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Sleep and Health Implications of Snoring: A Populational Analysis

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Objectives/Hypothesis: Determine the prevalence of snoring and if snoring is associated with negative effects on sleep patterns and other health conditions.

Study Design: Cross-sectional analysis of large-scale national risk-factor survey.

Methods: The Behavioral Risk Factor Surveillance System for the 2012 sleep health component was analyzed to determine the relationships between respondents' sleep patterns including average hours slept, days of insufficient sleep, falling asleep while driving, and the presence of snoring. The associations between snoring and coronary artery disease, stroke, and depressive disorder were also determined.

Results: Among 8,137,604 weighted respondents (raw N = 22,745), 52.8% (95% confidence interval, 51.9%-53.8%) reported that they snored. Males were more likely to report snoring than females (59.0% vs. 46.9%, respectively, $P < .001$) and increasing body mass index was associated with a higher prevalence of snoring (normal weight, 36% snoring vs. obese, 71%; $P < .001$). Snorers reported decreased sleep time, more lack of sleep days, and unintentional falling asleep days than nonsnorers (6.97 vs. 7.15 hours, 9.1 vs. 7.6 days, and 3.3 vs. 2.1 days, respectively; all $P < .001$). Snorers were more likely to have fallen asleep while driving than nonsnorers (odds ratio, 1.49; $P < .001$). Snorers also demonstrated increased odds ratios for coronary artery disease and depressive disorder (odds ratios 1.40 and 1.39; respectively, $P < .001$), but not for stroke ($P = .421$).

Conclusions: Self-reported snoring is associated with significant negative sleep pattern behaviors as well as coronary artery disease and depressive disorders. Further study of snoring as a risk factor for poor sleep and other diseases is warranted.

Key Words: Snoring, obstructive sleep apnea, sleep, accidents, coronary artery disease, depression.

Level of Evidence: 2c

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INTRODUCTION

Although snoring is a recognized potential sign of underlying obstructive sleep apnea (OSA), it is still commonly thought of as a social or marital nuisance.[1] Correspondingly, although the negative health consequences and risks associated with untreated OSA have long been the subject of study and are relatively well quantified, the potential negative sleep and health consequences of snoring itself have been less aggressively assessed. Recently, a review of the literature identified evidence that snoring itself may have important adverse health consequences.[2] However, large-scale, multi-institutional data further characterizing these potential adverse health consequences are relatively lacking.

In addition to the potential association between snoring and disease conditions, snoring may have a negative impact on sleep quality and healthy sleep patterns. For example, snoring may result in spousal disturbance, which in turn may result in forced arousals from the spouse, intrinsic awakenings, and even departures from the typical locale of sleep (e.g., leaving the bedroom).[1] Relatively little is known, particularly on a large-scale population basis, about the relationships between snoring and sleep behaviors and the consequences of potentially snoring-disrupted sleep. To answer some of these questions, particularly at the larger, population-based level, we examined data from the Behavioral Risk Factor Surveillance System (BRFSS). The objective of this study was to determine the impact of snoring as a symptom on sleep behaviors and its potential associations with comorbid conditions. We hypothesized that snoring would be associated with unintentional sleepiness and falling asleep while driving, and that snorers would exhibit a higher prevalence of coronary artery disease, stroke, and/or depression.

MATERIALS AND METHODS

The BRFSS for calendar year 2012 as administered by the Centers for Disease Control and Prevention served as the data source for this study. This study was reviewed by our hospital's committee on clinical investigations and was deemed exempt from review as a deidentified, publicly available dataset investigation. BRFSS is the nation's premier system of systematic health-related telephone surveys that collects annual state level data about US residents regarding their self-reported health-related risk behaviors, chronic health conditions, and use of preventive services. Data obtained are all by self-report;

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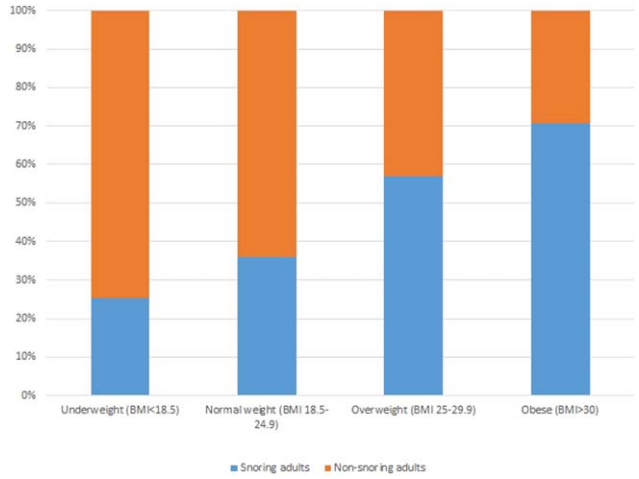

Fig. 1. Proportion of adults snoring according to body mass index (BMI) categories. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

information from insurance claims and primary care providers records are not included. BRFSS collects data in all 50 states as well as the District of Columbia and three US territories.[3] BRFSS completes more than 400,000 adult interviews each year, making it the largest continuously conducted health survey system in the world. Data within the BRFSS have been subjected to quality, validity, and reliability studies, and have been found to be in most instances quite consistent with household-based and in-person epidemiologic studies of risk factors and health conditions.[4–6] Within the BRFSS, in addition to the core survey, a sleep module component collects data regarding sleep quantification variables, snoring, and other sleep-related behaviors.

