Original Article

DOI: 10.5582/bst.2012.v6.2.57

Study pattern of snoring and associated risk factors among medical students

Vatsal Singh[1], Saurabh Pandey[1], Abhijeet Singh[1], Rishabh Gupta[1], Rajendra Prasad[1,*], Mahendra Pal Singh Negi[2]

[1] *Department of Pulmonary Medicine, CSM Medical University, Lucknow, Uttar Pradesh, India;*
[2] *Institute for Data Computing and Training, Lucknow, Uttar Pradesh, India.*

Summary **Snoring can impair lifestyle and cause late cardiopulmonary complications. Early detection of snoring and timely intervention during adolescence can avoid complications. A single center prospective cross-sectional study was conducted in 548 undergraduate 17-25 years old undergraduate medical students of CSM Medical University, Lucknow, who were interviewed on the basis of the modified Berlin Questionnaire along with their room-partners describing their snoring habits. Ninety-seven (17.7%) subjects were found to be snorers. Risk factors *viz.* day time sleepiness (European Stroke Scale (ESS) scores), smoking habits, alcohol intake, neck size and BMI were observed. The proportion of males, smokers, BMI, neck size and ESS scores were significantly ($p < 0.001$) higher in snorers than non snorers. Logistic regression found sex (OR = 5.73, 95% CI = 2.11-15.61), smoking (OR = 2.20, 95% CI = 0.97-5.62), BMI (OR = 3.16, 95% CI = 1.09-7.36) and neck size (OR = 2.03, 95% CI = 0.79-6.35) as significant ($p < 0.01$) independent risk factors for snoring. A clinically significant form of Sleep Disordered Breathing (Habitual snoring, ESS score ≥ 11 and BMI ≥ 25 kg/m^2) was suspected in 4 (0.7%) students. The findings of this study may also be validated in the general population. The study concluded that male undergraduate medical students are at a high risk for developing snoring habits.**

Keywords: Snoring, medical students, sleep disordered breathing, independent risk factors

1. Introduction

Snoring is a very common yet under recognized phenomenon in late adolescence. In recent years, snoring has been identified as not merely a nuisance factor for the co-sleeper but significantly associated with cardiopulmonary diseases. Epidemiologic investigation of snoring patterns has been hampered by difficulties in obtaining valid data from an adequate population based sample. Different sleep studies have reported a varied prevalence of snoring and related disorders among children and young adults (*1-3*). The variations arise due to laboratory constraints, different diagnostic criteria and association of other commonly found causative conditions, such as tonsillar hypertrophy, asthma, hypertension, gastro-esophageal reflux disorder and structural abnormalities in this age group (*4,5*).

Snoring may be only a symptom of a broad spectrum of obstructive respiratory abnormalities, clinically identified as Sleep Disordered Breathing (SDB) (*1*). SDB presents as partial respiratory tract obstruction as in Upper Airway Resistance Syndrome (UARS) or as complete obstruction resulting in Obstructive Sleep Apnea (OSA) with manifestations like snoring, episodes of hypopnea or apnea according to the extent and duration of obstruction (*6*). There are specific factors responsible for each of the clinical features of SDB which are not fully understood. Studies have indicated that habitual snoring is associated with hypertension, cardio-vascular disease and excessive daytime sleepiness (EDS) (*7*). Recurrent episodes of nocturnal asphyxia and arousal from sleep

**Address correspondence to:*
Dr. Rajendra Prasad, Department of Pulmonary Medicine, CSM Medical University, Lucknow 226003, Uttar Pradesh, India.
E-mail: rprasadkgmc@gmail.com

induce secondary physiological responses that may eventually produce cardiovascular, hemodynamic and neuropsychiatric manifestations (*8*). The behavioral problems may include excessive daytime sleepiness, aggressiveness, inattention, headache, poor memory and difficulty in socialization (*9*). Many underlying causes of SDB among adults such as obesity, start progressing during late adolescence. The effect of raised testosterone at puberty, which increases mass of pharyngeal muscles, cannot also be neglected. Therefore, there is an opportunity for intervention in development of SDB and related complications in the late adolescent age group.

