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Prevalence and Associated Factors of Obstructive Sleep Apnea in Saudi Arabia: A Web Based Questionnaire Based Study

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Abstract

Background: Obstructive sleep apnea (OSA) is a common condition that is prevalent among males. Though less is known about its prevalence among females. Furthermore, STOP-BANG score test is a self-reported survey that is widely used for diagnosing risks of obstructive sleep apnea. Due to the lack of determining the prevalence of OSA among females and its risk factors using STOP-BANG score test, the study was brought off.

Methods: A web-based cross-sectional study was conducted using modified STOP-BANG questionnaire that was distributed through WhatsApp, Twitter, Snapchat, and Telegram to determine the prevalence and associated factors of OSA among Saudi females in comparison to males.

Results: A total of 1377 participants completed the survey, total of 819 (59.4%) were females. The results showed that Prevalence of OSA among females is much less and the number of who had whether mild or moderate risk of OSA was 44 (3.9%) while 78 (14%) were males. Among the survey variables, the only significant factors were Smoking, Snoring, Body mass index, and tiredness.

Conclusion: OSA is a common sleeping disorder among men. Contrastingly, its prevalence is much less among females. STOP-BANG score is a good, cheap, and easy to use for diagnosing risk of OSA. Finally, OSA is associated with smoking, BMI, tiredness, and snoring.

Keywords: OSA, STOP-BANG, prevalence, Sleep Apnea, Saudi Females

1. Introduction

Sleep disorders are one of the most common public health issues that have been discovered since the 90s (Maurer, 2008; Santos et al., 2020). American Academy of Sleep Medicine (AASM) has classified sleep disorders into seven major categories which are central disorders of hypersomnolence, sleep-related breathing disorders (SRBD), circadian rhythm, sleep-wake disorders, parasomnias, insomnia and sleep-related movement disorders (SRMD). Each of which has sub-categories (Sateia, 2014). Obstructive sleep apnea (OSA) is classified as a SRBD and it is one of the most common sleep disorders which ranges between 9%–38%, specifically among men (Linz et al., 2018; Santos et al., 2020; Zhang et al., 2019). Pathophysiology of OSA is complex, yet not fully understood. Upper airway obstruction is the main cause of OSA that is caused due to muscle malfunction and decrease of its contractibility. Consequently, airway resistance and increased negative pressure during inhalation thereby frequent airway occlusion during sleep occurs. Nevertheless, anatomical abnormalities could prognose the condition too (Kim et al. 2020). OSA occurs when there is a partial or complete airway obstruction that might lead to patient desaturation, snoring, insufficient sleeping, nocturia, and arousals (Pretto, Gyulay, & Hensley, 2010; Zhang et al., 2019). Consequently, a mild to severe complications might occur such as daytime fatigue, dry mouth, hypertension, and heart attacks (Mekonnen et al., 2019).

OSA is associated with multiple complications. For instance, OSA is associated with cardiovascular disease, cognitive, behavioral, and metabolic issues (Baltzis et al., 2016; Santos et al., 2020). Risk factors for OSA might vary from one person to another while the most common factors are obesity, age, large neck circumference, increased airway length and enlarged tongue (Santos et al., 2020).

People with OSA might not be able to recognize that they have such a condition. Furthermore, due to different methods of diagnosing OSA, there are no optimum diagnostic test. However, Polysomnography is widely used for

diagnosing OSA. Formerly, patients used to sleep in hospital settings particularly in sleep labs to test whether they have any sleep disorders or not. Controversy, it is available as a portable device that can be taken to home nowadays (Kim et al., 2020).

Polysomnography measures multiple variables during night sleep through a continuous monitoring and recordings. As an example, neurological, muscular, cardiac, and respiratory activities will be measured. Simply, an electrical conductors called electrodes will be attached to the patient's different body parts which are electroencephalographic, electrooculographic and electromyographic that will detect any wakefulness, deep sleep, heart rate, respiration, and airflow. After a full night, the results will be analyzed to measure the different variables. As a case of point, apnea-hypopnea index (AHI) is one of the variables that measures the sum of apnea and hypopnea the patients had per hour during their sleep. Cessation of breathing for more than 10 seconds is called apnea while hypopnea is reduction of respiratory efforts combined with desaturation (Kim et al., 2020; Malhotra et al., 2017).

