Snoring and obstructive sleep apnea

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Abstract

Aim: In addition to sleep study, the self-administered questionnaires have been used to identify high-risk groups among the general population as they are more feasible than sleep studies. In the literature, the Berlin questionnaire was the most commonly used followed by Wisconsin sleep questionnaire, however, STOP and STOP-BANG questionnaires were recommended due to ease of use and higher methodological quality. This study aimed to identify high-risk group of OSA in the general population of Saudi Arabia and other important risk factors. Material and Method: This was a cross-sectional study conducted through the self-administered questionnaires distributed electronically among the general population in the Jazan region where 745 adult participants those living outside the Jazan region, or those with missing data were included. Data were collected anonymously through the STOP-BANG questionnaire and then coded. The data were analyzed using frequency, percentages as descriptive statistics, while Chi-Square was used to identify significant differences. The logistic regression was conducted to identify significant predictors for previously diagnosed OSA and any p-value less than 0.05 indicated significant differences. Results: Out of 745 valid questionnaires were included in the study, 51.4% were females and 48.6% were males. The body mass index indicated that about 52% of the respondents had elevated BMI and 22% were smokers. Based on the STOP-BANG questionnaire, 16.5% of the respondents were at a high risk of OSA. Among other reported risk factors, chronic sinusitis was the most common followed by tonsillitis with the prevalence of 23.4% and 16.9%, respectively. Significant associations between reported OSA and snoring, daytime tiredness, observed stop breathing during sleep, hypertension, BMI> 35 kg m−2, and age over than 50 years. The results of binary logistic regression demonstrated that the presence of hypertension and respiratory arrest observed by others during sleep are significant predictors for reported OSA. Discussion: The identification of a high-risk group of sleeping apnea using the STOB-BANG questionnaire was found valid and reliable. Arabic version of the STOB-BANG had a good internal consistency with 0.7 Cronbach's alpha, 98% sensitivity and 86% positive predictive value. We used 7-item questionnaire, after exclusion of neck circumferences question, since the vast majority of the respondents left this question blank. Similarly, Alharthi et al. found only 12% response rate for the question of neck diameter in Taif city. Conclusions: It was concluded that a considerable percentage of the general population in Jazan region had a high risk of obstructive sleeping apnea based on the STOP-BANG questionnaire. Hypertension and respiratory arrest observed by others during sleep were significant predictors for diagnosed OSA.

Keywords
Sleep Apnea; High Risk; Obesity; Snoring; Risk Factors
Introduction

Obstructive sleep apnea (OSA) is a syndrome represented by recurrent episodes of obstruction in respiratory airways during sleep [1]. Repeated airway obstruction can lead to sympathetic stimulation, poor quality sleep and may be associated with daytime tiredness and morning headache [2]. It is an emerging health problem, particularly in developed countries, that has been linked to cardiovascular diseases and psychosomatic conditions such as diabetes and depression [3,4].

Globally, the prevalence of OSA in the general population is varied from 9% to 38% according to the population’s characteristics and the methodological technique used to diagnose OSA [5]. Several studies have reported an increased prevalence of OSA in the last decades either in general population or in a population with a specific disease entity such as hypertension [2,4,6]. This can be attributed to the increased incidence of obesity which is the major risk factor of OSA [7]. Other risk factors include male gender, old age, familial history, smoking, or the presence of upper airways condition such as chronic tonsillitis, chronic sinusitis, and nasal adenoma [8].

Despite the development of simple diagnostic techniques with relatively accurate results, the gold standard method for diagnosis of OSA is full attended or home-based sleep-surveillance or polysomnography [9]. The self-administered questionnaires have been used to identify high-risk groups, for which polysomnography is indicated [10]. In the literature, the Berlin questionnaire was the most commonly used followed by Wisconsin sleep questionnaire, however, STOP and STOP-Bang questionnaires were recommended due to ease of use and higher methodological quality [10].

