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# Prevalence and Correlates of Snoring in Adolescents

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## ABSTRACT

Snoring can occur alone or it may be the presenting feature of Obstructive Sleep Apnea and other common chronic conditions. In our study, we aimed to estimate the prevalence and correlates of snoring in adolescent students in Tehran, Iran.

A cross-sectional study was designed and students were selected from 20 secondary and high schools, in 5 different zones in Tehran in order to have a representative sample of the adolescent population.

A total of 2900 students (1200 male and 1700 female students) 11-17 year-old who were attending secondary and high schools were investigated. Information was collected via a structured face-to-face interview, based on a questionnaire. In addition to snoring, nocturnal cough, asthma-related symptoms, and daytime symptoms were also questioned. BMI was measured by two trained physicians. The prevalence of snoring was 7.9% (4.8% in girls and 12.4% in boys). The prevalence of snoring was significantly higher among males ($P< 0.05$). Snoring was positively associated with asthma and nocturnal cough. Overweight/obese adolescents had significantly higher rates of snoring and asthma symptoms. Prevalence of daytime symptoms increased significantly in the snoring group.

These results suggest that snoring is associated with multiple factors in adolescents. We conclude that the prevalence of snoring is relatively high in children of this region. This highlights the need for awareness among physicians about the problem of sleep-disordered breathing, especially in children with asthma and obesity, and also the need for further studies to measure the prevalence of sleep breathing disorders among Iranians.

**Key words:** Adolescents; BMI; Correlates; Iran; Prevalence; Snoring

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## INTRODUCTION

Childhood obstructive sleep-disordered breathing (SDB) is a continuum that ranges from simple snoring to full blown Obstructive Sleep Apnea (OSA).[1]

Obstructive Sleep Apnea Syndrome (OSAS) in children is a disorder of breathing during sleep characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (obstructive apnea) that disrupts normal ventilation during sleep. It is associated with symptoms including habitual (nightly) snoring, sleep difficulties, and/or daytime neurobehavioral problems. Complications may include growth abnormalities, neurologic disorders, and corpulmonale, especially in severe cases.[2]

The prevalence of OSAS ranged from 0.7% to 10.3%, while the prevalence of snoring ranges from 3.2% to 12.1%.[2]

Snoring, a cardinal symptom of obstructive SDB,[3, 4] is a noise produced during sleep by the partial collapse of the oropharynx or hypopharynx. Snoring can occur alone or it may be the presenting feature of OSA and other common chronic conditions such as allergic rhinitis. Some studies have shown that snoring is significantly increased in children with asthma.[1, 3] In a study, snoring was associated with a history of exercise-induced asthma. [3] There are biologically plausible mechanisms that could explain the association between asthma and snoring. Worsening of gastroesophageaal reflux induced by snoring may trigger asthma. In addition, asthma and SDB may be linked because of the common risk factors that promote airway inflammation and/or disturbed neuromuscular control of breathing. Obesity is a possible risk factor for OSA.[1] An association between nocturnal cough and upper airway obstruction in sleep has also been observed in clinical settings.[3] SDB has been assumed to be a condition associated primarily with males. The reason for gender disparity is not fully understood; however, it has been suggested that the risk factors and mechanisms for the development of SDB, in structure and function of the upper airway, may differ between males and females. Sex hormones have also been thought to influence the development of OSA.[5]

Many studies have also indicated that habitual snoring is associated with hypertension, cerebrovascular disease and daytime sleepiness in adults. [6] At the same time, snoring in children has been associated with daytime sleepiness and restless sleep.[7]

This study was carried out in order to estimate the prevalence of snoring in a representative sample of adolescents in Tehran for the first time, and to discover the relationship between snoring and some possible risk factors in the same population.

## PATIENTS AND METHODS

### Procedures

In a cross-sectional study, 3300 students (1500 males and 1800 females) aged 11-17 years (350-500 students from each age group) were assessed in Tehran, between September 2004 and June 2005. During a multistage stratified cluster sampling, 20 secondary schools ($6^{th}$ to $11^{th}$ grades) were selected from different zones in the city to get an equal distribution of children by socio-economic status (SES). A questionnaire was filled providing information on demographic characteristics, sleep-related problems, such as snoring, sleep apnea, nocturnal cough, and daytime sleepiness, respiratory symptoms, and gastrointestinal problems focusing on gastro-esophageal reflux symptoms.

Information was collected via a structured face-to-face interview after a full explanation of the purpose of the study, and questionnaires providing information on the occurrence and frequency of snoring, sleep apnea and daytime symptoms (daytime sleepiness in different situations) were filled by two trained physicians. Participation was on a voluntary basis without teacher input. On the same day, body weight and height were measured to the nearest 0.1 kg and 0.5 cm and the students were evaluated for tonsillar hypertrophy.