Medical students typically start their education during late adolescence. There is sudden change from their active school life to a sedentary lifestyle. These students are exposed to risk factors of snoring like smoking and alcohol intake. Snoring might be the earliest manifestation of SDB in these students. There is a paucity of literature evaluating snoring habits among college students especially among medical students. Thus, in the present study, we have attempted to determine the pattern of snoring among the population of undergraduate medical students using a standardized questionnaire survey (*10,12-19*) and correlating the associated risk factors with snoring.

2. Materials and Methods

2.1. *Study population*

A single-center cross-sectional study was carried out in a sample of medical students of both genders ranging in age from 17 to 25 years between November 2010 and February 2011. Out of the 600 healthy individuals approached who qualified for the inclusion/exclusion criteria, 548 gave their consent and were included in the study. As inclusion criteria, we excluded subjects having systemic diseases like connective tissue disorders, chronic liver diseases, asthma, pulmonary tuberculosis, chronic pharyngitis, tonsillitis, immunosuppressive diseases, malignancies and heart diseases (except hypertension and vascular diseases).

2.2. *Procedure*

The subjects were interviewed on the basis of a predesigned standardized Berlin questionnaire (*10,12-19*) with some relevant modifications to elicit information from the subjects themselves and from their partners about the occurrence of snoring, cessation of breathing during sleep, tiredness, sleepiness while driving or any past history of hypertension. Often, people are unaware of their snoring habits themselves. Therefore, we used the standardized Berlin questionnaire which is designed to interview the room partners of the subjects. Sixty-five (11.86%) subjects whose partners were unavailable during the interview were contacted by telephone. The daytime sleepiness was also assessed using the Epworth Sleepiness Scale (ESS) (*11*). Some questions were also asked to evaluate possible risk factors for obstructive sleep apnea like smoking, alcoholism and use of sedatives or tranquillizers. Smoking status was defined if they smoked > 100 cigarettes in their lifetime and were still smoking or had given up less than one year ago (*20*) and alcoholism as daily intake of alcohol during the last one month. After getting a detailed clinical history, a relevant physical examination including height, weight, neck size and blood pressure was done. The neck size was measured at the level of cricoid cartilage. Blood pressure measurement was recorded in mm of Hg in a sitting and standing position after at least ten minutes of rest. Another recording was done after ten minutes along with any previous history of any anti-hypertensive medication in case the first recording was found to be abnormal. This was done in order to reduce the probability of a false risk group categorization.

2.3. *Statistical analysis*

Data were summarized as mean ± S.D. Groups were compared by independent Student's *t* test while discrete variables were compared by Fisher's exact test. Unadjusted binary logistic regression analysis was used to assess the effect of each independent predicator variable on snoring. The significant predictor variables were further analyzed by multivariate logistic regression analysis to assess the independent risk factor of snoring. Each regression model was adjusted for alcohol and hypertension. A $p < 0.05$ was considered statistically significant. MINITAB (Windows version 13.0) was used for analysis.

3. Results

3.1. *Basic characteristics*

3.1.1. *Subjects*

There were a total of 548 subjects. Of the total, 392 were males (71.53%) and 156 females (28.47%). The demographic profile of the study population has been described in Table 1.

3.1.2. *Snoring habits*

There were 97 (17.70%) snorers and 451 (82.29%) non-snorers in the study group. Among the snorers, as provided in Table 2, 16 (16.49%) snored louder than talking while 81 (83.50%) were non-loud snorers. The snoring frequency was more than 3-4 times per week in 19 (19.58%) subjects and less than 1-2 times per week in 78 (80.41%) subjects. Snoring of 39 (40.20%)

Table 1. Basic characteristics of subjects

Basic characteristics	*n* (%)
Mean Age (in years)	21.73 ± 1.81
Sex	
Male	392 (71.53%)
Female	156 (28.47%)
Mean neck size (in inch)	13.90 ± 1.23
Mean BMI (in kg/m^2)	21.95 ± 2.52
Mean ESS score	6.92 ± 3.11
Mean nocturnal sleeping hours	7.37 ± 1.10
Smoker	18 (3.28%)
Alcoholic	33 (6.02%)

Neck size was measured at the level of cricoid cartilage. BMI: Body Mass Index.

