Prevalence of Snoring in College Students

Minal Patel, BA; Duyen Tran, BS; Ashoke Chakrabarti, BA; Audrey Vasquez, BS; Paul Gilbert, PhD; Terence Davidson, MD

Abstract. Snoring in college students may be the earliest presentation of adult sleep-disordered breathing, yet the literature contains few studies that demonstrate its effects on learning or whether early diagnosis leads to interruption of disease progression or prevention of comorbidities. Objective and Participants: The authors conducted this study in January–April 2004 to assess the prevalence of snoring in college students (N = 2,200). Methods: They developed a questionnaire on sleep behaviors and distributed it to 18- to 25-year-old undergraduates at a California university. Results: Almost one-third (30%) of participants reported snoring. The prevalence of snoring was higher among men than women (42% and 25%, respectively). The prevalence of self-reported snoring was highest in Asian students (37%). Conclusions: Snoring is highly prevalent in college students; prevalence is higher in men than women, correlates with body mass index, and varies by ethnicity.

Keywords: BMI, college health, sleep-disordered breathing, snoring

Sleep-disordered breathing (SDB) is a recently recognized, prevalent, and mortal illness.1,2 The premiere symptom of SDB is snoring. The prevalence of SDB in children is 10% and in middle-aged men and women is 24% and 9%, respectively.3,4 The prevalence of SDB in young adults, such as college-aged students, is not well known or studied. Although daytime sleepiness in college-aged students is a common complaint,5 SDB’s contribution to this condition is not well-known.

Snoring in college students may be an early presentation of adult SDB, yet in a literature review, we found few studies on the prevalence of early adult SDB, its effects on learning, and whether early diagnosis leads to interruption of disease progression or prevention of comorbidities such as hypertension and obesity. Table 1 provides a list of common comorbidities. The 2006 National College Health Assessment reported that the third largest (24%, N = 5,952) impediment on academic performance in college students is sleeping difficulties.6 Hui et al7 studied first-year Chinese college students and found that 26% of participants reported snoring, 11% reported impaired performance ability, and 42% reported excessive daytime sleepiness (EDS). In a survey of 111 Pakistani medical students, Pasha and Khan8 found that 27% of men and 12% of women reported snoring. Six percent and 5%, respectively, reported apneic episodes. Ficker et al9 studied self-reported snoring among medical students taking exams and found that 49% claimed to be occasional snorers and 12% frequent snorers. Regression analysis showed an association between exam failure and snoring. The relative risk of exam failure for snorers adjusted for age, sex, and body mass index (BMI) was 1.26.

We conducted this study to assess the prevalence of snoring in college-aged students. This is especially important because snoring in the young adult may be a contributor to daytime sleepiness in college-aged students and may be the early presentation of adult SDB.

METHODS

An institutional review board approved the questionnaire (see Appendix), which we developed and had undergraduate students working in the sleep center distribute to undergraduate classes. The undergraduate assistants collected completed questionnaires at the time of consent and distribution. We included students aged 18 to 25 years. Of the 3,000 surveys distributed, we received 2,601 completed surveys, yielding a response rate of 87%. We omitted 401 surveys from the analysis, including 347 participants who reported not knowing whether they snored and 54 people who were older than age 25. No one aged younger than 18 completed a questionnaire. The ratio of female to male participants surveyed was 2:1; the undergraduate population in which we distributed the survey comprised 52% women and 48% men. To achieve a random sampling in the most efficient manner, the students distributing the survey went to the largest lecture rooms on campus, which have a capacity of 300 to 500 students. Departments that offer
courses in this capacity and in these rooms include biology, political science, economics, and psychology—the 4 most popular majors at the university. However, the majority of the classes in which the survey was distributed were psychology courses, with an average female to male ratio of 3:1 within the major. Psychology professors were more willing to have the survey distributed in their classes because they often use this method of data collection in their own research. Therefore, the present sample reflects the average demography of the university’s undergraduate students enrolled in psychology courses. After receiving the surveys, we entered data into a Microsoft Excel (Microsoft Corp., Redmond, WA) database and analyzed the means, standard deviations, and correlations using SPSS version 11 (SPSS Inc, Chicago, IL) for Mac OSX. We assessed specific correlations through univariate and multivariate analyses of variance (ANOVAs).

