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Obstructive sleep apnea and related symptoms in medical students

Apneia obstrutiva do sono e sintomas relacionados em estudantes de medicina

Apnea obstructiva del sueño y síntomas relacionados en estudiantes de medicina

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Abstract
Objective: This prospective and cross-sectional study investigated the occurrence of obstructive sleep apnea (OSA) and related symptoms in medical students. Method: Sociodemographic and anthropometric data were collected. The survey included the Epworth sleepiness scale, Berlin questionnaire, STOP-Bang, and NoSAS. Participants underwent overnight digital monitoring of respiratory events (≥ 3% drop in SpO2) using a high-resolution oximeter. Those with high risk for OSA in the Berlin questionnaire or an oxygen desaturation index ≥ 5 to < 15 events/hour, were examined through type 3 polysomnography. Results: The evaluated sample comprised 64 students, aged 22.3±2.3 years, and 38 (59.4%) males. A high risk for OSA frequency was detected in 10.9% of the sample through the Berlin questionnaire, and in 4.7% through STOP-Bang and NoSAS. A mild form of this disorder was diagnosed in 4.7% of the sample through type 4 polysomnography, and in 6.2% using type 3 polysomnography. Excessive daytime sleepiness and being overweight were associated with the occurrence of mild obstructive sleep apnea ($p \leq 0.05$). Males presented higher body mass index values, neck circumference, oxygen desaturation index events/hour, and continuous values in the Berlin questionnaire, STOP-Bang, and NoSAS, than females ($p \leq 0.05$). Conclusion: Despite a low occurrence of the assessed sleep-disordered breathing among medical students, male gender, overweight and sleepiness consisted of factors associated with obstructive sleep apnea, indicating that medical students with this profile should be early and systematically screened for this condition.
Keywords: Daytime sleepiness; Polysomnography; Student health; Obstructive sleep apnea.

Resumo
Objetivo: Este estudo prospectivo e transversal investigou a ocorrência de apneia obstrutiva do sono (AOS) e sintomas relacionados em estudantes de medicina. Método: Coletaram-se dados sociodemográficos e antropométricos. A pesquisa incluiu a escala de sonolência de Epworth, questionário de Berlim, STOP-Bang e NoSAS. Os participantes foram submetidos à monitorização digital noturna de eventos respiratórios (queda ≥ 3% na SpO2) usando um oxímetro de alta resolução. Aqueles com alto risco para AOS no questionário de Berlim ou índice de dessaturação de oxigênio ≥ 5 a < 15 eventos/hora foram examinados por meio de polissonografia tipo 3. Resultados: A amostra avaliada foi composta por 64 alunos, com idade de 22,3±2,3 anos, sendo 38 (59,4%) do sexo masculino. Um alto risco para frequência de AOS foi detectado em 10,9% da amostra pelo questionário de Berlim e em 4,7% pelo STOP-Bang e NoSAS. Uma forma leve desse distúrbio foi diagnosticada em 4,7% da amostra pela polissonografia tipo 4 e em 6,2% pela polissonografia tipo 3. A sonolência diurna excessiva e o excesso de peso foram associados à ocorrência de

apneia obstrutiva do sono leve (p ≤0,05). O sexo masculino apresentou maiores valores de índice de massa corporal, circunferência do pescoço, índice de dessaturação de oxigênio eventos/hora e valores contínuos no questionário de Berlim, STOP-Bang e NoSAS, do que o sexo feminino (p ≤0,05). Conclusão: Apesar da baixa ocorrência dos distúrbios respiratórios do sono avaliados entre os estudantes de medicina, o sexo masculino, o sobrepeso e a sonolência constituíram-se em fatores associados à apneia obstrutiva do sono, indicando que estudantes de medicina com esse perfil devem ser rastreados precoce e sistematicamente para essa condição.
Palavras-chave: Sonolência diurna; Polissonografia; Saúde do estudante; Apneia obstrutiva do sono.