According to AHI, OSA can be classified for mild (AHI between 5–15), moderate (AHI 15–30), and severe (AHI >30). Another variable is respiratory-effort related arousal (RERA) which is disturbance of sleep. Yet, the reason of disturbance is neither because of apnea nor hypopnea. Furthermore, respiratory disturbance index (RDI) is the sum of the numbers of apneas and hypopneas with the abnormal respiratory events calculated per hour during the total time of sleep. According to AASM, high RDI is corresponding to excessive daytime sleepiness and the correlation is higher if it is combined with desaturation (Hisamatsu, Matsuzaki, & Kudou, n.d.). To reach a proper diagnosis, all variables are used mutually in healthcare settings (Status, Status, & Published, 2022).

Treatment of OSA is based on the underlying cause and the severity of such a condition. In mild cases, patients are treated whether by behavioral therapy such as weight loss and caffeine avoidance or by positioning therapy such as advising the patients to sleep in a certain position. On the other hand, patients with moderate to severe OSA usually need to be connected to a machine that covers the patient's nose and mouth which delivers a continuous positive pressure to prevent collapsing of upper airway. It is called a continuous positive airway pressure (CPAP).(Calik 2019) As an advantage, patient go under a deep stage of sleep, less arousals, better cardiorespiratory condition, and will not feel sleepy during daytime (Ortiz & Kwo, 2015).

In 2008, a self-reportable valid and reliable questionnaire called STOP BANG was developed to be as a prehospital screening tool for Patients with OSA. It consists of two dichotomous (yes\no) questions and it measures four subjective items and four demographics. STOP BANG is an abbreviation for Snoring, Tiredness, Observed apnea, High blood Pressure, Body mass index (BMI), Age, Neck circumference, and Gender (BaHammam et al., 2015; Chung et al., 2008; Nagappa et al., 2015). The questionnaire sensitivity for mild, moderate, and severe OSA was 83.9, 92.9 and 100%.(Nagappa et al. 2015) STOP BANG questionnaire is scored from 1 to 8; a score that ranges between 0-2 is considered as a low risk while a score that ranges between 3–8 are considered as a moderate to severe OSA risk (Chung et al., 2008). Each point of the questionnaire has one score and it will be cumulatively calculated for each question (Ortiz & Kwo, 2015).

In comparison with Polysomnography, STOP BANG can be used as an indicator not as a diagnostic tool. Multiple studies have been conducted to determine, assess the prevalence, and risk factors of OSA among men. However, much less is known regarding OSA among females. Thus, this study is aiming to find the prevalence and risk factors of OSA among females through STOP BANG questionnaire in comparison to males. Findings from this study might dominate and emphasize effective prevention strategies.

2. Methods

King Abdullah International Medical Research Center (KAIMRC) institutional review board approval has been taken before the beginning of the study (Study Number: SP21R/418/09, approval date: 10 October 2021). Then, sample size calculations have been done using Raosoft sample size calculator and assuming that 50% of the population will respond, a margin of error of 5%, and 95% confidence interval with a total population size of 34,813,871in Saudi Arabia who can access to at least one mean of social media. The estimated sample size was 385.

After that, a cross-sectional study using a bilingual (Arabic and English) web-based questionnaire called STOP BANG score test was distributed via five social media applications; WhatsApp, Telegram, Twitter, Snapchat, and Instagram, to measure the prevalence and associated factors of OSA among Saudi Females in contrast with males. The survey has eight dichotomous questions that measure demographics and subjective questions regarding sleep apnea. Rather than the demographics, the main measures are Snoring, daytime tiredness, observed apnea during sleep, blood pressure, and neck size.

