Article published online: 2024-11-11

Snoring and its Associated Comorbidities

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Sleep Sci

Abstract

Objective Snoring is often perceived as a simple social nuisance, whereas it can be a telltale sign of serious respiratory diseases. The present study aimed to determine the prevalence of self-reported habitual snoring and to identify its associated factors.

Materials and Methods This cross-sectional study surveyed 815 individuals about their medical history, anthropometric characteristics, and lifestyle using a questionnaire.

Results The prevalence of self-reported habitual snoring in our sample was 29.2%. Variables independently associated with snoring were advanced age ($p = 0.008$), asthma ($p = 0.003$), sleepiness ($p < 0.001$), hyperthyroidism ($p = 0.006$), smoking ($p < 0.001$), diabetes ($p = 0.010$), and abdominal obesity ($p = 0.007$).

Conclusion This survey has highlighted the importance of snoring in an Arab-African context, to bring more awareness to this respiratory disorder and to understand that a simple snore can be a silent cry of an organism in need of help.

Keywords
- prevalence
- snoring
- questionnaire
- risk factors
- sleep disorders

Introduction

The transition from wakefulness to sleep is always associated with various physiological, respiratory, and neurological changes.[1] These changes result in a loss of cortical respiratory control, leading to a significant decrease in the ability of the respiratory muscles, particularly the pharyngeal muscles, to contract and maintain tone.[2,3] By exploring these various disturbances that occur during the switch from wakefulness to sleep, we can pinpoint a common symptom that is often associated with respiratory conditions, which is snoring.[4]

Snoring refers to the hoarse sound that occurs when air flows through narrowed airways during sleep.[5] It is a common condition that affects a significant portion of the general population, with a prevalence ranging from 9 to 50% and, according to some studies, even more.[6] It is important to take into consideration that various factors such as genetics, lifestyle habits, and ethnic origin may influence this prevalence.

Snoring may seem like a harmless consequence of daily fatigue, but it can be a warning sign of serious health issues. These include cardiovascular disease, metabolic syndrome,

received
November 19, 2023
accepted after revision
August 26, 2024

DOI https://doi.org/10.1055/s-0044-1791978.
ISSN 1984-0659.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

excessive daytime sleepiness, obstructive sleep apnea syndrome, and even all-cause mortality.[4,7]

In addition, emerging evidence suggests that snoring is associated with reduced work performance, impaired marital quality of life in snorers, and an increased risk of road accidents.[8]

The prevalence of snoring has not been widely studied, especially in developing countries.

To our knowledge, there is no quantitative analysis assessing the prevalence of snoring in Marrakech. Therefore, we conducted this survey to determine the prevalence of self-reported habitual snoring and understand its associated factors among the adult population of Marrakech City in Morocco.

Material and Methods

Ethical Standards

Ethical approval was obtained from the Ethics Committee of the University Hospital of Marrakech, which approved the survey before it was conducted (n° 50/2022). The participants were informed of the study's objective and procedure and provided a signed informed written consent. To ensure that the research was carried out following the ethical principles of the Declaration of Helsinki, the anonymity and confidentiality of the information received were respected.

Type of Study

The present cross-sectional study aims to estimate the prevalence of self-reported habitual snoring in the adult population of the city of Marrakech who attends public health centers and to identify its associated factors. The survey was conducted during the period from April 20 to October 20, 2022.

Subjects

The study recruited 815 participants from 21 public health centers in Marrakech through general consultations based on predetermined inclusion and exclusion criteria.

The survey involved mentally stable adult participants of both genders, aged 19 or older, who voluntarily consented to participate in the research at designated study sites. However, pregnant women, individuals with communication difficulties, and those who consume sleeping pills were excluded from the study. Additionally, people who lived alone were not included as there was no one who could confirm their snoring.

Data Collection Methods

The present study utilized a hetero-administered questionnaire to collect data on the following variables:

Sociodemographic and economic variables: sex, age, origin**,** matrimonial status, number of children, level of education, and monthly income level.

Anthropometric variables: weight, height, body mass index (BMI), neck circumference (NC), waist circumference (WC), and waist-to-height ratio (WHtR).