Resumen
Objetivo: Este estudio prospectivo y transversal investigó la aparición de apnea obstructiva del sueño (AOS) y síntomas relacionados en estudiantes de medicina. Método: Se recolectaron datos sociodemográficos y antropométricos. La encuesta incluyó la escala de somnolencia de Epworth, el cuestionario de Berlín, STOP-Bang y NoSAS. Los participantes se sometieron a una monitorización digital durante la noche de los eventos respiratorios (≥ 3% de caída en SpO2) usando un oxímetro de alta resolución. Aquellos con alto riesgo de AOS en el cuestionario de Berlín o índice de desaturación de oxígeno ≥ 5 a < 15 eventos/hora, fueron examinados mediante polisomnografía tipo 3. Resultados: La muestra evaluada estuvo compuesta por 64 estudiantes, con edad de 22,3±2,3 años, y 38 (59,4%) del sexo masculino. Se detectó un alto riesgo de frecuencia de AOS en el 10,9% de la muestra a través del cuestionario de Berlín, y en el 4,7% a través de STOP-Bang y NoSAS. Se diagnosticó una forma leve de este trastorno en el 4,7% de la muestra mediante polisomnografía tipo 4 y en el 6,2% mediante polisomnografía tipo 3. La somnolencia diurna excesiva y el sobrepeso se asociaron con la aparición de apnea obstructiva del sueño leve (p ≤ 0,05). Los varones presentaron valores de índice de masa corporal, circunferencia del cuello, índice de desaturación de oxígeno eventos/hora y valores continuos más altos en el cuestionario de Berlín, STOP-Bang y NoSAS que las mujeres (p ≤ 0,05). Conclusión: A pesar de la baja ocurrencia de los trastornos respiratorios del sueño evaluados entre los estudiantes de medicina, el sexo masculino, el sobrepeso y la somnolencia fueron factores asociados a la apnea obstructiva del sueño, lo que indica que los estudiantes de medicina con este perfil deben ser tamizados temprana y sistemáticamente para esta condición.
Palabras clave: Somnolencia diurna; Polisomnografía; Salud del estudiante; Apnea obstructiva del sueño.

1. Introduction

Obstructive sleep apnea (OSA) is characterized by repeated episodes of airway obstruction during sleep, leading to intermittent hypoxia, fragmented sleep and impaired ventilation during sleep, with repeated airway obstruction episodes (Kapur et al., 2017). The occurrence rate of this disorder increased considerably in the last two decades (Peppard et al., 2013), leading to serious adverse health consequences (Drager et al., 2007; Drager et al., 2009).

Considering an apnea-hypopnea index (AHI) cutoff of ≥ 5 events/hour, OSA affects 5% of women and 14% of men (Peppard et al., 2013). The odds for OSA onset increase in males and obese individuals or those over 60 years old (Tufik et al., 2010). However, OSA occurrence is not restricted to the elderly, its moderate form (≥5 AHI < 15 events/hour) affects respectively 12.4% (8.7% - 17.5%) and 1.4% (0.6% - 3.1%) of men and women aged 20 to 29 (Tufik et al., 2010).

Despite this alarming evidence, there is lack of data on OSA epidemiology in young adults (Migacz et al., 2017). Besides, there are no standards for screening and diagnosing this disorder among individuals at this specific age group (Nishijima et al., 2018). Additionally, the identification of contributing factors for OSA development in this population has been poorly investigated.

Moreover, the prevalence of OSA would be higher in this age range when screening includes objective sleep study findings and questionnaire based-responses (Migacz et al., 2017; Nishijima et al., 2018). Among the undergraduate population, medical students were identified as at higher risk for sleep-disordered breathing than other adults with similar age (Migacz et al., 2017; Nishijima et al., 2018, Hui et al., 1999; Singh et al., 2012).

In this context, the present study aimed to assess the risk for OSA, its related symptoms, and associated risk factors, using self-administered questionnaires and overnight digital monitoring (ODM) of the oxygen desaturation index (ODI).

2. Methodology

2.1 Ethical considerations

This study was approved by the Institutional Review Board (process number 1970019.6.000.5417) and complied with ethical standards. All participants signed an informed consent form agreeing to participate in the study. All assessments were performed in a cross-sectional and prospective manner.

