuresis and polyuria are completely suppressed by effective treatment of OSAS [8, 10]. A few series have been published of hospitalised children with SDB and concomitant enuresis [1, 2, 7, 11], and also a number of population-based studies have reported a significant correlation between habitual snoring and nocturnal enuresis [12-14].

The purpose of this research was to assess whether habitual snoring, mouth breathing and daytime sleepiness are associated with increased incidence of enuresis in children with obstructive apnea hypopnea syndrome during sleep (OSAHS), and whether the prevalence of enuresis was modified by the severity of OSAHS.

Material and methods

Study sample and location

The study group included 42 children who visited the Paediatric Sleep Laboratory of the 2nd University Paediatric Department of AHEPA Hospital in Thessaloniki, Greece. There were 28 males (66.7%) and 14 females (33.3%). Their age ranged from 3.5 to 14.5 years old (range ± SD: 7.63 ±2.90 years). Children entered the Sleep Laboratory with their parents between 9 and 9.30 p.m. After cleaning the study area of electrodes' placement, the recording started at about 11 p.m.

Study protocol

Information was gathered concerning the child's gender, age, difficulty in breathing during sleep, mouth breathing, witnessed apnoea, daytime sleepiness, restless sleep, difficulty in arousal, fatigue, mouth breathing and enuresis. Snoring and its severity were also recorded. The frequency of snoring was graded as "never," "rarely" (once per week), "occasionally" (twice per week), "frequently" (3-4 times per week), and "almost always" (> 4 times per week).

Otolaryngological evaluation was performed in each child, and tonsils size was classified according to Mallampati criteria [15]. Subjects were excluded if they had any known genetic or craniofacial syndromes.

Polysomnographic study (PSG) was performed in 42 patients with a commercially available system, Sleep Screen, Viasys Healthcare Corporation. The recording of polysomnographic information was classified based on the existing criteria, since polysomnographic sleep study is recommended by the American Paediatric Academy as the gold standard for confirmation and classification of the severity of OSAHS in children [13, 16].

A single night of attended polysomnography was performed in each subject at the sleep laboratory, and no drugs were used to induce sleep. The polysomnographic sleep study included measurements of right and left electrooculograms, heart rate by electrocardiogram (ECG), a bipolar submental electromyogram, electro-encephalogram (EEG), anterior tibial electromyograms (EMG), thoracic and abdominal excursions as detected by inductance plethysmography bands, air flow monitored with a nasal pressure cannula, a thermistor, and an end-tidal capnograph that also provided breath-by-breath assessment of end-tidal carbon dioxide levels with simultaneous recording of the pulse waveform, and was recorded with a 3-seconds averaging routine (Capnograph Sleep, Smith Medical family of companies), oxygen saturation via a palm oximeter, snoring through a microphone placed at the trachea area, and also evaluation of the body placement. Acceptable studies were those with at least 6 h of recorded data of sufficient quality to allow respiratory event detection and distinction of wakefulness from sleep.

Definitions

The proportion of time spent in each sleep stage was expressed as a percentage of total sleep time (TST). Obstructive apnoea was defined as the absence of airflow with continued chest wall and abdominal movement that lasts 2 respiratory cycles [16-18], and hypopnoea as a decrease in oro-nasal flow greater than 50% despite continuous respiratory efforts followed by a reduction of saturation of oxyhaemoglobin at least for 3%, and/or arousal [16, 18, 19].

The obstructive apnoea-hypopnoea index (AHI) was defined as the number of apnoeas and hypopnoeas per hour of TST. The abnormal diagnostic for children would be AHI > 1/h of sleep [17, 18]. Since there are no definite diagnostic criteria for the classification of OSAHS severity in children, the classification of mild, moderate and severe degree of OSAHS in children with OSAHS was performed based on their clinical appearance, the number of obstructive events per hour of sleep, the end-tidal expiratory pressure of carbon dioxide ($PetCO_2$), the incidence and the severity of oxygen desaturation and the

frequency of arousals that are correlated with respiratory obstructive events [1, 16]. Moreover, Harvey *et al*. [20] classified OSAS in children based on AHI value: as mild (1 > AHI < 5/h), moderate (5 > AHI < 9/h) and severe (AHI > 10/h).

Nocturnal enuresis refers to the involuntary loss of urine after the age of 4 to 5 years, when children are expected to have achieved full bladder control at night. It is classified as primary when the child has never achieved night-time dryness and secondary when bedwetting occurs after dryness for at least 6 months [3, 10, 21].