Health variables: pulmonary diseases (allergic rhinitis, asthma), cardiac diseases (hypertension, hyperlipidemia, heart failure), and metabolic diseases (diabetes, hyperthyroidism). The comorbidities were reported by the participants themselves.

Clinical variables: This category includes questions about clinical signs of sleep-disordered breathing, such as nocturnal suffocation, night sweats, morning headaches, nocturnal awakenings, apnea observed by others, and sleepiness.

Variable related to the narrowing of the upper airway: facial malformations (mandibular retrognathia or maxillary endognathia) and Mallampati classification.

Lifestyle variables: smoking, alcoholism, physical inactivity, cannabis consumption.

The questionnaire was tested and validated with 10 people before launching the study to ensure that all questions were clear and unambiguous. In addition, the Arabic version of this questionnaire was previously validated by our research team.

Operating Definitions

In the current study, the assessment of self-reported habitual snoring was based on the following question: do you snore loudly three or more times per week, to the point at which someone can hear you through a closed door or the person next to you elbows you awake? With an expected answer of « yes » or « no ».

The body mass index is weight (in kg) divided by height (in m^2). Participants were categorized according to the body mass index (BMI) indices proposed by the World Health Organization (WHO)[9]:

- IMC $<$ 18.5: Underweight
- 18.5 $\leq$ IMC $<$ 24.9: Normal
- 25.0 $\leq$ IMC $<$ 29.9: Overweight
- IMC $\geq$ 30.0: Obesity

Abdominal obesity was assessed by measuring WC, defined as the smallest area between the waist and the hips, using a tape graduated in centimeters. People are classified according to the normal values specified by the International Diabetes Federation (IDF): a WC $<$ 94 cm for men and a WC $<$ 80 cm for women.[10]

Waist-to-height ratio (WtHR) is an anthropometric measure used to assess the risk of cardiometabolic complications associated with central adiposity, obtained by dividing the waist circumference (WC) by the height. A WtHR greater than 0.5 is considered critical and indicates a high risk of cardiovascular complications related to abdominal obesity.[11]

Neck circumference (NC), also measured in centimeters, represents the mid-distance between the sternal fork and the mandible. Values of NC $<$ 33 cm for women and NC $<$ 38.3 cm for men are considered normal.[12]

Sleepiness was assessed using the Epworth Sleepiness Scale (ESS). A score of 8 or higher indicates that the person is drowsy.

The Mallampati classification is a simple clinical examination used to evaluate the narrowing of the upper airway. It assesses the visibility of several structures, including the soft palate, uvula, and palatine tonsils. During the examination, patients are seated upright with their heads in a natural position. They are then asked to open their mouths as wide as possible and stick out their tongues as far as they can, without using a tongue depressor. The Mallampati

classification categorizes individuals into four distinct grades based on their assessment results.

Grade 1: full visibility of the soft palate, uvula, and tonsillar pillars.
Grade 2: visibility of the soft palate and the upper part of the uvula.
Grade 3: visibility of the soft palate and only the base of the uvula.
Grade 4: visibility of the hard palate only.

Study Procedure

Before conducting the investigation, authorization was obtained from the Ministry of Health. It was also necessary to contact the health centers' chief physicians to explain the study's purpose and obtain their adhesion. At the end of their routine general consultation, the recruited participants were invited to take part in the study after being provided with all the necessary information about the survey. Voluntary participation, anonymity, informed consent, and the confidentiality of the collected information were all respected. An investigator filled out the questionnaire for each participant and also took their anthropometric measurements.

Data Analysis

Statistical analyses were performed using the IBM SPSS Statistics for Windows software version 25.0 (IBM Corp., Armonk, NY, USA).

For descriptive analysis, continuous variables were expressed as mean ± standard deviation, while qualitative variables were expressed as percentages. For bivariate analysis, the Student t-test was used to compare quantitative variables and the Chi-squared test for qualitative variables. Odds ratios (ORs), sometimes presented with their 95% confidence intervals (CIs), were used to assess possible associations between the variables studied.

A multivariate analysis was performed using logistic regression, with the final model including only those variables having a statistically significant relationship with the binary dependent variable, and their adjusted Odds Ratios with their confidence intervals. The association was considered significant for p-values < 0.05.

