Prevalence of Snoring and Symptoms of Sleep-Disordered Breathing in Primary School Children in Istanbul*

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Prevalence of Snoring and Symptoms of Sleep-Disordered Breathing in Primary School Children in Istanbul*

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Study objectives: **Snoring during sleep is an important manifestation of obstructive sleep apnea syndrome (OSAS). Although clinical history is not sufficiently sensitive and specific to distinguish primary snoring from OSAS, snoring is indicative of upper airway obstruction and may be associated with the presence of diurnal symptoms. Our study aims were to determine the prevalence of snoring in primary school children in Istanbul, and to evaluate the diurnal symptoms and conditions that may be associated with sleep problems.**

Design, setting, and subjects: **A parental questionnaire was used to assess the sleep and wake behavioral patterns in children. Eight representative schools in each of 9 school districts randomly selected from the 32 school districts in Istanbul were visited.**

Results: **The response rate was 78.1%; 2,147 of 2,746 questionnaires were fully completed, returned, and analyzed. The prevalence of habitual snoring was 7.0%. Habitual snorers had significantly more nighttime symptoms, such as observed apneas (odds ratio [OR], 16.9; 95% confidence interval [CI], 10.0 to 28.8; $p < 0.0001$), difficulty breathing (OR, 17.8; CI, 10.9 to 29.2; $p < 0.0001$), restless sleep, parasomnias, and nocturnal enuresis, compared to occasional and nonsnorers. There were also increased prevalence of daytime symptoms, such as falling asleep while watching television (OR, 1.8; CI, 0.9 to 3.7; $p = 0.01$) and in public places (OR, 2.1; CI, 1.2 to 3.8; $p = 0.03$), and hyperactivity (OR, 2.7; CI, 1.8 to 3.9; $p < 0.0001$). Exposure to cigarette smoke and the presence of asthma and hay fever increased the likelihood of habitual snoring. Children with a higher risk for OSAS (habitual snoring, apnea, and difficulty breathing during sleep) were also compared to nonsnorers. Although nighttime symptoms were more likely in the high-risk group, the risk of daytime symptoms increased as well.**

Conclusions: **Habitual snoring is a significant problem for children and may be associated with diurnal symptoms. Exposure to cigarette smoke at home and the presence of asthma and hay fever increase the likelihood of habitual snoring.** ***(CHEST 2004; 126:19–24)***

Key words: children; hyperactivity; passive smoke exposure; prevalence; snoring

Abbreviations: CI = confidence interval; OR = odds ratio; OSAS = obstructive sleep apnea syndrome

Obstructive sleep apnea syndrome (OSAS) is a disorder of breathing during sleep characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction that disrupts normal sleep patterns. OSAS is associated with symptoms including habitual snoring, sleep difficulties, and/or daytime neurobehavioral problems.[1] Episodes of upper airway obstruction often are associated with arousals, sleep fragmentation, intermittent hypoxia, and hypercapnia. Therefore, OSAS can have serious neurobehavioral and cardiorespiratory consequences, including excessive daytime sleepiness, growth failure, school failure, behavioral problems, cor pulmonale, or even death.[1] Snoring is common in childhood with reported prevalence between 3.2% and 12.1%.[2–6] Although clinical history is not sufficiently sensitive and specific to distinguish primary snoring from OSAS in children, the presence of snoring is indicative of upper airway obstruction and may be associated with the presence of diurnal symptoms.[7–10] The prevalence of snoring and behavioral problems associated with sleep-disor-

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dered breathing has not been studied in an epidemiologic sample in Turkey until now. Our study aims were to determine the prevalence of snoring in primary school children in Istanbul, and also to evaluate the nighttime and daytime symptoms and conditions that may be associated with sleep problems in these children.

Materials and Methods

Study Population

Approval by the Regional Director of Education, which serves as the Institute of Human Subject Protection Committee for the schools in Istanbul, was obtained prior to the study. Multistage randomized sampling was used for data collection. The city of Istanbul has a population of approximately 12 million people, and there are 32 school districts in Istanbul. Nine districts were randomly chosen, and systematic sampling was used for the determination of 72 schools from these districts. The classes were randomly chosen from every school. The number of students selected from each class was sufficient to guarantee a sample size $> 2,046$, a size that ensures an estimate of habitual snoring prevalence of 3.2% with a precision of 1%. The power of the study was 80%, and α value was taken as 5%.