The 2012 BRFSS was imported into SPSS version 22.0 (IBM, Armonk, NY) for data analysis. From the BRFSS data, respondents who were administered the core and sleep surveys components were extracted for further analysis. Within the sleep component of the BRFSS, questionnaire data included sleep time (in hours), number of days the respondent did not get enough sleep in the past 30 days, the number of days in the past 30 days the respondent fell asleep while driving, and the presence or absence of snoring. Additional disease-related questions determined whether the respondent was ever diagnosed with angina or coronary artery disease, ever diagnosed with the stroke, and ever told he/she had a depressive disorder.

From the survey data, standard demographic data were determined. For the entire population, the mean numbers of hours slept, number of days without enough sleep, and the number of days falling asleep while driving were determined. Next, comparisons were conducted between snorers and non-snorers for the same sleep variables, with χ^2 statistical significance set at $P = .05$. Statistical methods that incorporate stratification and weighting according to the survey design of the BRFSS were incorporated. The relationship between body mass index category (underweight, normal weight, overweight, and obese) and the presence of or absence of snoring was also determined.

Further comparisons were completed to determine if the presence or absence of snoring was associated with respondents' having had coronary artery disease, stroke, or a diagnosis of a depressive disorder. For significant associations between snoring and these diseases, adjusted odds ratios were computed, adjusting for age, sex, marital status, body mass index, and smoking status (current smoker, former smoker, never smoked).

RESULTS

Among 8,137,604 weighted adult respondents (raw N = 22,745, mean age 46.5 years), 52.8% (95% confidence interval: 51.9%-53.8%) reported that they snored. Males were more likely to report snoring than females (59.0% vs. 46.9%, respectively, $P < .001$). Figure 1 demonstrates the significant association between increasing body mass index and the presence of snoring ($P < .001$).

Overall, adults reported an average of 7.06 hours (7.03–7.08 hours) of sleep per night. They reported an average of 8.4 days (8.2–8.6 days) in the past month for which they did not get enough sleep and 2.8 days (2.6–2.9 days) in the past month during which they fell asleep unintentionally. Additionally, 3.9% (3.6%–4.3%) reported that they had fallen asleep while driving sometime in the past 30 days.

Table I presents the values for sleep variables according to snoring status. In addition, when stratified according to the presence or absence of snoring, snorers were significantly more likely to have fallen asleep while driving in the past 30 days (4.7 [4.2%-5.3%]) versus non-snorers (3.2% [3.6%-4.4%]; $P < .001$), with an increased odds ratio of 1.49 (1.21-1.84).

Table II presents the associations for the significant health conditions of coronary artery disease, stroke, and depressive disorder with snoring. After adjustment for age, sex, marital status, body mass index, and smoking status, the presence of snoring was significantly associated with having a diagnosis of coronary artery disease and having had a depressive disorder, but was not associated with history of stroke.

DISCUSSION

Restful sleep of a reasonable duration is a well-known requirement for sustained bodily health. Many factors can contribute to interrupted, insufficient duration or otherwise unrestful sleep including sleep apnea, snoring, restless leg syndrome, and other diagnoses. Among these, snoring has often been described as a symptom rather than a diagnosis, and has thus been at least partially overlooked as a risk factor for nonrestorative sleep and as a risk factor for other health conditions. Although the negative health consequences of OSA concerning cardiovascular, cerebrovascular, and accidental death are well known, similar negative health consequences as they pertain to snoring are less certain.[7]

Several cohort studies following patients with snoring over time have presented equivocal results regarding the negative health consequences of snoring. For example, in a relatively small prospective study with 17 years of follow-up, neither snoring severity nor time spent snoring was associated with all-cause mortality or incident cardiovascular or cerebrovascular disease.[8] In contrast, in a larger study with 9.9 years of follow-up among older adults (mean age 73.6 years) snoring with daytime sleepiness was associated with a significantly increased hazard ratio (1.46 [1.03-2.08]).[9] Another study (follow-up 6 years) demonstrated that self-reported snoring frequency was associated with an increased risk of

TABLE I.
Differences in Sleep Variables Associated With the Presence or Absence of Snoring.

