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Prevalence of habitual snoring and symptoms of sleep-disordered breathing in adolescents[☆]

Ayhan Sogut^{a,*}, Ozge Yilmaz^a, Gonul Dinc^b, Hasan Yuksel^a

^a Celal Bayar University, School of Medicine, Department of Pediatric Allergy and Pulmonology, Izmir Street, Manisa 45020, Turkey

^b Celal Bayar University, School of Medicine, Department of Public Health, Manisa, Turkey

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ABSTRACT

Objective: Sleep-disordered breathing is an important public health problem in adolescents. The aim of this study was to investigate the prevalence and risk factors of habitual snoring and symptoms of sleep-disordered breathing in adolescents.

Methods: A cross-sectional study was conducted with children from primary schools and high schools that the ages ranged from 12 to 17 years. Data were collected by physical examination and questionnaires filled in by parents regarding sleep habits and possible risk factors of snoring. According to answers, children were classified into three groups: non-snorers, occasional snorers, and habitual snorers.

Results: The response rate was 79.2%; 1030 of 1300 questionnaires were fully completed and analyzed. The prevalence of habitual snoring was 4.0%. Habitual snorers had significantly more nighttime symptoms including observed apneas, difficulty breathing, restless sleep and mouth breathing during sleep compared to occasional and non-snorers. Prevalence of habitual snoring was increased in children who had had tonsillar hypertrophy, allergic rhinitis, and maternal smoking.

Conclusion: We found the prevalence of habitual snoring to be 4.0% in adolescents from the province of Manisa, Turkey which is low compared to previous studies. Habitual snoring is an important problem in adolescents and habitual snorers had significantly more nighttime symptoms of sleep-disordered breathing compared to non-snorers.

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1. Introduction

Sleep-disordered breathing refers to a continuum of symptoms that ranges in severity from primary or simple snoring, through upper airway resistance syndrome, obstructive hypopnea syndrome and, in its most severe form, obstructive sleep apnea syndrome [1]. Symptoms of obstructive sleep-disordered breathing include habitual snoring, apnea, mouth breathing, sweating, nocturnal enuresis, restless sleep, and daytime neurobehavioral problems. Obstructive sleep-disordered breathing may cause growth failure, pulmonary hypertension, heart failure, and cor pulmonale, particularly in severe cases [2]. In previous studies reporting the prevalence of habitual snoring has used different criterias (i.e., always or most nights or often or $\geq 3 \times$ /week snoring) for habitual snoring. The prevalence of habitual snoring has been

reported in 3.2–12.1% of the general pediatric population [3–6]. Children with habitual snoring lack apnea, hypopnea, respiratory effort-related arousals, and gas exchange abnormalities [7]. Risk factors for snoring in children include hypertrophy of the tonsils and/or adenoids, nasal obstruction, and obesity [8,9]. Alterations in upper airway morphology at puberty may play a significant role in the development of sleep-disordered breathing in early adulthood [10]. In the adolescent population, however, there is little information regarding the prevalence and clinical expression of sleep-disordered breathing [11–13].

The prevalence of snoring and clinical expression of sleep-disordered breathing has not been previously examined in the adolescent population in Turkey. The aim of this study was to determine the prevalence of snoring and symptoms of sleep-disordered breathing in 12–17-year-old Turkish children.

2. Methods and materials

2.1. Study population

The province of Manisa, which is situated in west Turkey, has a population of 282,718. In total, 49,349 school children are 12–17

[☆] The institution at which the work was performed: Celal Bayar University, School of Medicine, Department of Pediatric Allergy and Pulmonology Unit, Turkey.

* Corresponding author. Tel.: +90 236 2323133; fax: +90 236 2370213.

E-mail addresses: ayhansogut29@yahoo.com (A. Sogut), oyilmaz_76@hotmail.com (O. Yilmaz), gonuldinc@yahoo.com (G. Dinc), hyukselefe@hotmail.com (H. Yuksel).

years old, making up 17.4% of the total population (34,899 children in primary schools and 13,373 in high schools). A cross-sectional study was carried out in order to find out the habitual snoring prevalence. The sample size was calculated as 1110 using an estimate of habitual snoring prevalence of 7% with a precision of 1.5% and a confidence level of 95%.