The minimal frequency of nocturnal urine loss required to diagnose the condition as nocturnal enuresis has varied in different studies from once in the previous year [20] to twice a week [22]. In our study a child was characterized as having urine incontinence when it appears at least one night per week in children older than 4 years of age [3, 4, 20, 23].

Ethical approval

Our study was approved by the Ethical Committee of the Medical School of Aristotle University of Thessaloniki, Greece, and written informed consent was obtained from parents of all subjects.

Statistical analysis

The statistical analysis was performed using SPSS 11.2 for Windows; SPSS; Chicago, IL (SPSS Inc, Chicago IL). Frequencies and descriptive statistics were used primarily in order to assess the sample's overall attributes. χ^2 test and Fisher's exact test were used between qualitative variables in order to calculate *p* values. Mann-Whitney and Kruskal-Wallis tests were used for variables that were not normally distributed. Values of *p* below 0.05 were considered significant. Moreover, since the *p* value depends on the size of the data set, the statistical inference was assessed using estimation with confidence intervals (CI) and odds ratios (OD). If the 95% CI excludes 1, there is a significant difference between the groups and when the 95% CI includes one, there is no significance at $p = 0.05$.

Table I. Demographic and clinical features and polysomnographic results of children with OSAHS

Sex	28 males (66.7%) : 14 females (33.3%) 2 : 1 ratio
Age [years] (Mean ± standard deviation)	3.5-14.5 (7.63 ±2.90)
BMI [kg/m²]	13.66-18.52 (18.52 ±4.24)
Nocturnal enuresis	7 (16.7%)
Snoring	38 (90.5%)
Restless sleep	34 (81%)
Difficulty in arousal	22 (52.4%)
Fatigue	14 (33.3%)
Mouth breathing	30 (71.4%)
Nasal congestion	32 (76.2%)
Apnea-hypopnoea index (AHI) [events per hour of sleep]	1.30-94.20 (10.54 ±15.67)
Apnea index (AI) [apnoeic events per hour of sleep]	0.8-21.10 (4.27 ±3.30)
Total sleep time [h]	7.15 ±1.07

Results

Forty-two children were evaluated for possible SDB, and polysomnography sleep study was performed on them. Their demographic and clinical features and polysomnographic results are presented in Table I. Comparisons between the presence of nocturnal enuresis and patients' clinical features and symptoms are recorded in Tables II and III. Mild degree of OSAHS was presented by 14/42 children (33.3%), 16 (38.1%) moderate and 12/42 (28.6%) severe. Children who snore had higher levels of AHI (11.02 ±16.37 events per hour of sleep) compared with non-snorers (6.05 ±4.81 events per hour of sleep), but there was no statistical significance ($p = 0.33$, $z = –0.96$).

Moreover, no significant association ($p = 0.68$, $z = –0.40$) was found between patients' age and sex

Table II. Correlations between the presence of nocturnal enuresis and clinical features of patients with OSAHS

Parameter	Children with OSAHS		
	Without NE	NE	
Age [years] (Mean ± standard deviation)	7.77 ±3.06	6.92 ±1.98	$p = 0.54$ $z = –0.61$
	3.5-14.5 (7.63 ±2.90)		
Sex	25/28 males : 10/14 females	3/28 males : 4/14 females	$p = 0.14$
	28 males (66.7%) : 14 females (33.3%) 2 : 1 ratio		$p = 0.19$ OD = 0.37 95% CI = 0.09-1.45
AHI	10.96 ±16.49	8.45 ±11.51	$p = 0.70$
AI	4.42 ±3.58	3.57 ±2.36	$p = 0.62$ $z = –0.49$