Results

Sociodemographic Characteristics

In this survey, 815 subjects were included. The prevalence of self-reported habitual snoring in the present study was 29.2% (26.0–32.3%). Most of the participants were women, with a male-to-female sex ratio of 0.62. The analysis showed a significant increase in snoring prevalence with age ($p < 0.001$). Snorers were on average thirteen years older than non-snorers. Additionally, the frequency of snoring was higher among illiterate individuals and those with children (►**Table 1**).

Associated Morbidities and Lifestyle

The statistical analysis of the results also revealed that high blood pressure ($p < 0.001$), hyperlipidemia ($p < 0.001$), diabetes ($p < 0.001$), hyperthyroidism ($p < 0.001$), and asthma ($p < 0.001$) were the comorbidities most commonly associated with snoring. In addition, maxillary endognathia

Table 1 Sociodemographic and economic characteristics of snorers and non-snorers.

characteristics	Snorers n = 238	Non-snorers n = 577	*p*-value
Gender, n (%)			
Man	99 (41.6%)	215 (37.3%)	0.24
Woman	139 (58.4%)	362 (62.7%)	
Age (year) ± ET	51.46 ± 16.36	38.09 ± 15.26	< 0.001
Matrimonial status, n (%)			
Married	157 (66.0%)	298 (51.6%)	< 0.001
No spouse	81 (34.0%)	279 (48.4%)	
Education level, n (%)			
Illiterate	100 (42.0%)	140 (24.3%)	< 0.001
Primary	54 (22.7%)	136 (23.6%)	
Secondary	56 (23.5%)	150 (26.0%)	
Higher	28 (11.8%)	151 (26.2%)	
Monthly income level, n (%)			
Low	187 (78.6%)	448 (77.6%)	0.74
Medium	34 (14.3%)	93 (16.1%)	
High	17 (7.1%)	36 (6.2%)	
Having children, n (%)			
Yes	189 (79.4%)	323 (56.0%)	< 0.001
No	49 (20.6%)	254 (44.0%)	

Table 2 Clinical features of snorers and non-snorers.

Self-reported morbidity	Snorers n = 238	Non-snorers n = 577	*p*-value
Cardiovascular diseases, n (%)			
Heart failure	10 (4.2%)	15 (2.6%)	0.22
High blood pressure	72 (30.3%)	43 (7.5%)	< 0.001
Hyperlipidemia	25 (10.5%)	15 (2.6%)	< 0.001
Metabolic diseases, n (%)			
Diabetes	64 (26.9%)	36 (6.2%)	< 0.001
Hyperthyroidism	41 (17.2%)	24 (4.2%)	< 0.001
Respiratory diseases, n (%)			
Asthma	27 (11.3%)	11 (1.9%)	< 0.001
Allergic rhinitis	24 (10.1%)	34 (5.9%)	0.03
Facial malformations, n (%)			
Mandibular retrognathia	14 (5.9%)	13 (2.3%)	0.008
Maxillary endognathia	21 (8.8%)	19 (3.3%)	0.001
Lifestyle			
Physical inactivity, n (%)	214 (89.9%)	418 (72.4%)	< 0.001
Alcoholism, n (%)	36 (15.1%)	27 (4.7%)	< 0.001
Smoking, n (%)	75 (31.5%)	81 (14.0%)	< 0.001
Cannabis consumption, n (%)	35 (14.7%)	42 (7.3%)	0.001

($p = 0.001$) was also found to be linked to snoring (►**Table 2**). Moreover, snoring prevalence significantly increases with a sedentary lifestyle, smoking ($p < 0.001$), alcohol consumption ($p < 0.001$), and cannabis use ($p = 0.001$) (►**Table 2**).

Clinical Signs Associated with Respiratory Disorders

The analysis of data on signs indicating sleep-related breathing disorders in participants announced that individuals who snore experience morning headaches ($p < 0.001$), sweating ($p < 0.001$), choking ($p < 0.001$), and nocturnal awakenings ($p < 0.001$) more frequently than non-snorers.

