

Obstructive Sleep Apnea: Prevalence, Risk Factors, and Impact on the Academic Performance of Medical Students at a Saudi Arabian University

Sara M. Alharbi, Albandari A. Alanazi, Asma S. Alamri, Hasah F. Alaluan, Wesam A. Alhuways, Raghad K. Suwayid, Aljohara S. Almeneessier¹

College of Medicine, King Saud University, ¹Department of Family and Community Medicine, College of Medicine, King Saud University Medical City, King Saud University, Riyadh, Saudi Arabia

Abstract

Background: Obstructive sleep apnea (OSA) is a common condition, but there is a lack of evidence from Saudi Arabia regarding its impact on the academic performance of medical students.

Objectives: To determine the prevalence and associated factors of OSA among medical students at a Saudi Arabian university and its impact on academic performance.

Methods: This cross-sectional study was conducted between October and December 2021 and selected first- to fifth-year medical students at King Saudi University, Riyadh, using a disproportionate stratified random sampling according to gender and academic year. The questionnaire comprised two sections: the first elicited sociodemographic information, self-reported GPA, and presence of chronic diseases, while the second included the English and Arabic versions of the Berlin Questionnaire.

Results: A total of 621 responses were received, of which 61.8% were male and the mean age was 21.1 (± 1.7) years. The prevalence of high-risk OSA was 14.5%. There was a significant association between being at a high risk of OSA and male gender ($P < 0.001$). In the multiple logistic regression model, male gender (odds ratio [OR] = 1.69, 95% CI: 1.01–3.9; $P = 0.047$) and overweight/obesity (OR = 2.59, 95% CI: 1.92–3.5; $P = 0.001$) were significant predictors of OSA. OSA was not a significant predictor of academic performance (OR: 0.7, 95% CI: 0.48–1.03; $P = 0.07$).

Conclusion: This study found that among first- to fifth-year medical students at a Saudi Arabian university, male gender and obesity were significant predictors of obstructive sleep apnea. On the other hand, obstructive sleep apnea was not a significant predictor of academic performance.

Keywords: Academic performance, Berlin Questionnaire, body mass index, medical students, obesity, obstructive sleep apnea, risk factors

Address for correspondence: Prof. Aljohara S. Almeneessier, Department of Family and Community Medicine, College of Medicine, King Saud University Medical City, King Saud University, P. O. Box 12372, Riyadh 7065, Saudi Arabia.
E-mail: aljoharas@yahoo.com

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INTRODUCTION

Obstructive sleep apnea (OSA) is a sleep-related breathing disorder characterized by repeated episodes of upper airway obstruction and hypoxemia during sleep.^[1] A systematic review of 24 general population-based studies revealed that the overall prevalence of OSA, quantified using the apnea-hypopnea index (AHI), at ≥ 5 ranged from 9% to 38%, and at AHI ≥ 15 , ranged from 6% to 17%.^[2] In Saudi Arabia, an outpatient study reported that 32% of Saudi Arabian adults were at high risk of developing OSA.^[3]

Age, male gender, and obesity have been widely reported to be factors that significantly increase the risk of OSA.^[1-4] Patients with OSA may present with various symptoms including snoring, apnea, daytime sleepiness, fatigue, and morning headaches.^[1,4] Patients with OSA also have trouble in concentrating, irritability, and memory problems.^[5] OSA is more common in individuals with medical conditions such as hypertension and diabetes.^[6-8] Patients with OSA have also been found to report worse sleep quality and shorter sleep duration, more often have symptoms of depression, anxiety, and fatigue, and have a cognitive function decline.^[5,9,10]

A large community survey found a strong positive relationship between unhealthy lifestyle and the risk of developing OSA.^[11] In Saudi Arabia, a recent study found that university students consumed unhealthy diet and led sedentary lifestyle.^[12] In addition, medical students have been extensively reported to have poor sleep patterns and its associated complications.^[13,14] While the prevalence of OSA among medical students has been reported, including from Saudi Arabia, few studies have assessed its impact on their academic performance.^[15-19] Studies that have reported the impact of OSA on academic performance of medical students have not found an association;^[18,19] however, there is lack of such studies from Saudi Arabia.

The current study was conducted to determine the prevalence and associated factors of OSA among medical students at a Saudi Arabian university and to determine the impact of OSA on the academic performance, reflected through GPA scores.