Table III. Correlations between the presence of NE and symptoms

Variables	Number of patients with the symptom (% *n* of patients with the symptom/*N* (= 42) of patients with OSAHS)	Nocturnal enuresis (NE) (*n* of children with NE (% *n* of children with NE/*N* of children with the symptom)	Value of *p*	Odds ratio for nocturnal enuresis	95% confidence interval
Mouth breathing	30 (71.4%)	2 (6.66%)	0.01	10	1.59-62.78
Snoring	38 (90.5%)	7 (18.42%)	1	0.88	0.78-1
Snoring almost every night	23 (56.1%)	4 (17.39%)	0.54	1.33	1.05-1.68
Restless sleep	34 (81%)	5 (14.70%)	0.60	1.93	0.30-12.42
Restless sleep almost every night	17 (41.5%)	3 (17.64%)	0.54	1.21	0.97-1.51
Witnessed apnoea during sleep	29 (69%)	3 (10.34%)	0.17	0.26	0.04-1.39
Difficulty in arousal	20 (47.61%)	2 (10%)	0.41	0.37	0.06-2.21
Nasal congestion	32 (76.2%)	2 (6.25%)	0.005	15	2.25-99.63
Fatigue	14 (33.3%)	2 (14.28%)	1	1.30	0.21-7.75
Behaviour problems	4 (9.5%)	0 (0%)	1	0.88	0.78-1
Hypermotility	11 (26.2%)	2 (18.18%)	1	1.15	0.19-7.03
Aggressiveness	1 (2.4%)	0 (0%)	1	0.98	0.91-1.03
Attention deficit	5 (11.9%)	0 (0%)	0.56	0.85	0.75-1

(7.79 ±2.95 year-old boys vs. 7.32 ±2.89 year-old girls) (Figure 1). However, there was a statistically significant association between the presence of mouth breathing and nocturnal enuresis (p = 0.014, OD: 10, 95% CI: 1.59-62.78). There was also a significant difference between groups concerning the presence of NE and: 1) nasal congestion (OD: 15, 95% CI: 2.25-99.63), and 2) snoring almost every night (OD: 1.33, 95% CI: 1.05-1.68) (Table III). Finally, OSAHS children with NE had a higher arousal index per hour of total sleep time (8.14 ±8.05) compared with children with OSAHS who did not present NE (4.61 ±7.95) (p = 0.19, z = –1.28) (Figure 2) and there was a positive correlation between AHI and tonsillar size (r = 0.20, p = 0.23).

Discussion

Recent literature indicates an association between SDB and NE. Studies have principally focused on uncontrolled clinical populations of children with SDB undergoing either assessment in sleep laboratories [24] or adeno-tonsillectomy [2]. Based on the existing studies, it appears that a correlation of the presence of NE and OSAHS exists, as in our study where 7/42 children with OSAHS (16.7%) presented NE. In the Tucson Children's Assessment of Sleep Apnea study [25] children with SDB (respiratory disturbance index greater than one episode per hour) were more likely to have enuresis than chil-

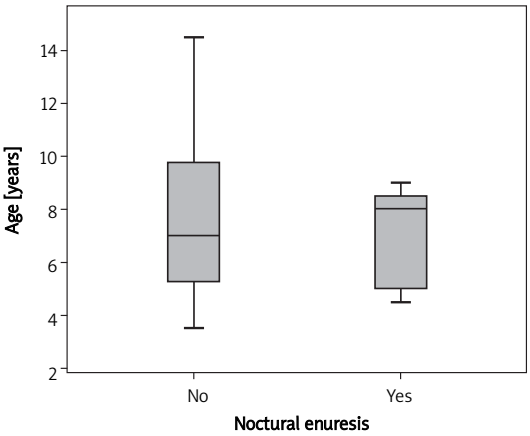

Figure 1. Age distribution based on the presence or not of nocturnal enuresis

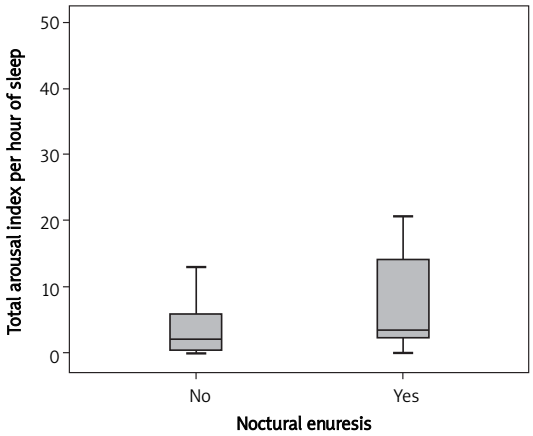

Figure 2. Correlation between the presence of nocturnal enuresis and arousal index per hour of sleep

dren without sleep-disordered breathing (11.3% vs. 6.3%). However, a recent large cohort of 7.5-year olds found that of the 15.5% children who wet the bed, the majority wet only once or less a week, with a relatively small number (2.6%) meeting the DSM-IV (American Psychiatric Association 1995) criteria of nocturnal enuresis, wetting at least twice a week [4].