RESULTS

The mean age of male participants was 19.93 years ($SD = 1.38$), and the mean age of female participants was 19.86 years ($SD = 1.38$). A one-way ANOVA revealed no significant age differences between male and female participants ($F[1, 2,196] = 1.30, p = .25$). The mean BMI was 21.66 kg/m² ($SD = 3.15$) for female participants and 23.59 kg/m² ($SD = 3.53$) for male participants. A one-way ANOVA revealed that BMI was significantly higher in male participants than in female participants ($F[1, 2,196] = 126.60, p < .001$). However, the Group × Sex interaction did not reach significance ($F[1, 2,147] = 1.40, p = .24$). The data shown in Figure 1 indicate that both men and women who reported snoring had a higher BMI than did those who reported not snoring.

Eighty-seven percent of participants reported that at least 1 of their parents snored. Ninety-five percent of snoring parents reported that at least 1 of their parents also snored. Eighty-four percent of participants who reported not snoring had parents who did snore. A chi-square analysis revealed that the prevalence of reported parental snoring was higher in participants who reported snoring than in participants who reported not snoring ($\chi^2[2, N = 2,053] = 51.53, p < .001$). We excluded from this analysis participants who did not know whether at least 1 of their parents snored ($n = 147$).

We performed a multivariate ANOVA (MANOVA) with group (snoring, nonsnoring) and sex (male, female) as between-group variables to analyze participant ratings of loudness of snoring, subjective feelings of fatigue after a full night of sleep, and frequency of falling asleep during daily activities. We included in the analysis only participants who supplied ratings on all 3 variables ($n = 2,166$). Results from a Newman-Keuls post hoc comparison test of the Group × Sex interaction for snoring loudness revealed that men who reported snoring rated loudness of snoring

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial fibrillation</td>
<td>50</td>
</tr>
<tr>
<td>Heart failure</td>
<td>50</td>
</tr>
<tr>
<td>Diabetes</td>
<td>50</td>
</tr>
<tr>
<td>Obesity</td>
<td>75</td>
</tr>
<tr>
<td>Men</td>
<td>90</td>
</tr>
<tr>
<td>Women</td>
<td>50</td>
</tr>
<tr>
<td>All hypertension</td>
<td>35</td>
</tr>
<tr>
<td>Drug-resistant hypertension</td>
<td>80</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>30</td>
</tr>
<tr>
<td>Asthma</td>
<td>15</td>
</tr>
<tr>
<td>Gastroesophageal reflux disease (GERD)</td>
<td>15</td>
</tr>
<tr>
<td>Involvement in motor vehicle accidents</td>
<td>7 × normal</td>
</tr>
</tbody>
</table>

Note. For the study population, the overall prevalence of sleep-disordered breathing was 17% (24% for men, 9% for women). Data courtesy of ResMed Corp.
Snoring is documented as an independent risk factor for hypertension in adults and children. Thirty-five percent of adults with SDB have hypertension, and two-thirds of hypertensive patients have SDB. Whether or not one believes that snoring alone, without upper-airway flow limitation, is a risk factor for hypertension, science shows that once flow limitation occurs, SDB is associated with hypertension. For example, Somers et al\textsuperscript{16} showed that during the period of flow limitation and obstruction, autonomic neural stimulation results in peripheral vascular vasoconstriction. This work is the clearest demonstration of how SDB causes hypertension. Given that hypertension is a chronic progressive condition associated with SDB, it is important to diagnose and treat SDB at its inception, thereby preventing its progression, consequences, and comorbidities. Recent research has shown significant improvements in systolic and diastolic dysfunction with long-term use of continuous positive airway pressure (CPAP).\textsuperscript{17,18}

The neurocognitive consequences of SDB are well-studied. Researchers have documented significant learning disabilities in children with SDB.\textsuperscript{19} These disappear after the SDB is corrected by tonsillectomy and adenoidectomy. Children generally experience hyperactivity rather than daytime sleepiness or the propensity to nap, as is seen in adults. This is an extremely important observation. In adults, EDS results in falling asleep at inappropriate times: while sitting at a desk, while watching TV or a movie, during a conference, or even while driving. It may well be that in this way, college-aged students behave in part like children (ie, hyperactive and belligerent) and in part like adults (ie, fatigued during the day). The psychoneurocognitive consequences may include diminished learning abilities, decreased attention span, and falling asleep in class. These consequences may manifest in behavioral abnormalities such as hyperactivity and difficulties with interpersonal relationships.