METHODS

Study design, setting, and participants

This cross-sectional study was conducted between October and December 2021 at the College of Medicine, King Saud University, Riyadh, Saudi Arabia, and included active first- to fifth-year medical students. Students with inactive records

were excluded. The study was conducted after obtaining ethical approval from the Institutional Review Board.

The required sample size was calculated as 207 using an online single proportion formula calculator (<https://statulator.com/SampleSize/ss1P.html>) by assuming a prevalence of OSA as 16%,^[16] with a 95% confidence level and a 5% margin of error. To reduce sampling error, the sample size was multiplied by a factor of three, and thus the final sample size was estimated as 621.

A total of 1457 medical students (847 males and 610 females) were actively enrolled at the College. The authors utilized a disproportionate stratified sampling technique. The total number of medical students was divided into two groups according to gender, and then, each group was divided into five strata according to academic year (i.e., first to fifth year), resulting in 10 strata. From each stratum, 50% of the students were selected by a simple random sampling technique using random numbers generated using MS Excel.

Data collection and instrument

With the cooperation of the student council, emails were individually sent to the selected participants with Google Forms links that comprised an English and Arabic language option of the questionnaire. A reminder was sent to all participants 1 week after the first email. The questionnaire website remained open for 1 month to collect the invited participants' responses. On the first page of the questionnaire, participants were assured of anonymity through code number assignment and informed that there were no incentives/rewards, and that participation was voluntary. All participants provided informed consent on the first page before proceeding to the survey.

The questionnaire was divided into two sections: the first section elicited sociodemographic information, self-reported GPA, and presence of chronic diseases. The second section included the Berlin Questionnaire (BQ).

BQ is a validated and commonly used instrument to screen for OSA.^[20,21] The English version of the BQ has a sensitivity of 78.7% and a specificity of 61.9%.^[22] The Arabic version of the BQ (ABQ) has high internal consistency and validity and Cronbach's alpha coefficient of 0.92. The validation of ABQ against AHI at a cut-off >5 was found to have a sensitivity of 97%, specificity of 90%, positive predictive value of 96%, and negative predictive value of 93%.^[23] BQ has three categories, wherein Category 1 comprises two items: snoring (resulting in assigning 1 point with 1 additional point for frequency or

intensity) and witnessed apnea (2 points). Category 2 elicits information regarding daytime sleepiness, and Category 3 is about hypertension or BMI ≥ 30 .^[21] BMI was calculated as weight (kg)/height (m)² and categorized as normal (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), or obese (≥ 30 kg/m²). High-risk OSA was defined as having two or more positive categories.^[24]

Variables and statistical analysis

Our study variables were age, gender, academic year, self-reported GPA, disease factors, and snoring score. The outcome variable was the severity of OSA based on BQ scores.

Data were reviewed for completeness, coded, and input into SPSS version 22 (IBM Corp, Armonk, NY). Descriptive analysis based on frequency and percentage distributions was performed for all variables. The distribution of students' risk for OSA by their characteristics was tested using the Pearson Chi-square test and the exact probability test for small-frequency distributions. The Student's *t*-test and ANOVA test were used to compare groups with continuous variables. A multiple logistic regression model was computed for the predictor variables of OSA and GPA. All statistical analyses were performed using two-tailed tests. Statistical significance was set at 0.05.

RESULTS

Sociodemographic characteristics

A total of 621 completed questionnaires were analyzed (response rate: 85%). The mean age of the students was 21.1 (± 1.7) years (range: 18–28), and the majority were male (61.8%). The highest number of respondents was from the third year (134 students, 21.6%), whereas the lowest was from the fifth year (107 students, 17.2%).

Regarding BMI, 133 (21.4%) students were overweight, and 107 (17.2%) were obese. According to an independent *t*-test, there was a significant difference between the BMI among male (26.5 ± 7.4) and female (21.9 ± 4.8) students ($P < 0.0001$). For BMI variations between males and females across different academic years, a two-way ANOVA revealed a statistically significant difference ($P = 0.022$). The simple main effect showed that males had significantly higher BMI in the third ($P = 0.026$), fourth ($P = 0.039$), and fifth ($P = 0.036$) academic years. Figure 1 illustrates the estimated marginal mean of BMI among males and females according to academic years.

Academic characteristics

In terms of GPA, most students reported a GPA of 4.5–5 (63.4%). In addition, chronic health problems were

reported by 61 students (9.8%), of which 23 (37.7%) had bronchial asthma (65.2% were male). Other reported problems included hypothyroidism, systemic lupus erythematosus, psoriasis, migraine, and anxiety [Table 1].