In Saudi Arabia, a study found that a third of middle-aged Saudi males at risk of OSA based on risk categorization of Berlin questionnaire. Snoring was reported in 52.3% of Saudi males and an episode/ per week of OSA was found in 11.3% [11]. Different clinical and polysomnographic features between males and females were demonstrated by sleep study conducted by Alotair and Bahammam [12]. No study used the STOP-BANG questionnaire to assess groups with high risk of OSA in Saudi general population, despite high prevalence of important risk factors such as obesity and hypertension. This study aimed to estimate the group with a high risk of OSA in the general population of Saudi Arabia and other important risk factors.

Material and Method

This was a cross-sectional study conducted through questionnaires distributed in Jazan region during the period from September 2018 to October 2018. Out of 1000 electronically distributed questionnaires viamails, 923 were received to the assigned email in form of Excel sheets. Finally, 745 participants were included in this study after exclusion of those under 18 years of age, those living outside Jazan region, or those with missing data (36 participants).

The human subjects were included in this study after obtaining of written informed consents. They were informed about their rights to participate or withdraw at any time. They were informed about the confidentiality of the information provided in this study.

The post hoc power calculation showed a very high statistical power (1- β = 0.95) for a sample size of 745 at an alpha error of 0.05, a degree of freedom equals to 3, and 0.15 effect size. The calculation was made using G*Power software, version 3. The STOP-BANG questionnaire was validated in the literature and has been found to have a higher sensitivity than other questionnaires used to assess the high-risk group of OSA [13]. It includes questions about snoring, daytime tiredness, apnea observed by others, blood pressure, age, neck circumference, male gender. This questionnaire was used in this study, however, only 4 participants responded to the question of neck circumference. Thus, the question of neck circumference was excluded from further analysis and the results were presented only for STOP-BAG variables. Additionally, the questionnaire contains questions about other risk factors including smoking, familial history of OSA, previous diagnosis of nasal adenoma, tonsillitis, nasal septal deviation, chronic sinusitis, or sleeping apnea.

The data were anonymously collected into Excel sheets and then imported to Statistical Package of Social sciences SPSS, version 21, for analysis. The data were summarized in frequencies and percentages for a qualitative variable. The Chi-Square was used to detect significant differences between the risk factors of OSA and the previously diagnosed OSA, as those confirmed with a physician. The logistic regression was conducted to identify significant predictors for previously diagnosed OSA and any p-value less than 0.05 indicated significant differences. The questionnaire was self-administered with covering letter explaining the aims of the study, the rights of the participants to respond or refuse, and the confidentiality of data provided. The respondent should agree to participate by checking on “I agree” before answering the questions. The study was approved by the ethical committee in Jazan University (Approval No. 52/18).

Results

Out of 1000 distributed questionnaires (500 males and 500 females), 745 valid questionnaires were included in the study. Females had a higher response rate than males since they completed 383 (51.4%) of total questionnaires, while male respondents completed 362 (48.6%) of these questionnaires. The majority of the respondents (66.2%) were young and aged 18-30 years old, while only 2.2% were older than 50 years old. The body mass index indicated that about 52% of the respondents had elevated BMI and 22% were smokers (Table 1).

The distribution of risk factors of OSA showed that feeling tired, fatigued, or sleepy during daytime is the most common risk factor which affected 66.3% followed by snoring which reported by 15.8% of the respondents. Based on the STOP-BANG questionnaire, 16.5% of the respondents were at a high risk of OSA. Among other reported risk factors, chronic sinusitis was the most common followed by tonsillitis with the prevalence of 23.4% and 16.9%, respectively (Table 2).

The relationship between STOP-BANG risk factors and reported OSA showed significant associations with such risk factors as snoring, daytime tiredness, observed respiratory arrest during sleep, hypertension, BMI> 35 kg m−2, and age over 50 years. Only male gender had no significant association with reported OSA (Table 3). Smoking and positive family history of OSA had no significant associations with reported OSA. In addi-
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The presence of nasal adenoma and chronic sinusitis were not significantly associated with the reported OSA ($p=0.39$ and $p=0.212$ respectively). Conversely, chronic sinusitis and nasal septum deviation were significantly associated with reported OSA (Table 4).