Questionnaire

A 55-item, multiple-choice questionnaire was formulated according to the guidelines of Carroll et al[7] and Brouillette et al.[11,12] An envelope containing the questionnaire to be filled out by parents and a personally addressed letter asking for consent was distributed to children at school with the help of their teachers. The study was performed during May 2002. The questionnaire sought information regarding sleep habits; nocturnal symptoms (snoring, reported apnea, difficulty breathing, presence and frequency of nocturnal enuresis, night terrors, nightmares, somnambulism, sleep talking, and bruxism); daytime symptoms (mouth breathing, headache, recurrent upper airway infections, daytime sleepiness in different situations, and hyperactivity); history of atopy, asthma, and allergic rhinitis; and exposure to cigarette smoke. Parents reported snoring on a 4-point scale: 0 (never), 1 (occasionally), 2 (often), and 3 (always). Habitual snoring was considered present if parents reported snoring as either often or always. The stability of the questionnaire was tested on an independent sample of 65 school-aged children prior to the epidemiologic survey.

Data Analysis

Statistical analysis was done using a statistical software package (Version 11.0 for Windows; SPSS; Chicago, IL). Children were grouped as nonsnorers, occasional snorers, and habitual snorers. The prevalence of symptoms in the three categories of snoring (never, occasional, habitual) were compared by Pearson χ^2 test and χ^2 test trend. Also, the prevalence of sleep-disordered breathing symptoms in children who never snored was compared to habitual snorers by Pearson χ^2 test. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. In addition, we established a group of habitual snorers with high risk of OSAS using the criteria of Brouillette et al[11] and compared these children with nonsnorers. Children with high risk of OSAS had apnea and difficulty breathing in addition to habitual snoring. A p value of < 0.05 was considered significant.

Results

Seventy-two schools from nine school districts of Istanbul were surveyed. These districts had different socioeconomic conditions and ranged from very poor to upscale neighborhoods. Response rate was 78.1%; 2,147 of 2,746 questionnaires were fully completed, returned, and analyzed. There were 151 habitual snorers (7%) and 743 occasional snorers (34.6%). The remaining children never snored. The ages of the children ranged from 5 to 13 years (mean $\pm$ SD, 8.5 ± 1.3 years). Habitual snoring was common in the 5- to 8-year age group, and prevalence decreased in the 9- to 10-year age group and increased in the 11- to 13-year age group (7.5% vs 5.7% vs 12.9%, respectively; $p < 0.0001$). There were equal numbers of girls and boys in the study group (49.5% girls and 50.5% boys). The percentage of male children who were habitual snorers was higher than the percentage of female children who were habitual snorers (8.5% vs 5.6%, respectively; $p = 0.008$). When we looked at the snoring prevalence of girls and boys in different age groups, snoring prevalence was significantly higher in the boys > 11 years of age (Table 1).

The prevalence of symptoms in three snoring categories (never, occasional, and habitual) are presented in Table 2. Habitual snorers had significantly more nighttime symptoms, such as observed apneas, difficulty breathing during sleep, sweating during sleep, blue color during sleep, parental shaking for apnea, increased parental anxiety, restless sleep, and excessive vocalization during sleep, nightmares, nocturnal enuresis, and bruxism. Prevalence of daytime symptoms including mouth breathing, falling asleep while watching television and in public places, and hyperactivity also increased. These associations showed a highly significant trend across the snoring groups, so that the prevalence of diurnal symptoms increased across the snoring groups and was highest in the habitual snorers.

In addition, parental smoking, frequent tonsillitis, and asthma and hay fever were more prevalent in the habitual snoring group. The prevalence of sleep-disordered breathing-related symptoms in children

Table 1—*Prevalence of Snoring in Boys and Girls in Different Age Groups*

Age, yr	Girls With Habitual Snoring, %	Boys With Habitual Snoring, %
5–8	6.9	8.2
9–10	3.6	7.9
11–13	6.3	17.0
p Value	0.03	0.002

Table 2—*Prevalence of Symptoms Related to Sleep-Disordered Breathing in Three Snoring Categories of Children Studied*