In the first category of BQ, a total of 64 (10.3%) respondents reported snoring, of which 79.7% were male. Further, 23.4% reported an almost daily frequency, and 46.9% stated that their “snoring bothered other people.” In addition, 148 (26.6%) respondents observed “stopping breathing during sleep” three to four times weekly. In the second category, 76 (12.2%) respondents reported almost every day feeling tired even after sleeping, and 82 (13.2%) reported almost every day feeling tired, exhausted, or not on par at the time of waking up. Surprisingly, 104 students (16.7%) said they nodded off or fell asleep while driving a vehicle, and one-fifth reported that this happened once or twice weekly. In the third category, high blood pressure was reported by 19 (3.1%) students [Table 2].

Prevalence, association, and predictors of obstructive sleep apnea

A total of 90 (14.5%) students were found to be at a high risk of OSA, and this predominantly included males (73; 19% of the study male population). The Chi-square test found a significant association between high-risk OSA and male gender ($\chi^2 = 16.6$; $P < 0.001$). In terms of risk by grade, there was a significant association between high-risk OSA and students in their second year compared with

Table 1: Sociodemographic characteristics of the study participants (N=621)

Variables	n (%)
Age (years)	
<20	117 (18.8)
20–22	362 (58.3)
23–28	142 (22.9)
Gender	
Male	384 (61.8)
Female	237 (38.2)
Academic year	
1	132 (21.3)
2	133 (21.4)
3	134 (21.6)
4	115 (18.5)
5	107 (17.2)
Grade point average (n=618)	
2.00–<3.75	39 (6.3)
3.75–<4.50	187 (30.3)
4.50–5.00	392 (63.4)
Have chronic diseases	
Yes	61 (9.8)
No	560 (90.2)
Body mass index	
Normal (18.5–24.9)	381 (61.4)
Overweight (25–29.9)	133 (21.4)
Obese (≥ 30)	107 (17.2)

students in other academic years ($\chi^2 = 22.8$; $P < 0.001$). Figure 2 shows the OSA risk distribution among the medical students according to gender and academic year. High-risk OSA was reported by nine students (23.1%) with a GPA < 3.75 ($\chi^2 = 12.2$; $P = 0.002$) [Table 3].

In the multiple logistic regression model, male gender (odds ratio [OR] = 1.69, 95% CI: 1.01–3.9; $P = 0.047$) and overweight/obesity (OR = 2.59, 95% CI: 1.92–3.5; $P = 0.001$) were significant predictors of OSA after adjusting for all other factors [Table 4]. On the other hand, OSA as a predictor for academic performance was computed as an OSA-adjusted OR of 0.7 (95% CI: 0.48 to 1.03; $P = 0.07$).

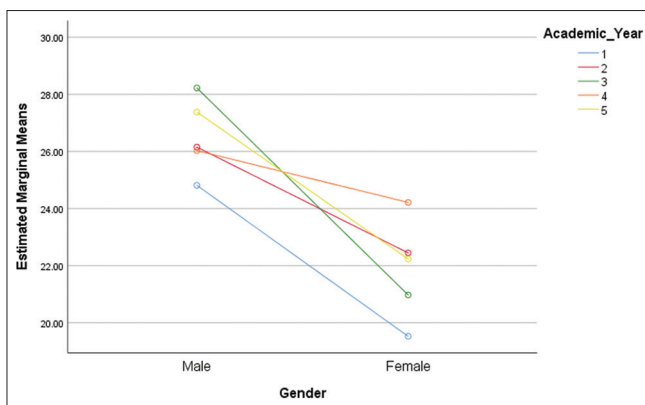


Figure 1: Estimated marginal means of body mass index among males and females according to academic years

DISCUSSION

This cross-sectional study found that among first- to fifth-year medical students at a major Saudi Arabian university, 14.5% were at a high risk of having OSA, and its associated factors were male gender and obesity. The prevalence of high-risk OSA in our sample was within the range mentioned in the literature for Arab countries (range: 5.4–21.5%)^[16–19,25] and Ethiopia (19%).^[26]

In coherence with our findings, previous studies have also reported that high risk of having OSA is associated