Table 2. Snoring habits of subjects

Snoring habits	*n* (%)
Snoring loudness	
Loud (more than talking)	16 (16.49%)
Non-loud (not more than talking)	81 (83.50%)
Snoring frequency	
≥ 3-4 times/week	19 (19.58%)
≤ 1-2 times/week	78 (80.41%)
Breathing quality	
Bothersome	39 (40.20%)
Non-bothersome	58 (59.79%)
Breathing pauses	
≥ 3-4 times/week	5 (5.15%)
≤ 1-2 times/week	18 (18.56%)
Never or almost never	39 (40.20%)
Not cared	35 (36.08%)

students bothered their partners while that of 58 (59.79%) did not. More than 3-4 breathing pauses during sleep were reported in 5 (5.15%) students, less than 1-2 times per week in 18 (18.56%), never or almost never in 39 (40.20%) while 35 (36.08%) students did not care to notice. In the overall population, there were 2.92% loud snorers, 3.47% habitual snorers, 7.12% bothered their partners and 0.91% had more than 3-4 breathing pauses per week during their sleep.

On comparing the risk factors between non-snorers and snorers (Table 3), the proportion of males, smokers, mean neck size, BMI and European Stroke Scale (ESS) scores in snorers was found significantly ($p < 0.001$) higher as compared to non-snores. However, the proportions (Y/N) of alcohol and hypertension did not differ ($p > 0.05$) between the two groups, *i.e.,* was found to be statistically the same.

3.1.3. *Daytime sleepiness*

Mean ESS score of the study population was 6.92 ± 3.11. Out of the 548 subjects, 44 (8.10%) reported morning tiredness more than 3-4 times per week, 172 (31.39%) had less than 1-2 times per week and 332 (60.58%) had never or almost never. Wake time tiredness was experienced more than 3-4 times per week by 89 (16.24%) subjects, less than 1-2 times per week by 153 (27.92%) subjects and never or almost never by 306 (55.84%) subjects. Drowsiness behind wheel more than 3-4 times per week was reported by 14 (2.55%) subjects, less than 1-2 times per week by 18 (3.28%) subjects, never or almost never by 230 (41.97%) subjects while 286 (52.19%) subjects did not drive.

Table 3. Basic characteristics of snorers versus non-snorers

Characteristic	Non-snorers (*n* = 451)	Snorers (*n* = 97)
Sex		
Males	300 (66.52%)	92 (94.85%)
Females	151 (33.48%)	5 (5.15%)
Mean neck size (in inch)	13.82 ± 1.17	14.69 ± 1.40
Mean BMI (in kg/m^2)	21.69 ± 2.38	23.44 ± 2.56
Mean ESS score	6.78 ± 2.90	7.71 ± 3.70
Smoking	6 (1.33%)	12 (12.37%)
Hypertensive	5 (1.11%)	3 (3.09%)
Alcoholism	26 (5.76%)	7 (7.22%)

BMI: Body Mass Index.

3.1.4. *Blood pressure and BMI*

Of all subjects, 8 (1.46%) were hypertensive, 173 (31.57%) were pre-hypertensive and 367 (66.97%) were found to be normotensive as per the JNC7 criteria (*21*). Sixty-four (11.67%) subjects were considered as obese according to the Asian classification of WHO (*22*).

3.2. *Identification of risk factors*

The effect of sex, smoking, BMI, neck size and ESS scores on snoring was evaluated by using logistic regression analysis and is summarized in Table 4. Logistic regression analysis (unadjusted) found a significant ($p < 0.05$ or $p < 0.001$) effect of sex, smoking, BMI, neck size and ESS scores on snoring. On evaluating the effect of all significant variables on snoring together (adjusted), all variables showed a significant effect on snoring except ESS scores. In other words, among observed risk factors, sex, smoking, BMI and neck size were independent risk factors for snoring.