Selection of subjects was based on the school, classroom, and age data of the province, which were obtained from the Ministry of Education. A total of 12 schools (7 primary and 5 high schools) were randomly selected. The selected schools represented each socioeconomic strata in the society. Each primary school had eight grades and each high school had four grades with approximately 40 students in each class. The number of students to be selected from each selected school was determined by probability proportional to size sampling method. Classes were selected from schools with the intent of providing an overall age distribution comparable to the population's age distribution. All of the students from randomly chosen classes were interviewed. The students who were not at the school during the data collection days were not included in the study. A total of 1300 students were accessed in this survey. Symptomatic children were identified by using a self-administered questionnaire, and were classified into three groups: non-snorers, occasional snorers, and habitual snorers, according to parents' answers.

2.2. Questionnaire

We used a 55-item, multiple-choice questionnaire adapted from the guidelines of Carroll et al. and Brouillette et al. [14–16]. Questionnaires were distributed to children in the classroom, and were then filled out at home by parents. Informed consent was obtained from the parents of the children. The study was performed between April and May 2007. The questionnaire sought information regarding sleep habits; nocturnal symptoms (snoring, witnessed apnea, difficulty breathing, presence and frequency of nocturnal enuresis, and excessive vocalization during sleep); daytime symptoms (mouth breathing, recurrent upper airway infections); history of atopy, asthma, and allergic rhinitis; and exposure to cigarette smoke.

Snoring was investigated with the following question: "Does your child ever snore?" On the basis of the answer, 4 categories were formed: 0 (never), 1 (occasionally), 2 (often), and 3 (always). Habitual snoring was considered present if parents reported snoring as either often or always. Questions about sleep-related problems included: "Do you see your child cease breathing during sleep? Do you see that your child has difficulty breathing during sleep? Do you get anxious about the way your child breathes during sleep?". Asthma was defined as either physician-diagnosed asthma or as at least three of the following: wheezing with colds, wheezing without a cold, dyspnea associated with wheezing, and wheezing after exercise. Questionnaire included questions on rhinitis ("Has your child ever had rhinitis [stuffy and running nose, itchy eyes, sneezing]?").

2.3. Clinical examination

All of the participants were examined by the same physician in their classroom. Size of the tonsils were evaluated and scored as defined by Brodsky [17]. The grading was summarized as follows: 0 = no enlargement; 1 = tonsils occupy less than half of the transverse diameter of oropharynx; 2 = tonsils occupy half of the transverse diameter of oropharynx; 3 = tonsils occupy more than half of the transverse diameter of oropharynx; 4 = tonsils occupy whole of the transverse diameter of oropharynx, i.e., kissing tonsils. Weights and heights of children were measured by the same physician in the classroom. The body mass indices (BMI;

weight/height²) were calculated and divided using standardized percentile curves in 4 classes: up to 75th percentile, 76th to 90th percentile, 91st to 95th percentile, and 96th to 100th percentile [18].

2.4. Statistical analysis

Data were analyzed using SPSS for Windows® 10.0. The χ^2 test was used for analysis. Univariate odds ratios and their corresponding 95% CIs and multivariate odds ratios and their corresponding 95% CIs for age, sex and BMI percentile groups were calculated using logistic regression model. *p* values less than 0.05 were regarded as statistically significant.

2.5. Ethical approval

This study was approved by the Ethics Committee of the Celal Bayar University, School of Medicine. Written informed consent was taken from the parents.

3. Results

3.1. Demographics and frequencies

Response rate was 79.2%; 1030 of 1300 questionnaires were fully completed and analyzed. There were 41 habitual snorers (4%), 291 occasional snorers (28.2%), and 698 never snorers (67.8%).

The study group consisted of 57.4% girls and 42.6% boys. There was no significant difference between male adolescents and female adolescents in snoring prevalence. Although snoring did not change linearly over the age categories, children who were 12 and 13 years old had significantly higher risk habitual snoring relative to reference group which is selected as children who were 17 years old (OR, 4.71; CI, 1.03–21.44; *p* = 0.04; OR, 5.89; CI, 1.32–26.23; *p* = 0.02, respectively) (Table 1).