2.2 Sampling procedure and study design

The participants were recruited at the [information omitted for peer-review], among first and second-year undergraduate medical students. The comprised 64 volunteers, representing nearly 50% of the available local population (120 students). The study included males and females, older than 18 years. Exclusion criteria were in agreement with Collop et al. (2007), as follow: verified medical history of pulmonary and/or neuromuscular disease, congestive heart failure, central sleep apnea, periodic limb movement disorder, insomnia, parasomnias, circadian rhythm disorders, or narcolepsy.

2.3 Anthropometric and survey data collection

Sociodemographic and anthropometric data were systematically collected face-to-face and classified according to the literature (Tufik et al., 2010; WHO, 2000; Joshipura et al., 2016). Portuguese translated and validated cross-cultural versions of the Epworth sleepiness scale (ESS), Berlin questionnaire (BQ), STOP-Bang - snoring, tiredness, observed apneas, blood pressure, body mass index (BMI), age, neck circumference (NC), gender, and NoSAS - NC, obesity, snoring, age, sex - were self-administered in the same day of the home sleep monitoring (Migacz et al., 2017; Bertolazi et al., 2009; Vaz et al., 2011; Duarte et al., 2017; Duarte et al, 2020). Cutoff scores for daytime sleepiness and subjective assessment risk for OSA are shown in Table 1.

Table 1: Self-rated questionnaires used for assessing sleep propensity in daily situations and screening of OSA.

Scale	*Assessed outcome / Time frame*	*Scoring*	*Cutoff for outcome definition*
ESS	Sleep propensity in daily situations / 1 to 4 weeks.	8 items rated 0 (never doze) to 3 (high probability of dozing).	Excessive daytime sleepiness: ≥ 11.
BQ	Screening for OSA / lifetime.	10 items, 3 domains (I -snoring, II - excessive daytime sleepiness, III - history of obesity and high blood pressure). MCQ with different scorings. Category I and II: positive, total score ≥2; III: positive, high blood pressure or BMI ≥30 kg/m^2.	High risk of OSA: ≥ 2 categories with positive scores.
STOP-Bang	Screening for OSA / lifetime.	4 items on symptoms (STOP - snoring, tiredness, observed apnea, high blood pressure) and demographics (Bang: BMI >35 kg/m^2, age >50, NC - ♂ = 43cm and ♀ = 41cm, gender = ♂).	Risk of OSA: low (0 to 2 "Yes"), moderate (3 to 4 "Yes"), high (5 to 8 "Yes" or 2 "Yes" on symptoms items + BMI >35kg/m^2 or increased neck circumference).
NoSAS	Screening for OSA / lifetime.	5 items (NoSAS - NC >40 cm; obesity with ≥25 BMI <30 kg/m^2 and BMI ≥30 kg/m^2, snoring, age >55, sex=♂. Different scorings.	High risk of OSA: score ≥8.

OSA = obstructive sleep apnea, ESS = Epworth sleepiness scale, BQ = Berlin questionnaire, MCQ = multiple choice question, BMI = body mass index, NC = neck circumference, ♂= male, ♀ = female. Adapted from Kurtis et al. (2018).

2.4 Sleep monitoring

The ODM BiologixTM (Oxistar™, Biologix Sistemas Ltd., Brazil) was used for the at-home sleep study (Pinheiro et al., 2020). Briefely, this is a wireless high-resolution oximeter with a built-in accelerometer linked to a smartphone with automated cloud analysis. The participants slept at home, recording data from "lights off till lights on" (Migacz et al., 2017; Collop et al., 2007). Those subjects that presented with a high risk for OSA in the BQ or with an ODI ≥ 5 in the Biologix, type 4 polysomnography, were invited to undergo a type 3 polysomnography using Alice Night One (Phillips Respironics, USA).

A drop ≥ 3% in the Oximetry defined a respiratory event (Collop et al., 2007). Scoring of the ODI events/hour and respiratory event index (REI) / hour were: < 5 = without OSA, ≥ 5 and < 15 = mild OSA, ≥15 and ≤ 30 = moderate OSA, and ≥ 30 = severe OSA.