The results of binary logistic regression demonstrated that the presence of hypertension and respiratory arrest observed by others during the sleep are significant predictors for reported OSA. The respondents who were observed by others and experienced a respiratory arrest during sleep had 5.6 greater risk to report previously diagnosed OSA. Furthermore, hypertensive patients had about 4 times greater risk to report previously diagnosed OSA. Other STOP-BANG factors such as snoring, daytime tiredness, BMI $>35$ kg/m$^2$, and age over 50 years had no significant associations with reported OSA (Table 5).

**Discussion**

The identification of the high-risk group of sleeping apnea using STOP-BANG questionnaire was found valid and reliable. Arabic version of STOP-BANG had a good internal consistency with 0.7 Cronbach’s alpha, 98% sensitivity and 86% positive predictive value [14]. We used 7-item questionnaire, after exclu-
The present study found 16.5% of the respondents at high risk of OSA based on STOB-BANG questionnaire, which was less than that found by Alharthi et al. who used Berlin questionnaire and found a quarter of the studied sample at a high risk of OSA [15]. As the STOB-BANG questionnaire used by our study was found more sensitive than Berlin questionnaire use by Alharthi et al. and this difference can be attributed partly to less false positives in our findings. In addition, our study area in Jazan are partially mountainous, while Taif city is elevated 1879 m above sea level. Sleeping at high altitude is characterized by poor sleep quality due to hypoxia [16]. Another study carried out by Foroughi et al. who used STOB-BANG questionnaire and found a higher prevalence of 38% in Tehran city [17]. This can be explained by the high altitude of Tehran city which located in 1189 above sea level and different population characteristics. The population characteristics are an important modifier in the assessment of OSA high-risk group. A study conducted among Chinese population recommended using BMI cutoff point of (28 kg/m²) and a STOB-BANG score ≥4, rather than (35 kg/m²) BMI cutoff point and a score ≥3 [18]. In the present study, the body mass index indicated that about 52% of the respondents had elevated BMI. Similar findings were reported by Alharthi et al. with the percentage of elevated BMI in Taif city equals to 52.7% [15]. The overall prevalence of overweight and obesity in Saudi Arabia was found to range from 35.5% to 53% [19,20]. In our study, 4.8% said they have or they are being treated for high blood pressure, a higher prevalence of 8.7% was reported by Alharthi et al. [15].

We found the relationship between STOP-BANG risk factors and reported OSA showed significant associations with risk factors such as snoring, daytime tiredness, observed respiratory arrest during sleep, hypertension, BMI> 35 kg m⁻², and aged over 50 years. Only male gender had no significant association with reported OSA. In a study conducted among patients who underwent pulmonary rehabilitation program no association between male gender and OSA was found [21]. In the current study, smoking had no significant associations with reported OSA, which was consistent with Alharthi et al. [15]. In a study conducted among patients who underwent pulmonary rehabilitation program no significant association between predictors such as male sex, old age group, and large neck circumference and OSA was found [21]. Several studies conducted in Saudi Arabia among patients with chronic diseases such as coronary heart diseases [22] or chronic renal failure [23] and their findings differed markedly from findings of the present study that surveyed general population. Wali et al. found 82% prevalence of high-risk OSA among patients with coronary heart diseases based on STOP-BANG questionnaire [22]. It is markedly higher than the prevalence in the present study (16.5%) and it can be attributed to the shared risk factors between OSA and coronary heart diseases such as old age, high BMI, hypertension and male gender. Another study conducted by Wali et al. found a 44.2% prevalence of high-risk OSA among patients with chronic renal failure based on the Berlin questionnaire [23]. Patients with chronic heart failure are more likely to be hypertensive [6], which is a shared risk factor with OSA and the Berlin questionnaire is more likely to detect false positive cases of OSA than the STOP-BANG questionnaire.