Symptoms	Never Snored, % (n = 1,253)	Occasional Snorer, % (n = 743)	Habitual Snorer, % (n = 151)	p Value	OR* (95% CI)
Apnea	2.1	7.2	26.7	< 0.0001	16.9† (10.0–28.8)
Difficulty breathing during sleep	2.6	9.6	32.0	< 0.0001	17.8† (10.9–29.2)
Sweating during sleep	36.3	50.9	63.1	< 0.0001	2.9† (2.1–4.3)
Blue color during sleep	0.7	3.1	5.3	< 0.0001	7.8† (2.9–20.4)
Shaking the child during sleep for apnea	2.0	6.4	22.1	< 0.0001	13.9† (8.0–24.1)
Increased parental anxiety about child's sleep	10.8	16.9	36.7	< 0.0001	4.1† (3.2–7.0)
Restless sleep	24.3	39.1	59.6	< 0.0001	4.6† (3.2–6.6)
Mouth breathing during daytime	10.3	20.5	61.0	< 0.0001	13.6† (9.2–20.2)
Frequent tonsillitis	9.6	23.7	41.6	< 0.0001	6.7† (4.6–9.8)
Adenoidectomy	4.5	8.9	7.3	< 0.0001	1.2§ (0.4–1.5)
Morning headache (% of children with headache)	11.8	9.3	22.0	0.08	2.1‡ (1.1–4.3)
Maternal smoking	27.5	34.4	46.2	< 0.0001	2.3† (1.6–3.3)
Paternal smoking	53.8	51.8	65.5	0.01	1.6‡ (1.1–2.3)
Hay fever	5.5	11.7	11.2	< 0.0001	2.1‡ (1.2–4.0)
Asthma	6.3	11.1	11.9	0.001	2.0‡ (1.1–3.6)
Falling asleep in public places	13.6	22.2	20.6	< 0.0001	2.1‡ (1.2–3.8)
Falling asleep while watching television	5.7	7.9	11.3	0.02	1.8‡ (0.9–3.7)
Hyperactivity	23.5	32.4	45.0	< 0.0001	2.7† (1.8–3.9)
Excessive vocalizations during sleep	31.5	49.8	65.1	< 0.0001	4.1† (2.8–6.0)
Nightmares	26.7	38.4	49.1	< 0.0001	2.6† (1.8–3.9)
Bruxism	20.0	37.3	34.9	0.001	2.1† (1.4–3.2)
Sleepwalking	4.4	4.4	7.7	0.2	1.8§ (0.9–3.7)
Nocturnal enuresis	7.5	9.9	14.8	0.005	2.2‡ (1.3–3.5)

*Habitual snores vs children who never snored.
†$p < 0.0001$.
‡$p < 0.05$.
§$p > 0.05$.

who never snored and habitual snorers with ORs and 95% CIs are also given in Table 2. We also compared diurnal symptoms in habitual snorers with a higher risk of OSAS based on the study of Brouillette et al[11] (children who had habitual snoring, apnea, and difficulty breathing during sleep) with nonsnorers (Table 3).[11] Interestingly, although symptoms such as sweating during sleep, blue color during sleep, shaking for apnea, increased parental anxiety, and restless sleep were much more likely in the high-risk group, the risk of daytime symptoms such as falling asleep while watching television or in public places, and hyperactivity did not increase as much in the high-risk snorers compared to the nonsnorers.

Discussion

In this study, the prevalence of habitual snoring in children aged 5 to 13 years in Istanbul was 7.0%. There are nine studies[2–6,13–16] evaluating the prevalence of snoring in children. In the study of Brunetti et al,[15] children aged 3 to 11 years were studied and the prevalence of snoring was reported as 4.9%. Corbo et al[5] and Ferreira et al[6] studied children aged 6 to 11 years and 6 to 13 years, respectively, and found similar prevalence of habitual snoring (8.6 and 7.3%, respectively). The remainder of the studies that reported the prevalence of habitual snoring in children surveyed preschool children or wider age range. The prevalence of 7.0% for habitual snoring reported in this study is in agreement with the previous studies performed in this age group.[5,6]

In our study, snoring was more prevalent in boys, which is not in agreement with previous epidemiologic data[2–5,15,17] that show no differences in snoring between boys and girls. However, there is a gender difference in adults, with snoring being more common in men.[18,19] This is attributed to sex hormones and their influence on respiratory control and/or body fat distribution. Clearly, these factors would play a smaller role in prepubertal children; however, in our study, since boys aged 11 to 13 years had the highest prevalence of snoring, these children may have been affected by puberty. Another possibility is that active smoking started among these children. Smoking has been reported as a risk factor for snoring in young students aged 15 to 20 years.[20] The prevalence of active smoking in children aged 11 to