### Definition

Snoring and nocturnal cough were defined as the presence of these symptoms for ≥ 3 nights per week [6] in the absence of a cold. [3] The definition of asthma was based on the following questions: 1) Has your physician ever told you that you have asthma or asthmatic bronchitis? 2) Have you ever had asthmatic attacks (attacks characterized by shortness of breath with audible wheezing)? 3) When playing, do you become breathless more easily than other children? Asthmatic children were defined as those who gave an affirmative answer to question 1 or questions 2 and 3. To record a student as allergic, we questioned students for allergy symptoms. Gastroesophageal reflux symptoms included heartburn and acid regurgitation.

The BMI was calculated as weight/height², and expressed as kg/m². Using reference growth charts from the National Center for Health Statistics (NCHS)/ Centers for Disease Control and Prevention (CDC) (2000) [8], overweight and obesity were defined as $\geq 85^{th}$ and $\geq 95^{th}$ percentile, of age- and sex-specific NCHS/CDC2000 BMI values, respectively. [9, 10]

SPSS 10.0 software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. We have used $\chi^2$ test to analyze qualitative variables. Group means were compared using analysis of variance (ANOVA) or t-test. Pearson's correlation test was used to calculate the correlation between the variables studied. All statistical inferences were made at $\alpha = 0.05$.

The study was approved by the ethic board of Tehran University of Medical Sciences and Iranian Ministry of Education and Training.

## RESULTS

Three thousand five hundred 11- to 17-year-old adolescent students from five districts in Tehran, distributed so as to represent all socioeconomic classes, were evaluated. Of the selected subjects from 20 schools, 3300 consented to participate in the survey (responded to questions). Four hundred questionnaires were discarded because of incomplete information (students not knowing the answers exactly) and incorrect information (unrealistic responses and humorous remarks).

In the 1200 boys and 1700 girls studied (the mean age of students was 15 in boys and 14 in girls), 146 boys (12.4%) and 82 girls (4.8%) had snoring for ≥ 3 nights per week, and 47 boys (4.0%) and 34 girls (2.0%) were reported to have nocturnal cough for ≥ 3 nights per week. In addition, 103 boys (8.7%) and 98 girls (5.8%) were defined as having asthma. The overall prevalence of snoring, nocturnal cough, and asthma were 7.9 %, 2.8%, and 7.0%, respectively. Prevalence and correlates of snoring are shown in Table 1.

The prevalence of snoring was significantly higher in males (P=0.00), and there was no trend for association with age (P=0.09)

Night cough (P=0.00) and asthma (P=0.02) were significantly more frequent in snorers compared to the non-snoring group. Exercise-induced asthma was also reported significantly more in the snoring group, while there was no such association between snoring and the history of allergies. Sleep apnea was only reported in 12 students (0.4 %) and there was no significant relationship between sleep apnea and snoring. On the other hand, sleep apnea was reported significantly more in overweight and obese students.

In male adolescents, the mean BMI was 22.17 kg/m² and in female students it was 20.61 kg/m². Mean BMI was significantly higher in male students and snoring was significantly more frequent in students with higher BMIs (P=0.00). There was a >2 fold risk of snoring in subjects with overweight or obesity. The prevalence of snoring in different BMI groups and also different age groups are summarized in Table 2.

**Table 1. Prevalence of snoring in groups of children defined according to sex, asthma, exercise-induced asthma, nocturnal cough, BMI, and age.**

| Variables | Snoring Prevalence (95% CI) | Odds Ratio (95% CI) | P-Value |
|---|---|---|---|
| ***Gender*** | | | |
| Female | 4.8 | 0.58(0.49-0.70) | |
| Male | 12.4 | 1.64(1.47-1.83) | 0.022 |
| ***Asthma*** | | | |
| Yes | 11.9 | 1.57 (1.05-2.36) | |
| No | 7.6 | 0.95 (0.91-1.00) | 0.041 |
| ***Exercise-Induced Asthma*** | | | |
| Yes | | | |
| No | 12.7 | 1.69 (1.11-2.56) | |
| | 7.6 | 0.95 (0.91-1.00) | 0.022 |
| ***Nocturnal Cough*** | | | |
| Yes | 23.5 | 3.56 (2.17-5.85) | |
| No | 7.5 | 0.93 (0.92-0.97) | 0.000 |

CI: Confidence Interval

**Table 2. Prevalence of snoring, asthma, nocturnal cough in children by age and BMI.**

| Variables | Snoring Prevalence | Asthma Prevalence | Nocturnal Cough Prevalence |
|---|---|---|---|
| **Age, yr** | | | |
| 11 | 5.3 | 3.5 | 3.7 |
| 12 | 17.1 | 10.9 | 16.0 |
| 13 | 11.0 | 10.4 | 8.6 |
| 14 | 14.0 | 20.9 | 21.0 |
| 15 | 12.3 | 17.4 | 14.8 |
| 16 | 17.1 | 18.4 | 16.0 |
| 17 | 23.3 | 18.4 | 19.7 |
| **BMI, kg/m$^2$** | | | |
| normal | 6.3 | 6.2 | 2.6 |
| overweight | 12.4 | 7.6 | 2.6 |
| obese | 13.9 | 13.9 | 6.0 |

Gastroesophageal reflux symptoms were not reported more in snorers compared to non-snorers but they were more significantly reported in subjects with higher BMIs.