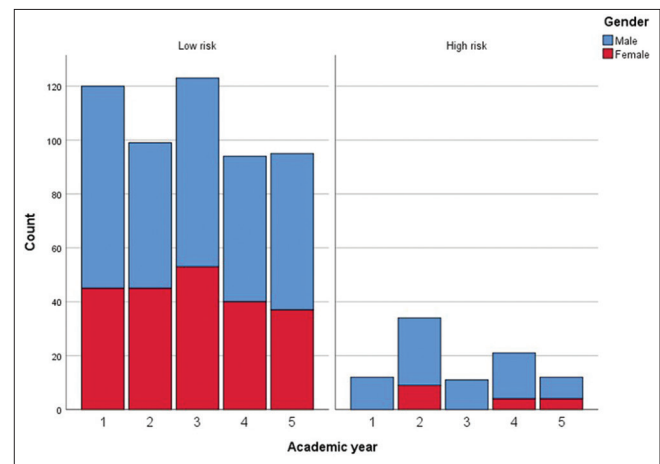


Figure 2: Obstructive sleep apnea risk distribution among the medical students according to gender and academic year

Table 2: Distribution of the participant's positive sleep apnea responses (N=621)

Berlin Questionnaire for sleep apnea	Positive responses	n (%)
Category 1 ^a		
1.1. Do you snore?	Yes	64 (10.3)
1.2. Your snore is (n=64) ^d	Louder than talking	0
	Very loud, can be heard in adjacent rooms	0
1.3. How often do you snore? (n=64) ^d	Almost every day	15 (23.4)
	3–4 times per week	13 (20.3)
1.4. Has your snoring ever bothered other people? (n=64) ^d	Yes	30 (46.9)
1.5. Has anyone noticed that you stop breathing during your sleep?	Almost every day	0
	3–4 times per week	148 (23.5)
Category 2 ^b		
2.1. How often do you feel tired or fatigued after your sleep?	Almost every day	76 (12.2)
	3–4 times per week	106 (17.1)
2.2. During your waking time, do you feel tired, fatigued, or not up to par?	Almost every day	82 (13.2)
	3–4 times per week	118 (19.0)
2.3. Have you ever nodded off or fallen asleep while driving a vehicle?	Yes	104 (16.7)
2.3.1. How often does this occur? (n=104) ^e	Almost every day	3 (2.9)
	3–4 times per week	4 (3.8)
	1–2 times per week	20 (19.2)
	1–2 times per month	8 (7.7)
	Rarely	69 (66.3)
Category 3 ^c		
3.1. Do you have high blood pressure?	Yes	19 (3.1)
3.2. BMI	≥ 30 kg/m ²	107 (17.2)

^aCategory 1 (questions 1.1–1.5) is positive if the total score is ≥ 2 points; ^bCategory 2 (questions 2.1–2.3.1) is positive if the total score is ≥ 2 points;

^cCategory 3 (questions 3.1 and 3.2) is positive if there is hypertension or if the BMI is ≥ 30 kg/m²; ^dQuestions 1.2, 1.3, and 1.4 the % calculate with dominator 64; ^eQuestion 2.3.1 the % calculated with denominator 104. High risk: If there are two or more categories where the score is positive.

BMI – Body mass index

Table 3: Association between obstructive sleep apnea risk and characteristics of the study participants

Personal data	OSA		χ^2	P ^a
	Low risk, n (%)	High risk, n (%)		
Age (years)				
<20	104 (88.9)	13 (11.1)	1.8	0.417
20–22	309 (85.4)	53 (14.6)		
23–28	118 (83.1)	24 (16.9)		
Gender				
Male	311 (81.0)	73 (19.0)	16.6	0.001
Female	220 (92.8)	17 (7.2)		
Academic year				
1	120 (90.9)	12 (9.1)	22.8	0.001
2	99 (74.4)	34 (25.6)		
3	123 (91.8)	11 (8.2)		
4	94 (81.7)	21 (18.3)		
5	95 (88.8)	12 (11.2)		
Have chronic diseases				
Yes	46 (75.4)	15 (24.6)	5.7	0.018
No	485 (86.6)	75 (13.4)		
BMI				
Normal	353 (92.7)	28 (7.3)	64.2	0.001
Overweight	115 (86.5)	18 (13.5)		
Obese	63 (58.9)	44 (41.1)		
GPA				
2–<3.75	30 (76.9)	9 (23.1)	12.02	0.002 ^{a,b}
3.75–<4.5	149 (79.7)	38 (20.3)		
4.5–5	350 (89.3)	42 (10.7)		

^aSignificant at <0.05; ^bExact probability test. BMI – Body mass index; OSA – Obstructive sleep apnea; GPA – Grade point average