Furthermore, snorers had a significantly higher prevalence of apneas, as reported by their relatives (16.4% vs. 1.2%), and sleepiness (47.1% vs. 15.9%), compared to non-snorers. There were also statistically significant associations observed between snoring and Mallampati grades, particularly grades 3 and 4 (►**Table 3**).

Anthropometric Characteristics

►**Table 4** presents the anthropometric characteristics of the surveyed individuals. All indices are statistically significant. Snorers have larger neck ($p < 0.001$) and waist

Table 3 Clinical signs suggestive of sleep-related breathing disorders among snorers and non-snorers.

Clinical signs of respiratory disorders	Snorers n = 238	Non-snorers n = 577	*p*-value
Night sweats, n (%)	115 (48.3%)	93 (16.1%)	< 0.001
Nocturnal suffocation, n (%)	80 (33.6%)	55 (9.5%)	< 0.001
Nocturnal awakenings, n (%)	74 (31.1%)	52 (9.0%)	< 0.001
Morning headaches, n (%)	134 (56.3%)	170 (29.5%)	< 0.001
Apneas noticed by others, n (%)	39 (16.4%)	7 (1.2%)	< 0.001
Sleepiness ± SD	8.62 ± 5.63	4.51 ± 3.92	< 0.001
Mallampati classification, n (%)			
Grade 1	35 (14.7%)	145 (25.1%)	< 0.001
Grade 2	60 (25.2%)	183 (31.7%)	
Grade 3	80 (33.6%)	160 (27.7%)	
Grade 4	63 (26.5%)	89 (15.4%)	

Abbreviation: SD, standard deviation.

Table 4 Anthropometric measurements among snorers and non-snorers.

Anthropometric measurements	Snorers n = 238	Non-snorers n = 577	*p*-value
Weight ± SD	76.32 ± 13.78	68.95 ± 11.64	< 0.001
BMI ± SD	27.70 ± 4.85	24.96 ± 3.98	< 0.001
Neck circumference ± SD	37.93 ± 3.54	35.82 ± 3.24	< 0.001
Waist circumference ± SD	95.06 ± 12.26	86.38 ± 11.61	< 0.001
Waist-to-height ratio (WtHR) ± SD	0.57 ± 0.07	0.52 ± 0.07	< 0.001

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 5 Factors associated with snoring in the multivariate analysis (logistic regression).

Risk factors	Adjusted OR	95% CI	*p*-value
Age	1.01	1.005–1.033	0.008
Asthma	4.24	1.64–10.95	0.003
Sleepiness	3.67	2.42–5.55	< 0.001
Smoking	3.09	1.72–5.54	< 0.001
Hyperthyroidism	2.44	1.28–4.65	0.006
Diabetes	2.10	1.28–4.65	0.010
Abdominal obesity	2.13	1.23–3.69	0.007

Abbreviations: CI, confidence interval; OR, odds ratio.

circumferences ($p < 0.001$), a higher WtHR ($p < 0.001$), and appear to be fatter ($p < 0.001$).

Risk Factors Associated with Snoring

The bivariate analysis showed significant associations between snoring and various factors studied. Further analysis using logistic regression revealed seven factors independently associated with snoring. These included advanced age ($p = 0.008$), asthma ($p = 0.003$), sleepiness ($p < 0.001$), smoking ($p < 0.001$), hyperthyroidism ($p = 0.006$), diabetes ($p = 0.010$), and abdominal obesity ($p = 0.007$). (►**Table 5**).

Discussion

In the present study, we found out that 29.2% of the participants reported snoring. Comparing the results with those of other studies carried out in different populations, we found that our prevalence is close to those reported in these surveys. For instance, a study conducted on 1,186 middle-aged Polish adults found a 44% prevalence of self-reported snoring, while another study in Cameroon found a frequency of 35.9%.[3,13] In addition, the Jackson Heart Sleep Study discovered a snoring prevalence of 20.5% among African Americans.[14] Furthermore, healthcare professionals reported a snoring rate of 69.4%.[15] The impact of environmental factors and ethnic diversity could explain these differences in prevalence.