Habitual snoring was more common in children with BMI between 91st and 95th percentile (OR, 3.09; CI, 1.09–8.78; *p* = 0.03). Moreover, the prevalence of snoring was more than 3-fold higher in children with BMI between 91st and 95th percentile compared to those with BMI $\leq$ 75th percentile (OR, 3.09) (Table 1). None of the children included in the study had genetic or neurologic disorders.

3.2. Habitual snoring associated symptoms

The prevalence of symptoms in three snoring categories (never, occasional, and habitual) is presented in Table 2. Habitual snorers had significantly more nighttime symptoms, such as observed apneas, difficulty in breathing during sleep, sweating during sleep, parental shaking for apnea, increased parental anxiety, restless sleep, mouth breathing during sleep, walking during sleep, excessive vocalization during sleep, and bruxism compared to children never snored (Table 2). Also, prevalence of mouth breathing and frequent tonsillitis was higher for habitual snorers relative to children never snored. The prevalence of sleep-disordered breathing-related symptoms in children who never snored and who are habitual snorers are given in Table 2.

3.3. Habitual snoring risk factors

Table 3 shows the association of snoring with risk factors. There was a significant association between habitual snoring and allergic rhinitis and maternal smoking. Risk of habitual snoring was significantly higher for children who had had allergic rhinitis and parental smoking (OR: 3.7 (1.03–13.5) and 2.3 (1.1–4.4), respectively).

Table 1

Snoring status of study group according to sex, age and BMI categories.

	Never snored, %	Occasional snorer, %	Habitual snorer, %	Total percentage	p value	OR ^a (95% CI)
Sex					0.01	
Male (n = 439)	62.6	32.8	4.6	100.0		1.47 ^{**} (0.78–2.75)
Female (n = 591)	71.6	24.8	3.6	100.0		
Age (year)					0.02	
12 (n = 220)	66.4	28.1	5.5	100.0		4.61 ⁺ (1.01–21.13)
13 (n = 241)	60.6	33.2	6.2	100.0		5.50 ⁺ (1.23–24.64)
14 (n = 118)	70.3	27.2	2.5	100.0		1.85 ^{**} (0.30–11.46)
15 (n = 136)	76.5	19.8	3.7	100.0		2.64 ^{**} (0.50–14.00)
16 (n = 159)	65.4	32.1	2.5	100.0		2.14 ^{**} (0.38–11.98)
17 (n = 156)	73.7	25.0	1.3	100.0		
BMI (percentile)					0.06	
≤75 (n = 777)	70.1	26.6	3.3	100.0		
76–90 (n = 166)	60.3	34.9	4.8	100.0		1.76 ^{**} (0.76–4.06)
91–95 (n = 53)	62.3	28.3	9.4	100.0		3.09 ⁺ (1.09–8.78)
>95 (n = 34)	58.8	35.3	5.9	100.0		1.81 ^{**} (0.39–8.30)

^a Habitual snores vs children who never snored.⁺ $p < 0.05$.^{**} $p > 0.05$.**Table 2**

Prevalence of symptoms related to sleep-disordered breathing in snoring categories in study group.

	Never snored, % (n = 698)	Occasional snorer, % (n = 291)	Habitual snorer, % (n = 41)	p value	OR ^a (95% CI)
Apnea	4.5	9.8	28.2	0.001	8.4 ⁺ (3.8–18.5)
Difficulty breathing during sleep	7.2	18.2	46.3	0.001	11.1 ⁺ (5.6–21.9)
Sweating during sleep	31.1	43.9	56.4	0.001	2.8 ^{**} (1.4–5.5)
Shaking the child during sleep for apnea	2.1	6.3	31.7	0.001	21.9 ⁺ (9.4–50.9)
Restless sleep	14.7	22.4	41.0	0.001	4.0 ⁺ (2.0–7.9)
Increased parental anxiety about child's sleep	7.3	14.6	43.9	0.001	9.9 ⁺ (5.0–19.7)
Mouth breathing during sleep	22.4	49.6	80.5	0.001	14.2 ⁺ (6.4–31.5)
Bruxism	10.0	17.5	23.7	0.001	2.7 ^{**} (1.2–6.1)
Excessive vocalizations during sleep	29.9	42.2	50.0	0.001	2.3 ^{**} (1.2–4.4)
Sleepwalking	2.8	5.9	10.0	0.009	3.9 ^{**} (1.2–12.0)
Enuresis nocturna	2.3	3.8	5.0	0.317	2.2 ^{***} (0.4–10.0)
Daytime mouth breathing	23.2	40.1	57.5	0.001	4.4 ⁺ (2.3–8.5)
Falling asleep while watching television	4.6	6.8	5.1	0.380	1.1 ^{***} (0.25–4.85)
Frequent tonsillitis	6.5	1.0	24.4	0.001	4.6 ⁺ (2.1–10.1)