Daytime symptoms including falling asleep while watching television and in public places, and fatigue were significantly reported more in male snorers (P=0.013) while it showed no significant relationship in females.

Tonsillar hypertrophy was significantly more detected in the students with snoring (P= 0.00)

## DISCUSSION

The results of our study showed that the prevalence of snoring is 7.9% in 11-17 year-old students in Tehran. There has not been any data on the prevalence of snoring in Iran, thus, this is the first study with such a large representative sample of the general population. Previous studies from various countries have shown that the prevalence of habitual snoring ranged from 3.2 to 12.1% in children[2,6] and from 5 to 40% in adults, depending on the definition of habitual snoring. In a sample of early adolescents, the prevalence of habitual snoring was reported to be 5.6%. It has also been demonstrated that the prevalence of habitual snoring ranges from 2.2% to 4.6% in girls and from 5.8% to 8.8% in boys among those aged 15 to 20 years, depending on BMI. [6] In a study by Shin et al, the prevalence of habitual snoring (defined as snoring ≥ 3 days per week) was estimated to be 11.2% among 11$^{th}$ grade high school students [6] and in a study by Lu et al, prevalence of snoring (defined as snoring ≥ 4 nights per week) was estimated to be 10.5% in preschool children.[3] However in the study conducted in Istanbul, Turkey, the prevalence of snoring in 5 to 13-year-old children was reported to be 7.0%, similar to the study of Ferreira et al [4, 11], which are both in agreement with our study. The differences in prevalence rate, therefore, may be largely attributed to the definitions of habitual snoring that were used and the different age groups which were studied.

In our study, similar to the study of Lu et al,[3] nocturnal cough, and asthma highly correlated with habitual snoring and it is stated that the high prevalence of nocturnal cough in children who snore cannot be explained by the coexistence of asthma and nocturnal cough, but is explained by both factors acting independently.

Furthermore, in the study of Redline et al,[12] children with SDB were significantly more reported to have had: usual cough, occasional wheeze, persistent wheeze, and doctor-diagnosed asthma. While Ersu et al.[11] reported higher atopy and asthma prevalence in children with habitual snoring, we found no such association between allergy and snoring, and this could be due to subjective reports rather than objective measures for allergy and atopy.

In our study, snoring was more prevalent in boys, which is in agreement with previous studies in children and adolescents[3,5,11-14] and even adults.[13,15] The gender difference in adolescents and adults is attributed to sex hormones and their influence on respiratory control and/or body fat distribution. These factors would play a smaller role in prepubertal children. However, in our study, since boys aged more than 12 years, they had a higher prevalence of snoring, thus the role of puberty is highlighted.[11,12]

Regarding the daytime symptoms, Ersu et al[11] reported habitual snorers to have had symptoms such as falling asleep while watching television and in public places in both genders. Shin et al[6] showed that habitual snoring correlated with increasing degrees of daytime sleepiness, while in our study, we found such relation only with males. This may be explained by the higher prevalence of snoring in males.

The strong association between BMI and snoring in the current report in adolescents also has been noted in

previous studies. [5, 12] Bloom et al suggested that this 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 or obesity.

We found that tonsillar hypertrophy is significantly more frequent in students who snore, and this association could be explained with frequent tonsillitis, and this finding is in agreement with previous studies.[11,12]

This cross-sectional study has some limitations. First of all, self-reported information is of concern and subjective responses are prone to errors and over- and under-reporting. Second, the presence of snoring was established on self-reported questions rather than objective tests and it is a less-than-optimal method for accurately to identify people with snoring. Furthermore, the cross-sectional design of the study introduces uncertainties regarding the sequence of cause and effect of the observed associations. On the other hand, the importance of this study is that it is the first one to report on the prevalence of snoring and associated factors in a sample of adolescents in Iran. The large sample size and the limited number of observers, who were physicians as well, are the strengths of the study.

We conclude that the prevalence of snoring, suggestive of obstructive sleep problems,[17] is relatively high in adolescents of this region. Although presence of these symptoms do not necessarily indicate presence of OSA, these findings highlight the need for awareness among the community and physicians about the problem of obstructive SDB, especially in children with asthma and/or overweight or obesity, and the need for further studies to measure the prevalence of sleep breathing disorders. [1]

Given the relatively high prevalence of snoring in adolescents, any causal association would likely have a large public health impact, necessitating more aggressive screening, diagnosis, and treatment strategies aimed at identifying and treating a potentially treatable disorder.

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