EDS is an important symptom of SDB; however, college students may report symptoms of daytime sleepiness for many reasons, including general sleep deprivation or circadian rhythm disharmony (ie, not maintaining a regular sleep schedule). Anxiety, depression, and insomnia are also seen in college students. In addition, shorter sleepers are more likely to report poor self-rated health.\textsuperscript{21} Although we did not intend to describe these conditions, SDB must be considered in the differential diagnosis of the tired college student.

The American insurance industry categorizes snoring, absent of neurocognitive consequences, as a social nuisance and not a medical condition. However, in the senior author’s clinical experience, habitual snoring causes major psychosocial effects for the patient. College students who snore frequently and loudly may not be able to cohabitate sleeping quarters, which is problematic for dormitory and apartment living. Snorers are often ridiculed by peers, which can ultimately result in psychological consequences. Snoring is sometimes considered a masculine trait, and although it is reported to cause bedroom disharmony in later years, college women generally describe snoring as impairing their ability to cohabitate sleeping quarters. For some, this may represent an impediment to marriage.

**SDB Diagnosis**

We found that SDB was prevalent in the college population under study. For future research or clinical examination, standard intake history should include frequency and
severity of snoring and daytime sleepiness. Those who snore should also report family history and achievement level in school. BMI should be measured. Physical abnormalities of the upper respiratory tract contribute to SDB, so the appropriate physical examination should include the nose, oral cavity, and pharynx. Nasal obstruction is common in patients with allergic rhinitis, nasal fracture, deviated septum, chronic sinusitis, and nasal polyps. During oral cavity and oropharyngeal examinations, clinicians should look for craniofacial abnormality, specifically underdevelopment of the mandible. Because large tonsils are a significant contributing factor to SDB, clinicians should also note tonsil size. Clinicians should examine tongue position and size with the Mallampati grading system, which is shown in Figure 2. Increasing Mallampati grade is associated with increasing SDB severity. In individuals with an oversized, high-riding tongue, the tongue fills the pharynx and obscures the view of the oropharynx, tonsils, uvula, and soft palate. A large neck circumference is also highly correlated with the occurrence of SDB and should be considered in the physical examination as well. Numerous studies have shown that physical examination alone can be an effective predictor of SDB. Last, the history and examination should look for the SDB comorbidities described throughout this article.

SDB diagnosis is based on history, physical exam, and sleep testing. One means of diagnosis is undergoing multichannel home sleep testing, which is as accurate as formal polysomnography in the diagnosis of SDB. Similar to polysomnography, multichannel home sleep testing measures several physiological parameters, including respiration, pulse, heart rate, and oxygen saturation. Two benefits of this type of test are that it is less expensive and permits patients to sleep in their regular environment. After diagnosis, the severity of SDB is reported through an apnea hypopnea index (AHI). Current guidelines for adult SDB warranting treatment are an AHI score of (a) 15 or greater or (b) 5 or greater with any 2 of the aforementioned comorbidities. However, some experts argue that an AHI score of 5 or more is significant, regardless of comorbidities. Given that some people believe that an AHI score of 1 or more may be significant in children and premenopausal women and that an AHI score of 5 or more is significant in young men, one must be careful in using the AHI as the ultimate diagnostic criteria. Nonetheless, patients with an elevated AHI score warrant therapeutic intervention. Those with lower AHI scores and fewer symptoms should be considered for further testing on a case-by-case basis.