The Survey was transferred from to an electronic form by using Google drive to be distributed conveniently. Then

forth, data storage and cleaning have been taken in place to EXCEL sheet. Total of 1635 participants have completed the questionnaire. All participants who agreed to participate and who are 18 Years old or above were included. On the other hand, all participants who declined to participate, missed data, or those who are less than 18 Years old were excluded leaving 1377 participants.

Data analysis has been done by using Statistical Package for the Social Sciences (SPSS) version 26. To control confounders, the questionnaire has been modified by including three more questions to identify if participants smoke, had previous surgeries, and their stress level. The questions were "Do you smoke", "have you done any previous surgery" and "do you have stress"

Also, the questionnaire's cut-off point has been tested by using Receiver Operator Characteristic curve (ROC) to test the best cut-off point for OSA risk category classification, whether it is mild, moderate or severe. The internal consistency has been tested before data analysis to make sure that the collected data are reliable. Descriptive statistical analysis has been performed to describe the demographics of the study sample population. The mean and standard deviation has been measured to describe numerical data and frequency with proportions to describe categorical variables. The level of statistical significance was estimated using 95% confidence interval (CI). Logistic regression was used to determine risk factors of OSA. Level of statistical significance was estimated using a P-value < 0.05. Multivariate analysis has been used for adjustments.

3. Results

Cronbach' alpha for internal consistency was 0.668 which reflects fair reliability (Table 1). The cross-sectional study constituted 1377 participants; the majority were females 819 (59.4%) while 558 (40.6%) were males. 1175 (85.3%) of respondents were less than 50 years of old leaving 202 (14.7%) at least 50 years old. Average BMI among Participants was 27.1. Controversy, 137 (9.9%) have BMI higher than or equal 35 kg/m2 (12.56 SD). The study included 1249 (90.7%) participants with low risk of OSA, for moderate risk 111 (8.0%), and 18 (1.3%) with high risk. All mentioned results are included in (Table 2). The overall OSA prevalence among females were 769 (94%) low risk compared with males who had a lower rate of low risk with 480 (86%) respondents. Furthermore, moderate risk for females in comparison with males were 48 (6%) alternately with 63 (11.3%). Finally, high risk of OSA among females were 3 (0.3%) while males prevalence were 15 (2.7%). Table 3 shows all the prevalence results.

Table 1. Reliability statistics

Cronbach's Alpha	N of items
.668	8

Table 2. Demographic Characteristics

Factor	**N (%)**	**Mean(Std.Deviation)**
Gender		
Male	558 (40.6)	
Female	819 (59.4)	
Age		
Less than 50	1175 (85.3)	
≥50	202 (14.7)	
Body Mass Index [BMI]		27.1(12.56)
BMI <35	1241 (90.1)	
BMI ≥35	137 (9.9)	
OSA category		
Low	1249 (90.7)	
Moderate	111 (8.0)	
High	18 (1.3)	

Table 3. Prevalence of OSA between females in comparison with males

Final score N (%)				
		Low Risk	Moderate Risk	High Risk
Gender	Male	480 (86)	63 (11.3)	15 (2.7)
	Female	769 (94)	48 (6)	3 (0.3)
Total		1249 (91.1)	111(7.6)	18 (1.3)

A total of 11% (N = 151) reported of having snoring during night, 60.4% (833) often feel tired and fatigue during daytime, and 12.8% (N = 177) has noticed that they have observed breathing pauses during night sleep. Among those who answered to blood pressure question, 7.7% (N = 106) are having or being treated for high blood pressure. Neck circumference more than 40cm is accounted for 10.7% (N = 147). For the adjusted questions, smokers were 15.8% of the total number of respondents (N = 218) while 37.7% had a previous surgery (N = 519). Finally, 66% of samples have stress (N = 910). Table 4 presents prevalence of different factors.