2.5 Data analysis

Sample characteristics were described as mean ± standard deviation (SD) when normally distributed (Kolmogorov-Smirnov analysis) or as median and interquartile range when non-normally distributed. Categorical data are presented as frequencies and percentages.

The differences of mean and median values for age, BMI, NC, ODM recovered data, and continuous questionnaire's scores were compared between males and females, individuals aged <25 and ≥25 years, and those with BMI <25kg/m2 and ≥25kg/m2, using unpaired two-tailed t-tests or its non-parametric counterpart Mann-Whitney's. Fisher's exact was used to detect significant associations between categorical data, using ODI as the dependent variable. A Bland–Altman plot compared the objective methods for OSA screening [Difference (A - B) vs. agerave]. Confidence intervals (CI) and their lower and upper limits for all analyses were set at the 95% level, and p values ≤ 0.05 were considered statistically significant.

3. Results

A total of 64 undergraduate medical students (22.3±2.3 years old), 38 (59.4%) males, and 46 (71.9%) being normotrophic, underwent complete survey, clinical assessment, and at-home sleep study with BiologixTM (Table 2).

Table 2: Descriptive statistics of the continuous variables for sample characterization.

Variables (N=64)	*Mean ± SD*	*Mean 95% CI*	*Median*	*25th percentile*	*75th percentile*	*Median 95% CI*
Age (years)	22.28±2.34	21.70-22.87	22.00	21.00	23.00	21.00-22.00
BMI (kg/m^2)*	22.96±3.47	22.09-28.83	22.35	20.30	25.90	21.30-24.20
NC (cm)	34.57±3.63	33.66-35.49	36.00	32.00	37.00	33.00-36.00
Type IV PSG:						
RT (min)*	400.80±79.91	380.80-420.70	397.00	347.70	457.90	365.00-437.80
ODI (events/h)	2.05±2.12	1.52-2.58	1.60	0.90	2.50	1.10-2.10
SPO_2 min (%)	91.84±2.13	91.31-92.38	92.00	91.00	93.00	91.00-93.00
SPO_2 mean (%)	96.42±0.95	96.18-96.66	96.00	96.00	97.00	96.00-97.00
ESS	8.81±4.48	7.69-9.93	9.00	6.00	12.00	7.00-10.00
BQ	1.57±1.65	1.16-1.99	1.00	0.00	2.00	1.00-2.00
SB (N=62)	1.01±0.80	0.81-1.21	1.00	0.00	1.00	1.00-1.00
NoSAS	2.98±2.60	2.33-3.63	2.00	0.50	5.00	2.00-4.00

*Passed Kolmogorov-Smirnov normality test (alpha=0.05). SD = standard deviation, CI = confidence interval, BMI = body mass index, NC = neck circumference, RT = recording time, PSG = polysomnography, ODI = oxygen desaturation index, SPO_2 min = minimum oxygen saturation, ESS= Epworth sleepiness scale, BQ = Berlin questionnaire, SB = Stop-Bang. Source: Authors.

Subjective assessment indicated a low risk for OSA in the vast majority of the sample, by BQ (57; 89.1%), STOP-Bang (59; 92.1%) and NoSAS (61; 95.3%), categorically interpreted. Objective assessment of OSA through type 4 polysomnography indicated that 95.3% (61) presented ODI below 5/events per hour (ODI < 5) and 4.6% (3) had mild OSA (≥5 ODI <15), respectively. The type 3 polysomnography increased OSA prevalence to 6.2% (4) (Table 3). Among the eight cases of high risk for OSA estimated by the BQ, one was confirmed in the type 4 polysomnography, and three in the type 3 exam (Table 3).