^a Habitual snores vs children who never snored.⁺ $p < 0.0001$.^{**} $p < 0.05$.^{***} $p > 0.05$.

When tonsil size was considered, snoring prevalence increased significantly as tonsil size increased ($p = 0.001$). Moreover, the prevalence of snoring was 10-fold higher in children with tonsil stage 3 when compared to those with tonsil stage 1 (OR, 19.17; CI, 7.15–51.42; $p = 0.001$) (Table 4).

4. Discussion

We found the prevalence of habitual snoring to be 4.0% in adolescents from the province of Manisa, Turkey which is low compared to previous studies in the literature [11–13]. Habitual snorers had significantly more nighttime symptoms including observed apneas, difficulty in breathing, restless sleep and mouth

breathing during sleep compared to non-snorers. Prevalence of habitual snoring was increased in children who had had tonsillar hypertrophy, allergic rhinitis, and maternal smoking.

Prevalence of habitual snoring in children may change according to study design, population characteristics such as age and gender, and the definition of habitual snoring. There are several studies evaluating the prevalence of snoring adolescents [12,13,19]. In a sample of 1104 adolescents with an age range of 13–16 years, the prevalence of habitual snoring was reported to be 6.0% [19]. In other studies, this prevalence was found to be 5.6% and 7.9% in children aged 9–15 and 11–17 years, respectively [12,13]. There are no data available on the prevalence of sleep-disordered breathing in 12–17-year-old Turkish adolescents. The prevalence

Table 3

Association of risk factors with snoring categories.

	Never snored, % (n = 698)	Occasional snorer, % (n = 291)	Habitual snorer, % (n = 41)	p value	OR ^a (95% CI)
Allergic rhinitis	2.2	6.2	7.7	0.003	3.7 ⁺ (1.03–13.5)
Asthma	2.6	2.7	2.6	0.9	0.9 ^{**} (0.1–7.5)
Father smoking	49.4	58.1	60.0	0.02	1.5 ^{**} (0.8–2.9)
Mother smoking	20	28.3	36.6	0.002	2.3 ⁺ (1.1–4.4)

^a Habitual snores vs children who never snored.⁺ $p < 0.05$.^{**} $p > 0.05$.

Table 4

Association of tonsil stage with snoring categories.

	Never snored, % (n=698)	Occasional snorer, % (n=291)	Habitual snorer, % (n=41)	p value	OR ^a (95% CI)
Tonsil stage				0.001	
1	70.5	27.3	2.3		
2	57.0	30.8	12.1		6.64 [*] (3.15–13.99)
3	34.2	44.7	21.1		19.17 [*] (7.15–51.42)

^a Habitual snores vs children who never snored.^{*} $p < 0.0001$.

of habitual snoring in our sample was 4.0% which is in agreement with the previous studies [12,19].

In this study, prevalence of snoring was equal in boys and girls, which is in agreement with previous epidemiologic data that show no differences in snoring between boys and girls [4–6]. In adult period, prevalence of snoring is more common in men [20]. The male predisposition has been attributed to the effect on respiratory control of sex hormones and/or gender-related differences in upper airway anatomy and function [21,22].

Studies about snoring in childhood do not suggest an obvious pattern of changes in prevalence with age [23]. Similarly, we have not detected a linear change of snoring prevalence over the age categories, but we detected a significantly higher risk of snoring in the 12–13 year age group relative to 17 years age group. A previous study has also demonstrated that there was no linear increase in snoring prevalence from 9 to 15 years, but a significantly higher prevalence among 15-year olds than the other age groups [12].