Table 4. Prevalence of different factors

Factor	**N (%)**
Snoring	151 (11.0)
Tiredness	833 (60.4)
Apnea	177 (12.8)
Pressure	106 (7.7)
Neck Circumference	147 (10.7)
Smokers	218 (15.8)
Previous surgery	519 (37.7)
Stress	910 (66)

Using the available data, ROC curve test has been conducted for determining the best cut-off point of OSA risk classification for mild, moderate, and high risk. The curve showed that the best cut-off point is 2 which means if the respondents have answered with “yes” for any two questions they will considered at a moderate risk of OSA (Figure 1). However, risk classifications that were used in this paper is same as the original classifications.

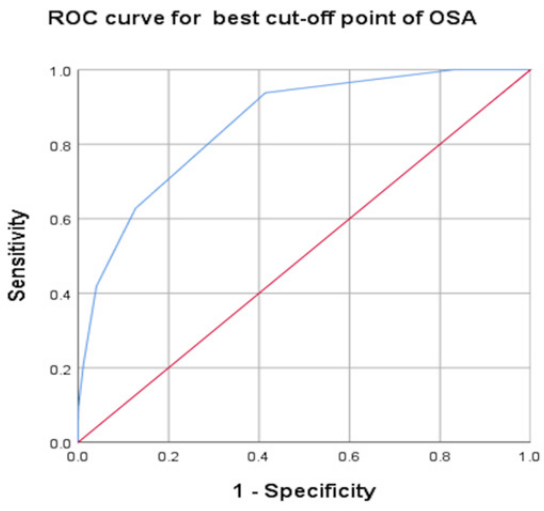

Figure 1. ROC curve for best cut-off point of OSA

To assess the association between OSA and snoring, tiredness, observed apnea, pressure, body mass index, age, neck circumference, and gender, multivariate logistic regression models were used. Backward method was used since it showed the best model fit with higher variability explained among all variables. Snoring during sleep has a significant association with OSA (P-value < 0.001 with adjusted odds ratio of 6.325 | 95% Cl= 2.2–9.4). Furthermore, people who snore have a higher risk of OSA by 6 times than people who do not. Tiredness is significantly associated with OSA (P-value < 0.004, adjusted odds ratio of 1.7 | 95% Cl = 1.19–2.54). Also tiredness seems to increase the risk of OSA by 1.7 times. Having a BMI greater than 35 is significantly associated with OSA with P-value < 0.009 (adjusted odds ratio of 1.9 | 95% Cl= 1.17–3.0). For each 1 kg\m2 increase in unit, risk of OSA tends to increase by 1.9. Furthermore, smoking is associated with OSA with P-value < 0.006 (adjusted odds ratio of 1.7 | 95% Cl= 1.1–2.6). Finally, data showed that there is no significant association between Gender and OSA. Also, age, blood pressure, neck circumference, and surgeries are not significantly associated with OSA (Table 5).

Table 5. OSA significant associated factors

Variable	P-value	Adjusted odds	95% Cl
Snoring	<.001	6.325	2.252 – 9.409
Tiredness / Fatigue	<.004	1.753	1.192 – 2.576
Body Mass Index	<.009	1.897	1.170 – 3.078
Smoking	<.006	1.784	1.784 – 1.183

*Hosmer and Lemeshow = .952; *Nagelkerke R Square = .181; *Reference group = Who answer with “NO”.

4. Discussion

The study was conducted mainly to determine the prevalence of OSA among females compared to males in Saudi Arabian population. Additionally, to determine the associated factors of OSA based on STOP BANG score. Depending on the gathered sample, it shows a contrasting risk of OSA between males and females. The higher risk is widespread among men with a 10% difference of OSA more than women. However, the results showed that females are susceptible to OSA too.

Wali et al. discussed the prevalence among Saudi population using a case-control study by enrolling one group for Wisconsin questionnaire as opposed to a full night polysomnography study group. The result revealed a similar prevalence of OSA risk among females with a slight variance of (0.3%) (Cho et al., 2020) Contrary to this study and Wali’s study, King Saud University has conducted a study between 2015–2016 on pregnant women that have been matched with non-pregnant. Both, the exposed and the control groups showed a high prevalence of OSA varying between 16.6 to 19.3 (Wali, Abalkhail, & Krayem, 2017). Furthermore, different studies reported different prevalence ranging from 15% up to 33.2% (Al-Jewair et al., 2016; BaHammam et al., 2009; Chen et al., 2020).