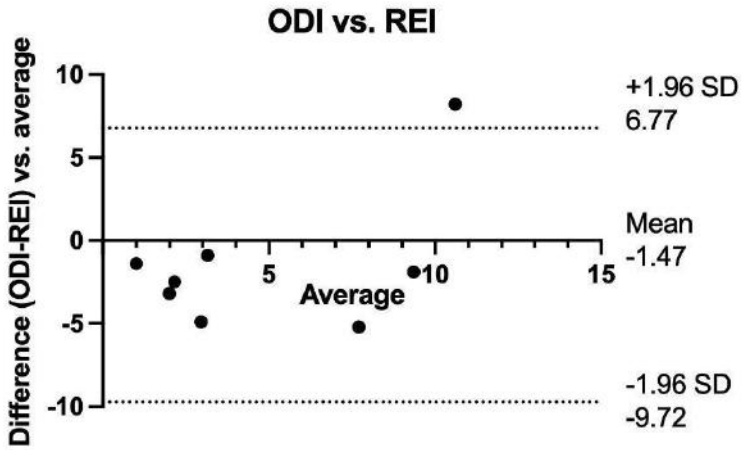
Table 3: Level 3 and 4 sleep studies results and questionnaires of individuals with increased risk for obstructive sleep apnea or sleepiness.

Case	*ODI PSG 3*	*REI PSG 3*	*ODI PSG 4*	*BQ*	*NoSAS*	*STOP-Bang*	*ESS*
1	2.2	3.4	0.9	HR	LR	LR	11
2	2.8	3.6	2.7	HR	LR	LR	9
3	4.7	6.5	14.7	HR	LR	HR	12
4	1.2	1.7	0.3	HR	LR	HR	8
5	2.0	3.6	0.4	HR	LR	LR	17
6	8.2	10.3	5.1	LR	LR	LR	17
7	12.1	10.3	8.4	HR	LR	LR	13
8	4.0	5.4	0.5	HR	LR	LR	10

ODI = oxygen desaturation index (events/hour), REI = respiratory events index, BQ = Berlin questionnaire, HR = high risk for obstructive sleep apnea, LR = low risk for obstructive sleep apnea, ESS = Epworth Sleepiness Scale. Source: Authors.

The Bland–Altman plot in Figure 1, displayed adequate agreement between the ODI and REI obtained through type 4 and 3 sleep tests, respectively (bias = -1.47; SD of bias = 4.205; 95% CI = -9.716 to 6.766). Additionally, the correlation between methods was good (r = 0.578; 95% CI = -0.2137 to 0.9114; p = 0.1334).

Figure 1: Bland-Altman plot illustrating the agreement between Oxygen Desaturation Index (ODI) measured by BiologixTM (Oxistar™, Biologix Sistemas Ltd., Brazil) and Respiratory Event Index (REI) by Alice Night One (Phillips Respironics, USA).



Source: Authors.

Males presented significantly greater BMI and NC than females, as well as higher continuous scores in BQ, SB, and NoSAS ($p \leq 0.05$). As expected, the mean values of NC and NoSAS continuous scores were increased among overweight individuals (BMI ≥ 25kg/m^2) compared to those within the normal weight range, at a statistically significant level (Table 4).

ODI values were statistically significantly greater in males than females, and among those with overweight (BMI ≥ 25kg/m^2) than in the normotrophic (BMI < 25kg/m^2).

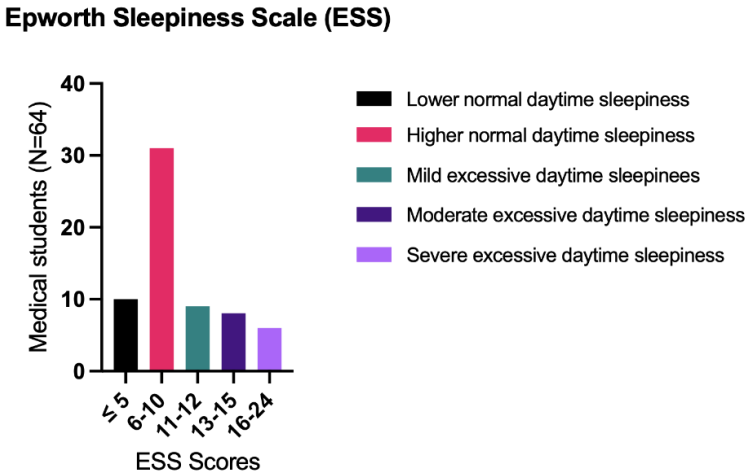
Table 4: Mean and median values of the assessed variables compared by sex, age, and BMI ranges.