	Snorers (N = 4.30 Million)		Nonsnorers (N = 3.84 Million)		
Sleep Variable	Mean	95% CI	Mean	95% CI	*P* Value
Hours of sleep	6.97	6.93-7.01	7.15	7.11-7.20	<.001
Days did not get enough sleep past 30 days	9.07	8.79-9.35	7.60	7.32-7.88	<.001
Days fell asleep unintentionally last 30 days	3.28	3.10-3.47	2.09	1.93-2.25	<.001

CI = confidence interval.

cardiovascular events among women but not men.[9] Recently, a large-scale study linking snoring identified by portable sleep study to the Social Security Death Master File identified increasing snoring to be associated with an increase in age and sex adjusted all-cause mortality (odds ratio 1.16 [1.01-1.32]) with a body mass index <30.0.[10]

Given the difficulties with respect to sample size, controlling for confounding variables and the need for extended follow-up durations that occur with cohort studies attempting to delineate the potential risks associated with snoring, we turned to a large-scale epidemiological analysis based on the BRFSS. As noted, we found that snoring was associated with decreased sleep time (loss of approximately 11 minutes per night), and increased days with insufficient sleep (+1.5 days) as well as days falling asleep unintentionally (+1.2 days) in the past 30 days. Although the loss of 11 minutes per night may seem like a small number, this corresponds to 77 minutes per week, which may be further cumulative over time. Also notable was the increased likelihood of having fallen asleep while driving in the past 30 days. These data suggest that self-reported snoring is associated with poorer quality and lesser quantity of sleep, resulting in negative functional (and perhaps dangerous) health consequences.

Using this large-scale, risk-factors survey, we were also able to identify significant associations between the presence of snoring and coronary artery disease as well as having had a depressive disorder. Although it is impossible to control for all confounders, we found that these associations with snoring persisted even after adjusting for age, sex, smoking status, marital status, and body mass index. These data should encourage longer and larger prospective cohort studies to more definitively determine the risks posed by snoring on cardiovascular health. The data, however, did not identify an association between snoring and stroke. This may be due to the fact that stroke is more closely linked to OSA rather than simple snoring, or due to the fact that stroke is more prevalent in older age groups, which are not densely represented in the current study population.

A fairly clear association between depression and OSA has been elucidated in the literature, with depression being present among 7% to 63% of patients with OSA.[11] However, the relationship between snoring and depression has been much less thoroughly studied. In a study of habitual snorers, Naughton and associates found that 43% had either a doctor diagnosis or positive Hospital Anxiety and Depression Score for depression.[11] Other studies have yielded conflicting results depending on the method of depression assessment by screening criteria, with depression being associated with snoring in women but not men.[12] Again, the current data suggest that physicians treating patients for snoring should likely assess for a relationship with depressive mood disorders, and that further scientific investigation into the snoring-depression relationship is warranted.

The current study does possess some limitations. First of all, it is a telephone-based survey reliant on self-reported measures including the presence of snoring and historical recall for coronary artery disease, depressive disorder, and other factors. The sleep- and snoring-specific questions have not been strictly individually validated. However, the BRFSS is considered a gold standard survey for the top-level view of risk factors as they pertain to health in the United States.[3] For example, many of the findings presented in the *Morbidity and Mortality Weekly Report* arise from data obtained via the BRFSS. A second potential problem with the current methodology is the possible influence of latent (undiagnosed) OSA among those reporting snoring. The

TABLE II.
Health Conditions Associated With the Presence of Snoring.

	Snorers		Nonsnorers			
Comorbidity	Mean	95% CI	Mean	95% CI	Adjusted Odds Ratio*	*P* Value
Ever diagnosed with angina or CAD (%)	7.2	6.6–7.8	3.9	3.4-4.4	1.40	<.001
Ever had a stroke (%)	3.1	2.7–3.5	2.3	2.0–2.7	NS	.421
Ever told had depressive disorder (%)	21.8	20.8–22.9	15.3	14.3–16.3	1.39	<.001

*Adjusted for age, sex, smoking status, marital status, and body mass index.
CAD = coronary artery disease; CI = confidence interval; NS = not significant.

survey queries only for the presence of snoring; naturally, a portion of these patients likely have underlying OSA. Several epidemiological studies have determined the presence of OSA in the general population to approximate 2% to 14%.[13] Given that the prevalence of snoring in the study was >50%, the contribution of latent OSA is likely to be relatively small in magnitude, especially after adjustment for body mass index, age, and sex. Overall, these data suggest that screening for snoring may be worthwhile to determine not only sleep quality among adults but also to further assess risk factors for coronary artery disease and depressive disorder.

CONCLUSION

Self-reported snoring is associated with significant negative sleep pattern behaviors including decreased sleep time, failure to obtain enough sleep, and unintentionally falling asleep, as well as other diseases such as coronary artery disease and depressive disorders. Further study of snoring as an independent risk factor for poor sleep and other diseases is warranted.

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