Table 4: Multiple logistic regression model for predictors of obstructive sleep apnea among medical students

Factors	P	OR _A	95% CI	
			Lower	Upper
Age (years)	0.871	1.04	0.62	1.75
Male	0.047	1.69	1.01	3.90
Academic years	0.796	1.32	0.87	2.64
Chronic diseases	0.146	1.68	0.34	3.73
Obese/overweight	0.001	2.59	1.92	3.50

P significant at <0.05; OR_A – Adjusted odds ratio; CI – Confidence interval

with gender and BMI.^[1,3,27] This result is consistent with other findings of studies among medical students from different continents.^[18,28,29] In contrast, a study of 2000 medical students found that the prevalence of high-risk OSA was equal in both genders. This finding could be due to differences in study populations and sample size.^[3]

While the study did not analyze synergism between factors, the number of males who were overweight/obese was higher among males, suggesting a synergy between these factors. A previous study has reported the odds of high-risk OSA increase by about ten and three-fold with general obesity and central obesity, respectively.^[30]

The prevalence of bronchial asthma in Saudi Arabia has been reported to be 14.3%,^[31] while in the current study, it was <4%. Nonetheless, among students with chronic diseases, bronchial asthma was most common. Bronchial

asthma has been reported to be associated with OSA, as both are obstructive respiratory diseases that affect sleep.^[32] The relationship is bidirectional, and inadequate treatment of one disease worsens the condition of the other. In addition, patients with asthma and OSA are at a higher risk of mortality when compared with those without asthma.^[32]

The current study found that about one-fourth of students with a GPA <3.75 were at a high risk of OSA, but this was not significant when compared with those with higher GPAs. This is coherent with findings of some previous studies where academic performance was not associated with or affected by OSA or other sleep disorders,^[16,18] but also in contrast with another study, wherein students with poor academic performance were found to be more likely at a high risk of OSA (OR: 2.4).^[25]

It has been reported that test performance and reaction time is affected in patients with OSA compared with matched healthy controls.^[33] In addition, a meta-analysis of 35 studies, including 500 healthy controls and 1000 patients with OSA, reported that domains of cognitive function were impaired in patients with OSA compared with controls. Patients with OSA have difficulty shifting tasks, updating working memory, inhibiting dominant responses, struggling to generate new information, and problem solving. Furthermore, OSA treatment improves the functions of these domains.^[34] In terms of academic performance, OSA cannot be the sole factor in students' performance and achievement. Academic performance is a complicated process that can be affected by multiple internal and external factors, including family support and type of educational program, in addition to the learning environment.

As OSA is known to have an adverse influence on general and mental health, it is essential to introduce awareness programs that promote a healthy lifestyle to inform students about the risk and provide appropriate advice and support to minimize the effect of OSA on medical students' physical and mental well-being, thus improving their academic performance.

Limitations

A limitation of this study was that our findings lacked validation through the use of a formal diagnostic tool such as polysomnography. Another limitation is that the GPA was not verified from the college/university records, which is important given that self-reported responses have potential for reporting bias. Notably, while the male-to-female ratio in this study mirrored that in our medical school, it could have potentially exaggerated

the influence of male gender as a risk factor for OSA. In addition, as this study only included students from a single university, the generalizability of the findings to the broader community is limited, underscoring the need for a longitudinal community-based study to identify the effect of OSA and confounder factors on students' academic performance.

CONCLUSION

This study found that a large proportion of first- to fifth-year medical students at a Saudi Arabian university were at a high risk of obstructive sleep apnea. In addition, male gender and obesity were significant predictors of obstructive sleep apnea. However, obstructive sleep apnea was not a significant predictor of academic performance.

Ethical considerations

Ethical approval for this study was issued by the Institutional Review Board of King Saud University (Ref. no.: 21/0768/IRB; date: September 9, 2021). An informed electronic consent was obtained from all participants before their enrollment in the survey. The study was conducted according to the principles of the Declaration of Helsinki, 2013.

Peer review

This article was peer-reviewed by two independent and anonymous reviewers.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions

Conceptualization: A.S.A.; Methodology: A.S.A., S.M.A., A.A.A., A.S.A., H.F.A., W.A.A., R.K.S.; Writing—original draft preparation: S.M.A., A.A.A., A.S.A., H.F.A., W.A.A., R.K.S.; Writing – review and editing: A.S.A.; Supervision: A.S.A.

All authors have read and agreed to the published version of the manuscript.

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Conflicts of interest

There are no conflicts of interest.

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