	Sex		*Age*		*BMI*	
Variables (N=64)	*Male* (N=38)	*Female* (N=26)	*<25 years* (N=56)	*≥25 years* (N=8)	*<25kg/m^2* (N=46)	*≥25kg/m^2* (N=18)
Age	22.00	20.00	22.00[a]	27.00[a]	22.00	22.00
BMI	23.97±3.41[b]	21.46±3.16[b]	23.09±3.50	22.00±3.66	20.91±1.96[c]	27.14±1.85[c]
NC	37.00[d]	31.00[d]	36.00[e]	30.50[e]	34.00[f]	38.00[f]
ODM:						
RT	378.20±74.22[g]	433.70±77.73[g]	396.50±70.55	430.40±131.21	406.30±73.41	388.20±406.30
ODI	2.20[h]	1.10[h]	1.50	2.00	1.50[i]	1.80[i]
SpO_{2min}	92.00	92.00	92.00	90.25	92.00	92.00
SpO_{2mean}	97.00[j]	98.00[j]	96.50	96.00	97.00	96.00
ESS	7.71±4.22[k]	10.42±4.45[k]	8.76±4.48	9.12±4.85	8.88±4.67	8.67±4.19
BQ	1.47±1.70	1.73±1.58	1.57±1.65	1.62±1.76	1.37±1.51	2.00±1.87
SB (N=62)	1.47±0.64[l]	0.38±0.57[l]	0.87±0.83	1.03±0.80	0.93±0.79	1.19±0.81
NoSAS	4.21±2.38[m]	1.19±1.74[m]	3.00±2.56	2.87±3.04	1.48±1.31[n]	6.04±1.74[n]

BMI = body mass index, NC = neck circumference, ODM = overnight digital monitoring, RT = recording time, ODI = oxygen desaturation index, SPO_2 min = minimum oxygen saturation, ESS= Epworth sleepiness scale, BQ = Berlin questionnaire, SB = STOP-Bang. Letters indicate statistically significant differences ($p \leq 0.05$). Mann-Whitney and t-test were used to compare medians and means, respectively. Source: Authors.

Drowsiness frequently occurred in the sample, affecting 35.9% of the students, and was more prevalent among female participants (Table 4). Stratification of excessive daytime sleepiness severity is shown in Figure 2.

Figure 2: Graphic representation of daytime sleepiness severity assessed through the Epworth Sleepiness Scale.



Source: Authors.

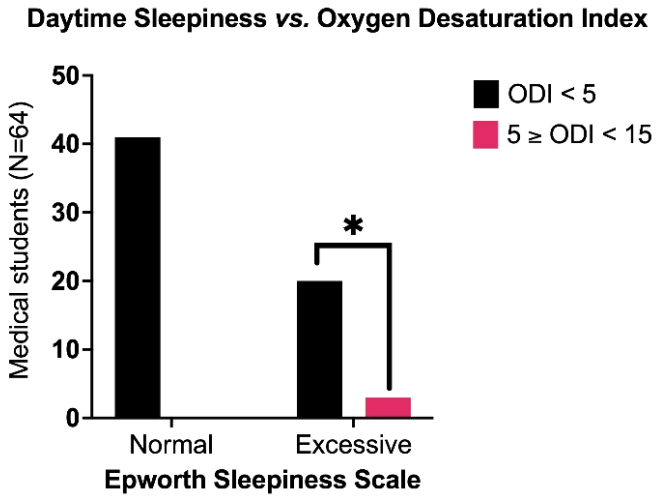
Having a night sleep duration (recording time) of less than 400 minutes was not associated with ESS scores ≥11 at a statistically significant level. The analysis suggested that having excessive daytime sleepiness was associated with having mild OSA (≥5 ODI <15 events/hour) (Table 5, Figure 3).

Table 5: Association of the oxygen desaturation index and survey responses, anthropometric or demographic data.