4. Discussion

We took undergraduate medical students as the sample population to estimate the prevalence and pattern of snoring among apparently healthy adolescent individuals. There is strong evidence of various pathophysiologies which suggest that sleep disturbed breathing starts manifesting during late adolescence. Hormonal changes, changes in neuromuscular tone and development of obesity are some of the contributions to this phenomenon. Obesity is proposed as an underlying cause as it is correlated with increased neck

Table 4. Unadjusted and adjusted identification of risk factors for snoring by logistic regression analysis

Predictor variables	Unadjusted			Adjusted		
	b	*p* value	OR (95% CI)	b	*p* value	OR (95% CI)
Sex (M)	2.16	$p < 0.001$	8.68 (3.44 to 21.87)	1.75	$p < 0.001$	5.73 (2.11 to 15.61)
Smoking (Y)	2.14	$p < 0.001$	3.12 (1.04 to 7.34)	1.59	$p < 0.005$	2.20 (0.97 to 5.62)
BMI	2.27	$p < 0.001$	4.31 (1.19 to 10.44)	0.19	$p < 0.001$	3.16 (1.09 to 7.36)
Neck size	0.55	$p < 0.001$	2.73 (1.42 to 9.10)	0.23	$p < 0.007$	2.03 (0.79 to 6.35)
ESS	0.09	$p < 0.011$	1.10 (1.02 to 1.18)	0.07	$p < 0.054$	1.08 (1.00 to 1.16)

circumference and internal compression of pharynx by superficially located fat (*23*). Many cohort studies have revealed smoking and alcohol consumption as independent risk factors for SDB (*24*). Habits of smoking and alcohol intake also commonly develop during adolescence.

Our results showed a 17.7% prevalence of snoring among the subjects. This is slightly lower than the prevalence reported by western studies (25.7% and 28.7% by David *et al.* (*25*) and Angeles *et al*. (*26*), respectively). In another study, Balakrishnan *et al*. reported a lesser prevalence of 13.8% among adolescents (*27*). Overall, different studies state the prevalence of snoring in younger children in the range of 10-15% and 4-29% in adults (*28,29*). Similarly, in our earlier study we had found a 28.3% snoring prevalence among adults (*30*). We can decipher that prevalence of snoring increases from childhood to the adult age group with a steep rise during late adolescence. The fact that most of the independent risk factors like obesity, smoking and alcohol consumption are modifiable indicates the need to utilize the opportunity for intervention during adolescence. It should also be understood that the prevalence of snoring does not necessarily indicate the development of obstructive complications but these findings do highlight the need for awareness about possible complications.

Furthermore, habitual snoring even in the absence of SDB has been shown to be associated with EDS that adversely affects the performance and learning abilities of children (*31*). We found habitual snoring among 3.5% subjects which is comparable to 6% shown by Johnson and Roth (*32*). EDS was found among 63 (11.5%) subjects while in a study by Mahmoud *et al.*, EDS among adolescents was reported from 26.7% to 43% (*33*). Strikingly, 12 (63.2%) of the 19 habitual snorers in our study group had EDS. Habitual snorers have symptoms such as falling asleep while watching television or in public places in both genders (*34*). Shin *et al.* have also showed that habitual snoring correlates with an increasing degree of daytime sleepiness (*7*). This is thought to be related to sleep fragmentation as a result of partial upper airway obstruction during sleep, not necessarily with the presence of frank hypopnea or apnea (*35*). However, other factors like sleep deprivation due to demanding study or work schedules, together with irregular sleeping patterns common in this age group, may influence the results.

Among the 97 (17.7%) snorers in our study, there were 92 males and only 5 females. The gender drift could be due to the smaller female sample size but it may also be attributed to a hormonal influence on respiratory control and fat distribution. Male gender, large neck size, high BMI and smoking were identified as independent risk factors for snoring. Male gender and high BMI have also been proved as risk factors for snoring by other studies like by Bidad *et al.* (*2*) and David *et al.* (*25*). Similar to David *et al.*, alcohol consumption was not found to be associated with snoring in our study (*25*).

If we analyze to find the prevalence of clinically significant SDB, *i.e.,* suspicious for developing complications, defined as snoring at least 3-4 times per week, having excessive daytime sleepiness (ESS score ≥ 11) and obesity (BMI ≥ 25 kg/m^2), it was found in 4 (0.7%) subjects. Recently Amra *et al.* (*36*) and Johnson (*32*) have reported an SDB prevalence of 4.9% and 6% among adolescents in their respective studies. Though a clinically significant form of SDB was found to be comparatively lower than that of other studies, still its possibility cannot be underestimated.