Several studies have shown that advanced age is a risk factor for snoring.[16,17] The muscles in the upper airways, which are responsible for maintaining the airtightness of the respiratory tract during inspiration, lose their elasticity with age, leading to a partial collapse and resulting in snoring.[1] Moreover, based on the analysis of our sample data, there is a statistically significant difference in age between snorers and non-snorers.

Numerous epidemiological studies have demonstrated that abdominal obesity leads to decreased lung volumes due to central adiposity.[18,19] In our survey, we observed highly significant differences in BMI and weight ($p < 0.001$) between the snoring and non-snoring groups in a bivariate analysis. These results are consistent with previous research established in literature.

Over the last few years, researchers have been focusing more on the distribution of body fat rather than just excess weight. This has led to the inclusion of anthropometric indicators, such as neck circumference, abdominal circumference, and WtHR, in studies related to sleep-related breathing disorders. These measures are considered relevant as they reflect the accumulation of body fat that leads to metabolic complications associated with central obesity.[12,20]

In this sense, neck circumference is a crucial indicator of excessive fat accumulation in the pharyngeal region, leading to the narrowing of the upper airways.[1,4] Our study found that snorers had significantly higher mean values compared to non-snorers for all anthropometric measures studied.

Several studies among the general population have shown that a sedentary lifestyle is strongly linked to snoring, as it increases visceral adiposity.[21] In this survey, 89.9% of snorers reported being physically inactive. This could be due to their lifestyle, which involves a lack of physical activity combined with sedentary behavior, such as consuming high-calorie diets, using motorized transportation, and engaging in

sedentary leisure activities like playing video games and watching television.[15]

Tobacco use and alcohol consumption are widely known to be associated with snoring.[19,22] This is because tobacco and alcohol cause inflammation of the soft pharyngeal tissues, which results in snoring.[22,23] The disruption of sleep caused by snoring can lead to frequent awakenings during the night, leading to excessive sleepiness the following day.[24] As a result, smokers and alcoholics may find it difficult to initiate and maintain sleep.[22] Our study also confirms the role of tobacco and alcohol consumption in the pathogenesis of snoring.

Epidemiological studies have revealed that hyperthyroidism can lead to snoring.[25] Hyperthyroidism speeds up metabolism and causes weight loss, often associated with muscular weakness, including the pharyngeal muscles.[25] The findings of the current study also confirm that hyperthyroidism is indeed a risk factor for snoring.

Although the exact mechanisms are not well understood, researchers have asserted the association of snoring with carbohydrate metabolism and the development of diabetes [1,7,20]. A 10-year prospective study of the influence of snoring on diabetes found that snoring individuals had a 2-fold increased risk of developing type 2 diabetes.[7] These results were in line with those of the present study, according to which diabetes increased the risk of snoring 2.10-fold.

Regarding chronic bronchopulmonary conditions, asthma was associated with the development of sleep-disordered breathing.[26] The data from the present study affirmed that asthma and allergic rhinitis were the pulmonary pathologies most associated with self-reported snoring.

The upper airway narrowing assessment data revealed a statistically significant association between snoring and Mallampati grades. Several studies have also shown that hypertrophy of the soft tissues of the upper airway, notably the uvula, soft palate, and palatine tonsils, leads to the narrowing of the airway and promotes snoring.[27,28] However, other researchers think that this hypertrophy is not a cause of airway obstruction, but rather a consequence of the intense vibrations that traumatize the soft tissues and nerve fibers of the pharyngeal structures.[29]

The present study has several strengths. First, we used a structured questionnaire that had been validated by our research team and adapted to our target population. Secondly, we had a sufficient sample size that allowed us to estimate parameters with greater precision and enhance the generalizability of our findings to the target population. However, there were also some limitations. The assessment of sleepiness was subjective and based on the Epworth Sleepiness Scale. Additionally, we identified apneas using reports from the participants' relatives in the absence of polysomnography.

Conclusion

In conclusion, snoring is a respiratory disorder whose prevalence constantly increases, particularly in Africa. It can reveal serious illnesses, such as obstructive sleep apnea syndrome, known for high cardiovascular and neuropsychological morbidity.

Funding
The authors declare that they did not receive financial support from agencies in the public, private, or non-profit sectors to conduct the present study.

Conflict of Interests
The authors have no conflict of interests to declare.

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