Variables (N=64)		*ODI events/hour*				*p value (≤ 0.05)*
		ODI < 5		*≥ 5 ODI <15*		
		N	*%*	*N*	*%*	
ESS	Normal	41	64.06	0	0.00	0.045*
	DES	20	31.25	3	4.69	
BQ	Low risk	56	87.50	2	3.13	0.259
	High risk	5	7.18	1	1.56	
SB (N=62)	Low risk	58	93.55	1	1.61	0.095
	High risk	2	3.23	1	1.61	
NoSAS	Low risk	59	92.18	2	3.13	0.136
	High risk	2	3.13	1	1.56	
Snoring	No	36	56.25	0	0.00	0.078
	Yes	25	39.06	3	4.69	
BMI	< 25kg/m^2	45	70.31	0	0.00	0.023*
	≥ 25 kg/m^2	16	25.00	3	4.69	
Tiredness	< 3 times/week	41	64.06	2	3.13	0.999
	≥ 3 times/week	20	31.25	1	1.56	
Sex	Female	26	40.62	0	0.00	0.264
	Male	35	54.68	3	4.69	
Age	< 25 years	54	84.83	2	3.13	0.334
	≥ 25 years	7	10.94	1	1.56	
NC	<41cm	60	93.75	3	4.69	0.999
	≥41cm	1	1.56	0	0.00	

*Fisher's exact test (alpha 0.05). ODI = oxygen desaturation index, ESS = Epworth sleepiness scale, DES = daytime excessive sleepiness, SB = Stop-Bang, BQ = Berlin questionnaire, BMI = body mass index, NC = neck circumference, Snoring and tiredness data were recovered from BQ. Source: Authors.

Figure 3: Graphic representation of the association between sleep propensity in daily situations *vs*. oxygen desaturation index (ODI) events/hour. Fisher's exact test (* p ≤ 0.05).



Source: Authors.

4. Discussion

In the present study we found a small but significant frequency of OSA among medical students, ranging from 4.7% to 6.3% using type 4 and 3 polysomnography, respectively. This study results, highlights that OSA and its related symptoms, among young adults, should not be ignored or neglected (Tufik et al., 2010; Nishijima et al., 2018; Migacz et al., 2017; Hui et al., 1999; Singh et al., 2012).

In Southeast Brazil - the geographical area of the present study - a representative sample of 236 adults aged 20 to 29 years exhibited a prevalence of 12.4% of mild OSA (≥5 AHI <15 events/hour), and 3.8% of males had the severe form of the disorder (AHI >30 events/hour) when evaluated by type I polysomnography (Tufik et al., 2010). The lower frequency of OSA in our study may be related to the fact that our population was younger. Additionally, portable polygraphs (type 3 and 4) were used in the present study, instead type 1, which is a high-cost method and is relatively difficult to perform in developing countries (Aielo et al., 2019).

Our study found OSA prevalence that are in the range of other studies. Hui et al. (1999) detected ODI ≥5 events/hour in 2.3% of undergraduate students using type 4 polysomnography, revealing a prevalence of 0.1% of OSA when symptoms were considered. Migacz et al. (2017) considered 11% and 24% of their sample, university students, being at risk of OSA using questionnaires and at-home diagnostic devices, respectively. Nijishama et al. (2018) detected a 37% rate of OSA among Japanese medical students by type 3 polysomnography.

The diagnosis of OSA by unattended examination should be performed in conjunction with a comprehensive sleep evaluation, avoiding patients with comorbid medical conditions (Collop et al., 2007). The present study fulfilled these criteria. Still, on the other hand, the ODM device was used to identify OSA in a sample whose initial probability of having moderate to severe OSA was low, which could compose a bias factor for this screening device (Collop et al., 2007).

Herein we used the ODM device validated by Pinheiro et al. (2020), whose results demonstrated that the ODI measures presented a high performance for detecting moderate to severe OSA and agreement with AHI values in a population referred to a sleep laboratory and in a controlled setting. In this study, an ODM device was used in an unreferred sample, and in an uncontrolled setting, which could lead to a different performance of this device.