There is a strong association between BMI and snoring in adolescents [12,19,24]. It had been demonstrated that a BMI of above 90th percentile was associated with snoring, and the association was more relevant in children with a BMI >95th percentile [12]. Similarly, overweight adolescents were found to have a 2.6-fold excess risk of habitual snoring when compared to those with a BMI <20 [13]. It is proposed that the strong relationship between high weight status and snoring may be related to a reduction in pharyngeal airway diameter produced by deposits of adipose tissue in obese individuals. Pharyngeal resistance correlates with increasing weight/height ratio [24]. We found that habitual snoring was more common in children with BMI between 91st and 95th percentile. The prevalence of snoring was more than 3-fold higher in children with BMI between 91st and 95th percentile compared with children with BMI of under 75th percentile.

Sweating during sleep is associated with the increased upper airway resistance. In the previous studies, apnea, difficulty breathing during sleep and sweating during sleep have been found to be associated with obstructive sleep apnea syndrome [25,26]. Risk of habitual snoring was found to be significantly increased in adolescents with higher frequencies of witnessed apneic events [13]. Mouth breathing usually reflects nasal obstruction that provokes snoring by lowering the negative intraluminal pressures that collapse the pharynx. Mouth breathing may also have long-term consequences on the dental arch and on facial development [27]. Recent data suggested that daytime mouth breathing is significantly associated with habitual snoring in the primary school children [26]. Our data showed that mouth breathing, apnea, difficulty in breathing, and sweating during sleep is more common in habitual snorers compared to the non-snoring adolescents.

Previous studies reported that restless sleep among habitual snorers is more common during preadolescent period [4,25]. We also found that restless sleep was 4.0 times more likely in the habitual snoring group compared to non-snorers. In our study, vocalization during sleep and bruxism were more prevalent for

habitual snorers, which is in agreement with a previous study performed among primary school children [26].

There is conflicting data about the association of nocturnal enuresis with habitual snoring [25,26]. The results of our study did not demonstrate a significant correlation between habitual snoring and nocturnal enuresis.

The size of the pediatric airway is dependent on craniofacial and soft tissue structures. Increases in upper airway resistance, including any combination of narrowing/repositioning of the maxilla/mandible or adenotonsillar hypertrophy, will predispose to OSA [7]. Adenotonsillar hypertrophy is the most common anatomic cause of sleep-disordered breathing in children [28]. Our data demonstrated a significant increase in the prevalence of habitual snoring due to tonsillar hypertrophy which is concordant with a previous study that had demonstrated an association between tonsillar hypertrophy and habitual snoring [29].

Smoking may provoke mucosal edema and inflammation of the pharynx, resulting in the narrowing of pharyngeal airway, and leading to an increased risk of snoring [6,24]. It was reported that active and/or passive smoking is a risk factor for habitual snoring [12]. Moreover, a significant dose–effect type of correlation was suggested to exist between prevalence of habitual snoring in children and number of cigarettes smoked by parents [6]. In our study, prevalence of snoring was increased in children who had had parental smoking, especially maternal smoking. This was attributed to the fact that children spend more time with their mothers in Turkey.

Allergic rhinitis causes nasal obstruction due to mucus secretion and nasal mucosal edema. Nasal obstruction results in upper airway obstruction. Recent studies suggested a significant correlation between allergic rhinitis and snoring [4,5,12]. In our study, rhinitis was more prevalent in children with habitual snoring, and the risk was higher in the habitual snorers.

Previous studies have reported a positive association between snoring and asthma [12]. Also, it is suggested that asthma in childhood may affect sleep quality in children [30]. In our study, we could not detect any significant association between asthma and prevalence of habitual snoring.

Frequent tonsillitis was significantly associated with habitual snoring in our study. This finding was consistent with previous researches [4,6,27]. This was explained by the fact that tonsillitis causes tonsillar enlargement and subsequently airway obstruction and snoring.

5. Conclusion

We found the prevalence of habitual snoring to be 4.0% in adolescents from the province of Manisa, Turkey. The risk of habitual snoring is significantly increased with maternal smoking, allergic rhinitis, and in adolescents with higher tonsil stage.

Conflict of interest

All of the authors of this article have no conflict of interest to declare.

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