There was evidence for an association between SDB and NE in a large Greek community sample of children aged 5-14 years [26], whereas children with habitual snoring were 4 times more likely than those who did not regularly snore to have primary enuresis. It is known that snoring symptomatology alone correlates poorly with objective (polysomnographic) findings [27]. In our study there was also an association between the presence of snoring and the severity of OSAHS, although without statistical significance ($p > 0.05$). No statistically significant association was also recorded between the degree of OSAHS expressed as AHI and the presence of NE ($p = 0.70$). However, no population-based studies have assessed the association between primary nocturnal enuresis and snoring while considering the effect of the subjects' age and sex. Nocturnal enuresis is also more common in the habitual snoring group [13], as in our study where 7/38 children who snore had NE (18.42%), while none of the non-snorers had NE (4/4, 100%), and all belong to the habitual snorers group (more than 4 times per week). Based on 95% CI shown in Table III there were statistically significant associations between NE and snoring almost every night (OD: 1.33, 95% CI: 1.05-1.68).

A number of polysomnographic studies (PSG) have compared patients with NE to controls and in general found no evidence of SDB, but did note that enuretic patients had a high arousal threshold [13]. It has been postulated that nocturnal enuresis in people with airway obstruction results from increased production of atrial natriuretic peptide, which increases the arousal threshold in sleep [6]. Moreover, based on the article of T. Nevéus, enuresis is not just a nocturnal problem but a disorder of sleep. The high arousal threshold is one of three major pathogenetic factors in enuresis – nocturnal polyuria and detrusor hyperactivity being the other two [28]. In our study, children with NE had a higher arousal index per hour of TST (8.14 ±8.05) compared with children with OSAHS who did not present NE (4.61 ±7.95) ($p = 0.19$).

The relationship between sleep EEG and the enuretic event cannot safely be assumed to be the same in these different subgroups of children, because it is quite possible that sleep mechanisms might interact with urine production and/or bladder function [23]. Children with OSA have fewer EEG arousals compared to adults with OSA, and thus are able to better preserve sleep architecture. This observation may reflect increased sleep pressure leading to decreased arousability in the child. As such, the decreased arousability may contribute to the increased frequency of nocturnal enuresis seen in paediatric OSA [7].

The most common aetiology of OSAHS in children is hypertrophy of adenoids and/or tonsils. In these cases, surgical removal is the treatment of choice and can also affect bedwetting. For example, Weissbach *et al*. [29] documented significant reductions or elimination of nocturnal enuresis in children who had surgical repair for upper airway obstruction. Similar results were reported by Firoozi *et al.* [2] for children who underwent surgical resection of hypertrophic tonsils and adenoids. In our study, there was a positive correlation between the severity of OSAHS expressed with AHI and the tonsillar size ($r = 0.20$, $p = 0.23$), according to the Mallampati classification [15]. This observation is in agreement with our findings that the most important symptoms that are correlated with the presence of NE were mouth breathing ($p = 0.01$, OD: 10, 95% CI: 1.59-62.78) and nasal congestion ($p = 0.005$, OD: 15, 95% CI: 2.25-99.63), which are symptoms that are correlated with hypertrophic tonsils and adenoids and OSAHS [30].

Primary nocturnal enuresis is usually more common in boys than in girls, with a 3 : 1 gender ratio [31, 32]. In published reports, the prevalence of bedwetting was greater in populations with low socioeconomic status, and declined with increasing age [4, 31], as in our study where NE was not recorded in children older than 10 years of age and its frequency was reduced after 8 years of age (5/42 patients [11.8%] in the age group 2-8 years old and 2/42 patients [4.8%] in the age group > 8 years old). In our study, there was a predominance of female sex concerning the appearance of nocturnal enuresis in children with OSAHS. In particular, there were 3/28 males (10.71%) with OSAHS (3/42 patients, 7.14% of the study population) and 4/14 females (28.57%) with OSAHS (4/42 patients, 9.5% of the study population) who presented with nocturnal enuresis ($p = 0.14$) (Table II).

There were significantly higher levels of reports of daytime sleepiness and behavioural problems in all NE children [13]. In our study, behaviour problems were reported in 9.5% of children with OSAHS, but none presented NE. Hyper-motility was recorded in 26.2% of patients with OSAHS (11/42), aggressiveness in 2.4% (1/42), attention deficit in 11.9% (5/42) and difficulty in arousal in 47.6% of patients with OSAHS (20/42). Aggressive behaviour or attention deficit disorder has not been reported for any of the patients with OSAHS and NE. Only 2/11 (18.18%) with hyper-motility also had NE ($p = 1.00$) and 2/20 children with difficulty in arousal had NE ($p = 0.41$). According to 95% CI shown in Table III, behaviour problems and attention deficit disorders did not appear to be statistically significant factors that were correlated with the presence of NE in children with OSAHS.