Moreover, according to Stradling et al. (1990), in younger individuals with average cardiorespiratory reserve, upper airway obstruction can occur without alterations in the ODI, remaining undetected by portable monitoring devices. Another source of bias of at-home sleep tests, as pointed by Hui et al. (1999) and reported by the individuals included in this study, were artifacts introduced by a poorly adapted oximeter probe in the subject's finger and due to the discomfort of using the device during sleep.

In our study we confirmed the results found by type 4 PSG with type 3 PSG. In those individuals with ODI ≥5 events/hour and at high risk for OSA in the BQ, a type 3 polysomnography was conducted. It was seen that in seven subjects the type 3 and 4 polysomnography results were concordant. In only one subject (case 8 in Table 3), which presented with high risk in the BQ and a 10 score in the Epworth Sleepiness Scale, the ODI was < 5 and the REI ≥5.

The presence of mild OSA may have clinical significance. An ODI greater than 5 events/hour is a predictor of developing type-2 diabetes after adjusting for confounding variables in a community-based sample (Rashid et al., 2021). Also, hypoxia with oxyhemoglobin saturation < 90% for > 9 minutes is a stronger predictor of cardiovascular events over AHI (Drager et al., 2007; Drager et al., 2009; Rashid et al., 2021; Kapur et al., 1999). Both findings suggest the clinical relevance of measuring these parameters in the general population. Therefore, identifying mild OSA in nearly 5% of our sample highlights the importance of systematically evaluating these medical students, from a systemic perspective, considering the onset of cardiometabolic morbidities.

Males had higher continuous scores in BQ, STOP-Bang, NoSAS, and mean values of ODI, BMI and NC, all previously associated with OSA onset. It is well known that STOP-Bang, NoSAS and BQ are instruments for screening OSA, exhibiting good predictive values, especially, when used as continuous variables, associated with both AHI and ODI measures (Peng at al., 2018; Herschmann et al., 2021 & Veugen et al., 2021). In our sample, however, considerable discrepancy was observed between the objective and subjective measures.

In other samples of undergraduate students, BMI was a predictor of OSA in males (Nishijima et al., 2018; Hui et al., 1999). According to the literature, weight gain predicts an increase in the relative risk and odds of having OSA, and this association is stronger in men than women (Peppard et al., 2013; Nishijima et al., 2018). Thus, preventive and educative health measures encouraging healthy nutrition and regular exercise practice should be encouraged in Medical School Campuses and among young adults in general, especially males. It should be considered that lifestyle interventions may effectively improve OSA severity and are seen as critical components for OSA prevention and treatment (Edwards et al., 2019).

Finally, it is essential to highlight that 31.3% of the students felt tired ≥3 times/week, and 39.1% were snorers, despite not having OSA. Snoring in the present study was assessed by the BQ question "Do you snore?", therefore it was a subjective measure. Future studies are necessary to better evaluate the snoring pattern, considering that early detection and intervention of snoring can avoid late cardiovascular complications (Hui et al., 1999; Bhattacharyya, 2015).

Insufficient sleep is common among medical students, which would be the main cause of a high prevalence of tiredness, independently of snoring and OSA. However, in our study, no statistically significant association of sleepiness scores with sleep duration were found. Although, the mean time of sleep duration was below 7 hours per night. Evaluations using the Pittsburgh Sleep Quality Index should be considered in future studies to assess sleep quality more properly in order to better explain sleepiness prevalence in this population. Other biological and social factors that would contribute to drowsiness should be further explored. Especially among women, which despite having a statistically reduced ODI than men, presented more severe daytime sleepiness.

5. Conclusion

Obstructive sleep apnea (OSA) prevalence among Brazilian medical students was within the expected range for young adults in Brazil. Male gender, overweight and sleepiness consisted of factors associated with obstructive sleep apnea in this population, indicating that medical students with this profile should be early and systematically screened for this condition, and engaged in awareness programs. Validated survey methods and at-home monitoring sleep tests together should be considered in low-income settings as initial screening alternatives for OSA. Finally, we suggest that future studies involving this population address the quantitative impact that overweight and sleepiness have on the onset or worsening of obstructive sleep apnea (OSA), as well as the repercussion of this disease on the student's quality of life.

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