Table 3—*Prevalence of Symptoms Related to Sleep-Disordered Breathing in Children Who Never Snore and Habitual Snorers With Apnea and Difficulty Breathing During Sleep (High-Risk Snorers)*

Symptoms	Never Snored, % (n = 1,253)	High-Risk Snorer, % (n = 26)	OR (95% CI)	p Value
Sweating during sleep	36.3	70.4	4.2 (1.8–9.6)	< 0.0001
Blue color during sleep	0.7	7.4	11.0 (2.3–53.6)	0.02
Shaking the child during sleep for apnea	2.0	70.4	115.7 (46.3–289.2)	< 0.0001
Increased parental anxiety about child's sleep	10.8	81.5	36.5 (13.6–98.0)	< 0.0001
Restless sleep	24.3	85.2	17.9 (6.2–52.3)	< 0.0001
Mouth breathing during daytime	10.3	74.1	24.9 (10.3–60.2)	< 0.0001
Frequent tonsillitis	9.6	55.6	11.8 (5.4–25.8)	< 0.0001
Morning headache	11.8	16.7	1.4 (0.3–6.8)	0.4
Maternal smoking	27.5	56.0	3.3 (1.5–7.5)	0.003
Paternal smoking	53.8	80.0	3.4 (1.3–9.2)	0.007
Hay fever	5.5	20.0	4.3 (1.4–13.1)	0.02
Asthma	6.3	23.8	4.6 (1.7–13.1)	0.01
Falling asleep in public places	13.6	19.0	1.5 (0.5–4.5)	0.3
Falling asleep while watching television	5.7	12.5	2.3 (0.7–8.1)	0.2
Hyperactivity	23.5	45.8	2.8 (1.2–6.2)	0.01
Excessive vocalizations during sleep	31.5	60.0	3.3 (1.5–7.4)	0.003
Nightmares	26.7	56.5	3.6 (1.5–8.2)	0.003
Bruxism	20.0	28.0	1.5 (0.6–3.8)	0.2
Sleepwalking	4.4	7.7	1.8 (0.4–8.0)	0.3
Nocturnal enuresis	7.5	11.1	1.5 (0.5–5.2)	0.3

15 years in Turkey is 8.2%, and it is more common in boys.[21] However, we did not ask for active smoking in this study, since we thought that the responses would not be reliable.

Mouth breathing was more common in the habitual snoring group in our study. Mouth breathing usually reflects nasal obstruction that provokes snoring by lowering the negative intraluminal pressures that collapse the pharynx. It may also have long-term consequences on the dental arch and on facial development.[22] In this study, snoring was also associated with frequent tonsillitis, which causes tonsillar enlargement and therefore airway obstruction and snoring. This finding is also consistent with previous studies.[2,5] A history of adenoidectomy was more commonly found in the snorers compared to children who never snored. This could be due to parental misreporting of current snoring in children who snored prior to adenoidectomy, or some children may continue to snore despite adenoidectomy secondary to long-term effects of adenotonsillar hypertrophy.[23]

Passive smoke exposure was more common in habitual snorers compared to the nonsnoring children in this study. Both maternal and paternal smoking increased the likelihood of passive smoking, but maternal smoking had more impact. Corbo and coworkers[5] showed a dose-response effect between snoring children and the number of cigarettes consumed by their parents. In a study[2] performed by investigators at Oxford, a dose-response effect of passive smoke exposure was shown, as well as a stronger effect of maternal smoking on children with habitual snoring and symptoms suggestive of sleep disordered breathing. This was attributed to the fact that children spend more time with their mothers, and her smoking habits have the greatest impact on their environment. This would be the same for our study group because children in Turkey typically spend more time with their mothers.