SDB Treatment

Figure 3 shows the current diagnostic treatment paradigm for SDB in adults. In a patient without obvious correctable anatomic abnormality, CPAP is the treatment of choice for SDB. Although CPAP compliance reaches 80% in symptomatic adults, CPAP will unlikely be popular for college students, absent severe abnormality, because it requires one to sleep with a mask that is attached to an apparatus that delivers pressurized room air. College students may find this embarrassing or difficult to adapt to on a daily basis, as they often cohabit sleep quarters. Oral appliances have been shown to be effective in the treatment of obstructive sleep apnea. Although comparative studies have shown that CPAP is the recommended and ideal form of treatment, oral appliances are effective in those with mild obstructive sleep apnea or in those unable to tolerate CPAP. In college
In individuals with correctable anatomic abnormality that may lead to SDB, clinicians should recommend procedures such as maxillofacial surgery, septoplasty, turbinate reduction, and endoscopic sinus surgery. A recent publication showed reduction in SDB with treatment of allergic rhinitis using nasal steroids. Individuals with 3+ or 4+ tonsils should be considered for tonsillectomy. Clinicians should discourage surgery for patients without anatomic abnormality because these procedures are often invasive and do not guarantee correction of obstructive sleep apnea. In individuals with snoring as their major complaint but with no obvious anatomic cause or presentation of SDB, a multitude of nonsurgical snoring procedures are available; however, these are generally not covered by insurance.

**Limitations**

With regard to methodological aspects, the questionnaire design was similar to that used in other studies. Reporting bias may have occurred because we used self-report; however, Stooohs et al found that the level of agreement between self-report and an objective measure of snoring was high in young adults, thus supporting our findings and hypothesis that SDB may be highly prevalent in this population. Although snoring is a premiere symptom of SDB, this alone does not demonstrate the severity of the condition; sleep testing may be a more accurate measure of that. A more demographically diverse college population also may demonstrate stronger ethnic and sex trends in regard to snoring patterns. In addition to snoring, future researchers should assess the range of symptoms associated with SDB, specifically witnessed apneic episodes.

**Conclusion**

Snoring can be an early manifestation of SDB with significant neurocognitive and physical consequences. Snoring was highly prevalent in this college population (30%), with prevalence higher in men (42%) than women (25%) and correlating with BMI. We also observed some differences in regard to ethnicity. The physician caring for the college-aged adult should ask about snoring, take the complaint of snoring seriously, and perform a thorough evaluation and sleep test in those at risk for SDB. Future investigators should consider investigating these and related issues in more demographically diverse college populations.

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**FIGURE 3. Algorithm for treatment of sleep-disordered breathing (SDB).** ENT = ear, nose, and throat; CPAP = continuous positive airway pressure; AHI = Apnea Hypopnea Index; TIA = transient ischemic attack.
implementing objective sleep testing in young adult populations and its effective application in student health centers. Physicians should help students with SDB and learn about and choose appropriate therapeutic paradigms.

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NOTE

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### APPENDIX

**Questionnaire**

The cumulative information collected in this study will be used for scientific publication. Completing the below questionnaire implies consent to publish collected data. If you are under the age of 18, you should not participate in this study. If you are pregnant, you should not participate in this study.

**Circle or Fill in the Best Answer**

1. Do you snore?
   - Yes
   - No
   - I don’t know

2. How loudly do you snore?
   - 5-Heard outside the house
   - 4-Heard throughout the house
   - 3-Heard in adjacent room
   - 2-Soft, occasional
   - 1-Do not snore

3. After a full night’s sleep, are you still tired?
   - 5-Always
   - 4-Often (2–4 days/wk)
   - 3-Occasionally (once a week)
   - 2-Rarely (once a month)
   - 1-Never

4. Do you fall asleep when you shouldn’t? (eg, while driving, at the movies, watching TV, at meetings)
   - 5-Always
   - 4-Often (2–4 days/wk)
   - 3-Occasionally (once a week)
   - 2-Rarely (once a month)
   - 1-Never

5. Do your parents snore? 6. If yes, grade by scale in Question 2
   - Yes
   - No
   - I don’t know

6. If yes, grade by scale in Question 2
   - Mother (1–5) __________
   - Father (1–5) __________

Please provide your:

7. Age __________

8. Gender Male Female

9. Height __________

10. Weight __________

11. BMI (to be filled in by researcher) __________

12. Ethnicity
   - 1-Black/African American
   - 2-Hispanic/Latino
   - 3-White/Caucasian
   - 4-East Indian/Pakistani
   - 5-Asian
   - 6-Pacific Islander
   - 7-Middle Eastern
   - 8-Native American
   - 9-Other __________
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