Our cross-sectional study may have the limitation of sampling bias. However, the strength of associations found in our study show that the extent of effects of sampling error on results was minimized to a very low level. There is a possibility of under diagnosis of snoring when a standard full night polysomnography test is not administered. On the other hand, it may be better to assess snoring pattern over a period of time by subjective means rather than evaluating this symptom during a single night test. Uncertainties regarding the other causative factors were reduced by using extensive exclusion criteria. We attempted to remove the self-reporting bias by interviewing with their room partners. Nevertheless, the effect of unknown confounding factors cannot be excluded completely.

We conclude that the prevalence of snoring is high among the male population of late adolescent age group and is comparable to adults. The habit of snoring is frequently ignored as many people, including medical students, are unaware of the possible complications. Spreading information on snoring is necessary to encourage self-reporting. Also, it is important to

understand the pattern of snoring in addition to the causal associations, so as to identify the individuals at clinically significant risk for developing complications. The Berlin questionnaire is an effective and inexpensive modality for screening clinically significant snoring. Inclusion of more physical activities in the medical curriculum and avoidance of smoking should be promoted. Various treatment modalities like continuous positive airway pressure (CPAP), mandibular splints and other surgical interventions are available. Further, there is a need to study the impact of early diagnosis and intervention on the progression of snoring habits and associated co-morbidities.