We found higher atopy and asthma prevalence in children with habitual snoring. Teculescu and coworkers[4] reported that atopy in the index child or in a sibling was significantly associated with habitual snoring, and exercise-induced bronchospasm had a more powerful effect. In another epidemiologic study by Redline et al,[17] sinus problems and persistent wheeze independently predicted sleep-disordered breathing. In a recent study by Lu et al,[24] snoring was significantly associated with nocturnal cough and asthma. In addition to nasal obstruction caused by rhinitis, there are several mechanisms suggested by the authors of this study that may link asthma and snoring. In this current study, both asthma and rhinitis were more prevalent in children with habitual snoring, and ORs were higher in the high-risk snorers.

Restless sleep was 4.6 times more likely in the habitual snoring group compared to nonsnorers in our study. Previous studies[2,3,15] also showed that habitual snorers are more likely to be restless at night. In an earlier study[25] of children, restlessness at

night fell toward control levels, as did the sleep video recording after adenotonsillectomy. These findings support the studies suggesting that snoring in children leads to measurable daytime symptoms of sleepiness and behavior problems. Although no sleep studies were performed in this current study, daytime symptoms clearly were more common in the habitual snoring group. Children with habitual snoring were reported as hyperactive by their parents more commonly than nonsnorers in our study. Habitual snorers were also more likely to fall asleep while watching television and in public places. Daytime symptoms associated with snoring and sleep-disordered breathing have been described in many studies, [2,6,10,26] and include daytime sleepiness, hyperactivity, and poor academic performance. The combined OR for neurobehavioral abnormalities in snoring children compared to control subjects was calculated as 2.93 in a report published by American Academy of Pediatrics.[1] The conclusion of this report[1] was that studies show a threefold increase in behavior and neurocognitive abnormalities in children with sleep-disordered breathing, and it is possible that primary snoring, even in the absence of clear-cut OSAS, might place children at risk for neurobehavioral morbidity.

Nightmares and vocalization during sleep were more common among habitual snorers in our study. Ferreira et al[6] found that bedtime problems (fears and struggles) and behaviors characteristic of parasomnias were all common in loud-snoring children. Owen and coworkers[13] reported behavioral sleep disturbances in nearly one fourth of children with OSAS. Children with intermittent hypoxia experience obstruction primarily during rapid eye movement sleep, which occurs predominantly in the early morning hours when the parents are not observing them, but when nightmares and excessive vocalizations take place.[27]

Nocturnal enuresis was also more common in the habitual snoring group. Although nocturnal enuresis is a variable finding in children with OSAS, a recent study[28] showed a high prevalence of enuresis in children with suspected sleep-disordered breathing and increased risk of enuresis in children with respiratory index > 1.

In 1984, Brouillette et al[11] reported a high accuracy for a diagnostic questionnaire for OSAS in children with adenotonsillar hypertrophy. But further studies[7,8] proved that the use of this questionnaire as a substitute for polysomnography would lead to numerous false-positive and false-negative results in the diagnosis of OSAS. However, habitual snoring, presence of apnea, and difficulty breathing have been found to be associated with OSAS in number of studies.[2,3,11,15] Therefore, we formed a group of patients with those three features and compared these children to nonsnorers. In this group of high-risk snorers, the OR for parents shaking the child during sleep for apnea was very high (115.7; 95% CI, 46.3 to 289.2), suggesting that this too could be included in the criteria for OSAS. In addition, these high-risk children had higher ORs than habitual snoring group for sweating during sleep, blue color during sleep, increased parental anxiety about the child's sleep, and restless sleep. Night sweating is likely associated with the increased effort required to inspire against increased upper airway resistance. Prevalence of mouth breathing and frequent tonsillitis was also higher in the high-risk snorers, suggesting upper airway passage obstruction. Interestingly, ORs for falling asleep while watching television and in public places, and hyperactivity did not change for high-risk snorers, which is in agreement with studies[2,6,10,25] showing behavioral disturbances in both primary snoring and OSAS groups. However, this may be due to small sample size of high-risk group in our study.

In this study, the prevalence of habitual snoring in children aged 5 to 13 years in Istanbul was found as 7.0%. Also, in habitual snorers, nighttime symptoms such as restless sleep, difficulty breathing during sleep, increased parental anxiety about the child's sleep, nightmares, excessive vocalization during sleep, nocturnal enuresis, and bruxism were much more common compared to nonsnorers. Habitual snorers also had daytime symptoms including falling asleep while watching television and in public places, as well as hyperactivity. Exposure to cigarette smoke at home and the presence of asthma and hay fever increased the likelihood of habitual snoring.

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