We should also mention that 95% CI were quoted because clinically important outcomes may fail to

achieve statistical significance if they are observed only in small samples, as in our groups. A confidence interval is a measure of how much trust can be placed in an estimate derived from a sample, taking into account the scope for chance variation from one sample to another. The larger the size of a sample, the narrower the confidence interval that will be obtained. This reflects the fact that bigger samples provide more information and therefore allow more confident conclusions with a smaller range of uncertainty. Thus, one of the disadvantages of our study was the small sample size limiting the possibility to obtain statistically significant differences, and which explains the wide range of 95% CI. But, our study is the second study performed in Greece that correlates the presence of NE in children diagnosed with PSG as having OSAHS [33]. Thus, future studies in larger populations would probably provide further information on whether and to what extent nocturnal enuresis is observed in OSAHS children.

Finally, if our findings are verified with multi-centre studies of patients-controls, sleep apnoea should be included in the differential diagnosis of children with nocturnal enuresis. We should also mention that none of the children with NE received any medical treatment, although urinary tract abnormalities and infection as well as psychological factors and constipation have previously been excluded.

In conclusion, the co-existence of mouth breathing, snoring almost every night, nasal congestion or a high threshold of arousals during sleep should be more carefully evaluated in cases of children with nocturnal enuresis who do not respond to standard treatment. Thus, in these cases, paediatricians who treat children with enuresis should consider the possibility of OSAHS. The performance of polysomnographic studies in these children seems to be important, although further studies are needed in order to confirm these findings. Thus, NE could be used as a predictor of SDB leading to earlier diagnosis and treatment of SDB, and hopefully reducing the significant morbidity associated with this condition. Moreover, the early differential diagnosis between SDB and NE will reduce hospitalization rates and costs and the discomfort resulting from misdiagnosis.

Finally, the co-existence of enlarged adenoids and snoring should be a sign for further evaluation of children, in case they present other symptoms that are correlated with OSAHS, such as NE.