Variation of OSA among different studies is justifiable due to the lack of standardization of the assessment tool that is used; whether by using polysomnography, STOP-BANG, Wisconsin, or other diagnostic tools. Additionally, Prevalence of such a condition is subjected to timeframe.

By comparing between the indicated sensitivity of the score and sensitivity of the gathered data, ROC curve for the sample showed that STOP-BANG score ≥2 is considered as a moderate risk which might question the sensitivity of the available tool. Multiple literatures discussed that all STOP-BANG items are indicating and correlating with OSA. Whereas our results showed that the significant associated factors for OSA among the gathered sample was snoring, tiredness, blood pressure, BMI greater than 35 kg/m^2, and more importantly smoking which was not included in the original tool. It is similar to different studies that BMI, snoring and smoking are significant risk factors (Cho et al., 2020; Foroughi et al., 2017). In contrast, our study did not reveal that gender, observed apnea, blood pressure, and neck size are significantly associated with risk of OSA (Abdissa, 2020; Wong et al., 2020).

To delineate, these differences among the studies and our study are justifiable that might be subjected to cultural norms. For instance, females might become hesitant to respond to observed apnea and age questions since it is considered as an embarrassing questions. Furthermore, since the study was a web-based study; neck circumference might not be accurately measured or answered accurately due to measurements inconvenience and could affect the survey accuracy. Also, majority of respondents were less than 50 years which decreases the chance of having high blood pressure. Yet, further investigations are advised for reaching more precise information regarding

nonsignificant variables.

Sampling bias is a limiting factor that sample technique was convenience and targeting all Saudi regions was not guaranteed; non-social media users also were not captured. Since the study was a web-based survey, some questions potentially were not correctly responded such as neck circumference size. Furthermore, study type is considered as a limitation that incidence of OSA compared to the prevalence could not be investigated because the study was conducted in a single point of time. It is limiting that this study cannot determine if cessation of the risk factors might lead to risk absenteeism lessening. Conducting a similar study with design adjustment would be preferable to detect such changes. Since the survey has two age category, it is hard to determine the specific age range which has higher OSA rate too. Finally, the survey itself is considered as a limitation since it cannot measure all OSA risk factors such cardiovascular and central risks.

Criticizing the best cut-off point is a strength since our results showed different cut-off point rather than the available literatures even though that it was not the main aim of the study. Also, declaring that smoking is significant factor which was not indicated in the original survey might lead to a further investigations of the relationship between different kinds of smoking and its effect on OSA among Saudi population. For instance, vaping, electronic cigarette, and hookah (waterpipe). Additionally, regulations and increasing awareness regarding weight and tiredness controls might be emphasized on due to their significance of correlation with the dependent variable. Finally, this paper might lead to better conclusion if it is included in further systematic reviews and metanalysis.

5. Conclusion

Obstructive Sleep Apnea is a common condition that occurs when airway is being blocked during sleeping. Its prevalence among men is high and is associated with different variables while there are no sufficient studies for comparing its risk among women using STOP BANG score test. STOP BANG score is a quick, cheap, eight dichotomous questions, and easy survey that can be used to determine OSA risk. The results of using STOP BANG survey showed that OSA prevalence among females is not as high as in males. Furthermore, adjusted STOP BANG score showed that only four out of eleven items are significantly related to OSA which are snoring, tiredness, BMI greater than 35 kg/m^2 , and smoking. Most importantly, there is no association between gender and the risk of OSA. The study concluded that the survey might not be sufficient for OSA risk diagnosis among females and determining all risk factors. Yet, it could be as a cheap and pre-diagnostic tool. Finally, further studies are needed using different tools and systematic reviews to reach a more specific conclusion regarding its prevalence and risk factors.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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