References

1. Stoohs RA, Blum HC, Haselhorst M, Duchna HW, Guilleminault C. Normative data on snoring: A comparison between younger and older adults. Eur Respir J. 1998; 11:451-457.
2. Katayoon B, Shahab A, Asghar A, Narges G, Sorush Z, Moaieri H. Prevalence and correlates of snoring in adolescents. Iran J Allergy Asthma Immunol. 2006; 5:127-132.
3. Umana AN, Anah MU, Udonwa NE, Mgbe RB, Oyo-Ita V, Onoyon-Ita, Ukpong EE. Pattern of snoring among school children in Calabar, Nigeria. Nigerian Medical Practioner. 2007; 51:103-106.
4. Marcus CL, Omlin KJ, Basinki DJ. Normal polysomnographic values for children and adolescents. Am Rev Respir Dis. 1992; 146:1235-1239.
5. Carroll JL, Loughlin GM. Obstructive sleep apnoea ayndrome in infants and children: Clinical features and pathophysiology. In: Principals and Practice of Sleep Medicine in the Child. WB Saunders Company, Philadelphia, PA, USA, 1995; pp. 163-191.
6. Lugaresi E, Cirignotta F, Geraldi R, Montagna P. Snoring and sleep apnea: Natural history of heavy snorers disease. In: Guilleminault C, Partinen M, eds. Obstructive sleep apnea syndrome: Clinical research and treatment. Raven Press, New York, NY, USA, 1990; pp. 25-36.
7. Shin C, Joo S, Kim JK, Kim T. Prevalence and correlates of habitual snoring in high school students. Chest. 2003; 124:1709-1715.
8. Bradley TD, Phillipson EA. Pathogenesis and pathophysiology of the obstructive sleep apnea syndrome. Med Clin North Am. 1985; 69:1169-1185.
9. Caroll JL. Obstructive Sleep Disordered Breathing in Children: New controversies, new directions. Clin Chest Med. 2003; 24:261-282.
10. Nikolaus CN, Stoohs RA, Cordula MN, Kathryn C, Kingman RS. Using the Berlin questionnaire to identify patients at risk for the sleep apnea syndrome. Annals internal Medicine. 1999; 131:485-491.
11. Johns MW. A new method for measuring daytime sleeping, the Epworth sleepiness scale. Sleep. 1991; 14:540-545.
12. Cirignotta F, Alessandro RD, Partinen M. Prevalence of every night snoring and obstructive sleep apnoeas among 30-69 year old men in Bologna, Italy. Acta Psychiatr Scand. 1980; 79:366-372.
13. Redline S, Strohi KP. Recognition and consequences of obstructive sleep apnea hypopnea syndrome. Clin Chest Med. 1998; 19:1-19.
14. Kapuniai LE, Andrew DJ, Crowell DH, Pearce JW. Identifying sleep apnea from self-reports. Sleep. 1988; 11:430-436.
15. Flemons WW, Whitelaw WA, Brant R, Remmers JE. Likelihood ratios for a sleep apnea clinical prediction rule. Am J Respir Crit Care Med. 1994; 150 (5 Pt 1):1279-1285.
16. Flemons WW, Remmers JE. The diagnosis of sleep apnea: Questionnaires and home studies. Sleep. 1996; 19 (10 Suppl):S243-S247.
17. Kump K, Whalen C, Tishler PV, Browner, Ferrettee V, Strahi KP. Assessment of the validity and utility of a sleep-symptom questionnaire. Am J Respir Crit Care Med. 1994; 150:735-741.
18. Wu H, Yan-Go F. Self-reported automobile accidents involving patients with obstructive sleep apnea. Neurology. 1996; 46:1254-1257.
19. Maislin G, Pack AI, Kribbs NB, Smith PL, Schwartz AR, Kline LR. A survey screen for prediction of apnea. Sleep. 1995; 18:158-166.
20. West R, Hajek P, Stead L. Outcome criteria in smoking cessation trials: Proposal for a common standard. Addiction. 2005; 100:299-303.
21. Chobanian AV, Bakris GL, Black HR. Seventh report of the Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure. Hypertension. 2003; 42:1206-1252.
22. World Health Organization, Western Pacific Region. The Asia-Pacific Perspective. Redefining obesity and its treatment. International Diabetes Institute, WHO/IASO/IOTF, Melbourne, Australia, 2000; pp. 15-21.
23. Stradling JR, Crosby JH. Predictors and prevalence of obstructive sleep apnoea and snoring in 1,001 middle aged men. Thorax. 1991; 46:85-90.
24. Young T, Finn L, Palta M. Chronic nasal congestion at night is a risk factor for snoring in a population-based cohort study. Arch Intern Med. 2001; 161:1514-1519.
25. David SC, Joseph KW, Alice SS, Dominic KL, Christopher KW, Roland CC. Prevalence of snoring and sleep-disordered breathing in a student population. Chest. 1999; 116:1530-1536.
26. Angeles SA, María FP, Francisco CG, Emilio GD, Soledad CG, Carmen CB, José CG. Sleep-related breathing disorders in adolescents aged 12 to 16 years: Clinical and polygraphic findings. Chest. 2001; 119:1393-1400.
27. Balakrishnan D, Thirunavukkarasu S, Edwin R, Virudhagirinathan BS. The prevalence of Snoring in the South Indian city of Chennai – Report of a population based survey (PEDEX). Presented in the First International ORL-HN conference of the National University of Singapore, 27-30 January 2005.
28. Teculescu DB, Caillier I, Perrin P. Snoring in French preschool children. Pediatr Pulmonol. 1992; 13:239-244.
29. Zamarrón C. Snoring and vascular diseases. An Med Interna. 1998; 15:669-671.
30. Prasad P, Garg R, Verma RK, Agarwal SP, Ahuja RC. A study on snoring habits in healthy population of Lucknow. Indian J Sleep Med. 2006; 1:37-40.
31. Ulfberg J, Carter N, Talback M. Excessive daytime sleepiness at work and subjective work performance in the general population and among heavy snorers and patients with obstructive sleep apnea. Chest. 1996;

110:659-663.
32. Johnson EO, Roth T. An epidemiologic study of sleep-disordered breathing symptoms among adolescents. Sleep. 2006; 29:1135-1142.
33. Mahmoud M, Babak G, Mir GB, Ebrahim A, Shahnaz K, Shervin S, Mahmoud RA. Sleep patterns and sleep problems among preschool and school-aged group children in a primary care setting. Iran J Ped. 2007; 17:213-221.
34. Ersu R, Arman AR, Save D, Karadag B, Karakoc F, Berkem M. Prevalence of snoring and symptoms of sleep-disordered breathing in primary school children in Istanbul. Chest. 2004; 126:19-24.
35. Guilleminault C, Stoohs R, Clerk A. A cause of excessive daytime sleepiness: The upper airways resistance syndrome. Chest. 1993; 104:781-787.
36. Amra B, Farajzadegan Z, Golshan M, Fietze I, Penzel T. Prevalence of sleep-related symptoms in a Persian population. Sleep Breath. 2011; 15:425-429.

(*Received August 30, 2011; Revised March 28, 2012; Accepted April 7, 2012*)