References

1. Stone J, Malone PS, Atwill D, McGrigor V, Hill CM. Symptoms of sleep-disordered breathing in children with nocturnal enuresis. J Pediatr Urol 2008; 4: 197-202.
2. Firoozi F, Batniji R, Aslan AR, Longhurst PA, Kogan BA. Resolution of diurnal incontinence and nocturnal enuresis after adenotonsillectomy in children. J Urol 2006; 175: 1885-8.
3. Alexopoulos EI, Kostadima E, Pagonari I, Zintzaras E, Gourgoulianis K, Kaditis AG. Association between primary nocturnal enuresis and habitual snoring in children. Urology 2006; 68: 406-9.
4. Butler RJ, Golding J, Heron J; ALSPAC Study Team. Nocturnal enuresis: a survey of parental coping strategies at 7 1/2 years. Child Care Health Dev 2005; 31: 659-67.
5. Caldwell PH, Edgar D, Hodson E, Craig JC. 4. Bedwetting and toileting problems in children. Med J Aust 2005; 182: 190-5.
6. Leiberman A, Stiller-Timor L, Tarasiuk A, Tal A. The effect of adenotonsillectomy on children suffering from obstructive sleep apnea syndrome (OSAS): the Negev perspective. Int J Pediatr Otorhinolaryngol 2006; 70: 1675-82.
7. Beebe DW. Neurobehavioral morbidity associated with disordered breathing during sleep in children: a comprehensive review. Sleep 2006; 29: 1115-34.
8. Umlauf MG, Chasens ER. Bedwetting – not always what it seems: a sign of sleep-disordered breathing in children. J Spec Pediatr Nurs 2003; 8: 22-30.
9. Alexopoulos EI, Kaditis AG, Kostadima E, Gourgoulianis K. Resolution of nocturnal enuresis in snoring children after treatment with nasal budesonide. Urology 2005; 66: 194.
10. Hjalmas K, Arnold T, Bower W, et al. Nocturnal enuresis: an international evidence based management strategy. J Urol 2004; 171: 2545-61.
11. Nield LS, Kamat D. Enuresis: how to evaluate and treat. Clin Pediatr 2004; 43: 409-15.
12. Ersu R, Arman AR, Save D, et al. Prevalence of snoring and symptoms of sleep-disordered breathing in primary school children in Istanbul. Chest 2004; 126: 19-24.
13. Section on Pediatric Pulmonology, Subcommittee on Obstructive Sleep Apnea Syndrome. American Academy of Pediatrics. Clinical practice guideline: diagnosis and management of childhood obstructive sleep apnea syndrome. Pediatrics 2002; 109: 704-12.
14. Gozal D, O'Brien LM. Snoring and obstructive sleep apnoea in children: why should we treat? Paediatr Respir Rev 2004; 5 (Suppl. A): S371-6.
15. Mallampati SR, Gatt SP, Gugino LD, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J 1985; 32: 429-34.
16. Montgomery-Downs HE, O'Brien LM, Gulliver TE, Gozal D. Polysomnographic characteristics in normal preschool and early school-aged children. Pediatrics 2006; 117: 741-53.
17. Iber C, Ancoli-Israel S, Andrew I, Chesson A, Quan SF. The AASM Manual for the Scoring of Sleep and Associated Events: rules, terminology and technical specifications. 1st ed. Westchester: American Academy of Sleep Medicine; 2007.
18. Muzumdar H, Arens R. Diagnostic issues in pediatric obstructive sleep apnea. Proc Am Thorac Soc 2008; 5: 263-73.
19. Kushida CA, Littner MR, Morgenthaler T, et al. Practice parameters for the indications for polysomnography and related procedures: an update for 2005. Sleep 2005; 28: 499-521.
20. Harvey JM, O'Callaghan MJ, Wales PD, Harris MA, Masters IB. Aetiological factors and development in subjects with obstructive sleep apnoea. J Paediatr Child Health 1999; 35: 140-4.
21. Ozden C, Ozdal OL, Altinova S, Oguzulgen I, Urgancioglu G, Memis A. Prevalence and associated factors of enuresis in Turkish children. Int Braz J Urol 2007; 33: 216-22.
22. Butler RJ, Heron J. The prevalence of infrequent bedwetting and nocturnal enuresis in childhood. A large British cohort. Scand J Urol Nephrol 2008; 42: 257-64.
23. Tai HL, Chang YJ, Chang SC, Chen GD, Chang CP, Chou MC. The epidemiology and factors associated with nocturnal enuresis and its severity in primary school children in Taiwan. Acta Paediatr 2007; 96: 242-5.

24. Brooks LJ, Topol HI. Enuresis in children with sleep apnea. J Pediatr 2003; 142: 515-8.
25. Guilleminault C, Lee JH, Chan A. Pediatric obstructive sleep apnea syndrome. Arch Pediatr Adolesc Med 2005; 159: 775-85.
26. Goodwin JL, Kaemingk KL, Fregosi RF, et al. Parasomnias and sleep disordered breathing in Caucasian and Hispanic children – the Tucson children's assessment of sleep apnea study. BMC Med 2004; 2: 14.
27. Kaditis AG, Finder J, Alexopoulos EI, et al. Sleep-disordered breathing in 3,680 Greek children. Pediatr Pulmonol 2004; 37: 499-509.
28. Nevéus T. The role of sleep and arousal in nocturnal enuresis. Acta Paediatr 2003; 92: 1118-23.
29. Weissbach A, Leiberman A, Tarasiuk A, Goldbart A, Tal A. Adenotonsilectomy improves enuresis in children with obstructive sleep apnea syndrome. Int J Pediatr Otorhinolaryngol 2006; 70: 1351-6.
30. Lee SD, Sohn DW, Lee JZ, Park NC, Chung MK. An epidemiological study of enuresis in Korean children. BJU Int 2000; 85: 869-73.
31. Xu Z, Cheuk DK, Lee SL. Clinical evaluation in predicting childhood obstructive sleep apnea. Chest 2006; 130: 1765-71.
32. American Academy of Sleep Medicine. International Classification of Sleep Disorders. Diagnostic and Coding Manual. 2nd ed. Diagnostic and Coding Manual. Westchester: American Academy of Sleep Medicine; 2005.
33. Alexopoulos EI, Kaditis AG, Kostadima E, Gourgoulianis K. Resolution of nocturnal enuresis in snoring children after treatment with nasal budesonide. Urology 2005; 66: 194.