Table 4. Cross tabulation between important risk factors and diagnosis of OSA (n = 745)

| Risk factors | Diagnosed Sleep Apnea | Chi-square | P-value |
|--------------|-----------------------|------------|---------|
|              | Not diseased          |            |         |
| Smoking      | Yes                   | 5          | 159     | 0.199   | 0.815   |
|              | No                    | 22         | 559     |          |         |
| Have you been diagnosed with nasal adenoma? | Yes | 7.8% | 92.2% | 21 | 647 | 4.271 | 0.39 |
|              | No                    | 3.8% | 96.2% | 15 | 604 |          |         |
| Have you been diagnosed with chronic tonsillitis? | Yes | 9.5% | 90.5% | 18 | 658 | 15.112 | 0.001 |
|              | No                    | 2.4% | 97.6% | 10 | 70 |          |         |
| Have you been diagnosed with septal deviation in the nose? | Yes | 13.0% | 87.0% | 18 | 658 | 19.316 | 0.001 |
|              | No                    | 2.7% | 97.3% | 10 | 70 |          |         |
| Have you been diagnosed with chronic sinusitis? | Yes | 5.2% | 94.8% | 18 | 553 | 4.271 | 0.39 |
|              | No                    | 3.2% | 96.8% | 10 | 70 |          |         |
| Did any 1st degree relative of you had OSA? | Yes | 6.2% | 93.8% | 20 | 613 | 2.602 | 0.107 |
|              | No                    | 3.2% | 96.8% | 10 | 70 |          |         |

Table 5. Findings of binary logistic regression showed predictors of obstructive sleeping apnea

| Variables | P-value | Odd Ratio (OR) | 95% CI for OR |
|-----------|---------|---------------|---------------|
| Gender: Male | 0.589 | 0.792 | 0.340 | 1.844 |
| Snoring: I snore loudly (loud enough to be heard through closed doors)? | 0.656 | 1.251 | 0.467 | 3.349 |
| Tired: I often feel tired, fatigued, or sleepy during daytime? | 0.083 | 2.647 | 0.881 | 7.960 |
| Observed: Somebody observed that I stop breathing during my sleep? | 0.000* | 5.602 | 2.294 | 13.680 |
| Blood pressure: I have or I am being treated for high blood pressure? | 0.015* | 3.977 | 1.314 | 12.034 |
| Age: Age over 50 year old? | 0.765 | 0.704 | 0.071 | 7.012 |
| BMI: BMI more than 35 kg/m²? | 0.083 | 2.440 | 0.890 | 6.688 |

The response rate of the question of neck circumference question, since the vast majority of the respondents left this question blank. Similarly, Alharthi et al. found only 12% response rate for the question of neck diameter in Taif city.
About 10% of our respondents reported that somebody noticed that they stop breathing while sleeping, a lower percentage reported by Alharthi et al. with only 4.8% who said that anyone observed that they stop breathing while sleeping [15]. In the present study, 66.3% of the respondents felt tired, fatigued, or sleepy during the daytime. Similarly, Alharthi et al. found 64.7% complaining of daytime tiredness and fatigue in Taif city [15]. This reflected similar characteristics of the populations in Jazan and Taif regions. However, Foroughi et al. found loud snoring as the most common symptom when using STOB-BANG questionnaire [17]. In the present study, loud snoring reported by 15.8% of the respondents, agreed with Alharthi et al. who reported that 14.2% of the mountainous inhabitants snored louder than talking [11].

Binary logistic results showed that the presence of hypertension and respiratory arrest observed by others during sleep were significant predictors for reported OSA. Soler et al. conducted a logistic regression analysis and found traditional predictors of OSA, included in STOB-BANG questionnaire, not significant except for the presence of cardiovascular diseases [21]. The logistic regression is usually controlling the confounding effects of the variables introduced in the model, thus many significant associations which previously detected by Chi-Square became non-significant associations in the regression model. In the model, the respondents were observed by others to have a respiratory arrest during sleep had 5.6 greater risk to report previously diagnosed OSA. Moreover, hypertensive patients had about 4 times greater risk to report previously diagnosed OSA. These results explained the importance of observed and hypertension items of STOP-BANG questionnaire in the detection of people with high risk of OSA.

Conclusions
It was concluded that a considerable percentage of the general population in Jazan region had a high risk of obstructive sleep apnea based on STOB-BANG questionnaire; however, it was less than the percentage identified by other questionnaires. In addition, this percentage was less than that detected in other chronic disease-specific groups or other regions in Saudi Arabia. Hypertension and respiratory arrest observed by others during sleep were significant predictors for documented OSA.

Scientific Responsibility Statement
The authors declare that they are responsible for the article’s scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement
All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest
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