Obstructive Sleep Apnea – Clinical predictors and correlation with questionaires

Original Article

Authors

Filipa Ferreira
Hospital Garcia de Orta, Portugal

Henrique Teixeira
Hospital Garcia de Orta, Portugal

Ricardo São Pedro
Hospital Garcia de Orta, Portugal

Anita Paupério
Hospital Garcia de Orta, Portugal

Cláudia Santos
Hospital Garcia de Orta, Portugal

Vitor Proença
Hospital Garcia de Orta, Portugal

Helena Rosa
Hospital Garcia de Orta, Portugal

Luis Antunes
Hospital Garcia de Orta, Portugal

Correspondence:
Filipa Ferreira
anafilipa.ferreira@gmail.com

Article received on April 5, 2022.
Accepted for publication on July 31, 2022.

Abstract

Objectives: To analyse epidemiological, demographic and clinical factors that may be related to Obstructive Sleep Apnea (OSA). To evaluate the correlation between several questionnaires (Epworth Sleepiness Scale, STOP-Bang and Berlin Questionnaires) with polysomnography (PSG) results, in order to apply them as a tool for selecting patients for PSG.
Material and Methods: Prospective study. Completion of questionnaires at the time of the type III PSG study, at the Otorhinolaryngology Department of Hospital Garcia de Orta and review of the patient clinical file.
Results: 193 patients were evaluated, with a mean age of 57(±14) years, 57.5% were male. Age (p = 0.001), BMI (p = 0.001), the presence of arterial hypertension (p = 0.006) and diabetes mellitus (p = 0.003) were found to be factors associated with the presence of OSA. Of the three questionnaires tested, only the STOP-Bang questionnaire showed a statistically significant correlation with the presence of OSA (p = 0.001) in the population studied. Analysing the ROC curves, the STOP-Bang questionnaire showed the best discriminative capacity for the presence of OSA (0.853 p = 0.001), followed by the Berlin questionnaire (0.659 p = 0.002) and finally the Epworth sleepiness scale (0.559 p = 0.257).
Conclusions: The STOP-Bang was the questionnaire that demonstrated a significant correlation with the presence of OSA, constituting a useful tool, particularly in the context of in-office consultation, for the selection and referral of patients for PSG study.

Keywords: obstructive sleep apnea; OSA; obstructive sleep apnea syndrome; polysomnography; questionnaire.

Introduction

Obstructive sleep apnea (OSA) is etiologically based, as the name implies, on repeated episodes of upper airway obstruction during sleep, resulting in oxyhemoglobin desaturation and sleep fragmentation. It may entail clinical symptoms, such as excessive daytime sleepiness and morning headaches, leading to

the diagnosis of OSA syndrome.[1] OSA is highly prevalent, ranging from 6% in young adults to 47% in older groups.[2,3] Despite being common, it often remains undiagnosed.[4]

It is associated with several pathologies, such as obesity, arterial hypertension, diabetes mellitus, stroke, arrhythmia, heart failure, and neoplasms.[4-6] Patients with OSA also have a higher risk of traffic and occupational accidents.[1,4]

Despite the frequent use of diagnostic tools, such as the Berlin questionnaire, the STOP-Bang questionnaire, and the Epworth Sleepiness Scale as presumptive OSA indicators, studies on their diagnostic capacity are controversial.[7]

Level I polysomnography (PSG) has traditionally been considered the gold standard test for diagnosing OSA. However, due to the high prevalence of OSA as well as the technical complexity and associated costs of the test, it is necessary to find an alternative to mitigate this public health problem. Outpatient level III PSG, with high sensitivity (79%) and specificity (79%), is a valid alternative for people with OSA.[4,5]

Due to its increased incidence over the last decade, the diagnosis of OSA, identifying and defining its risk factors as well as validating its diagnostic questionnaires that may also help establish OSA's correlation with PSG findings has become increasingly pertinent.

Material and methods

Prospective study conducted between January and December 2021. The STOP-Bang questionnaire, Berlin questionnaire, and Epworth Sleepiness Scale were administered when OSA patients underwent level III PSG at the Department of Otorhinolaryngology, Garcia de Orta Hospital – Centro de Responsabilidade Integrada.

All patients also filled in a questionnaire that sought information about their demography (age, sex), weight, height, smoking habits, use of sedative or sleep-inducing medication, number of antihypertensive drugs used, whether they worked in shifts, risk activities (professional driver or machine operator), number of traffic accidents in the previous year, nighttime symptoms (number of times they wake up to go to the toilet, difficulty in getting to sleep after waking up during the night), daytime symptoms (morning headache), and other associated pathologies, such as high blood pressure (HBP), diabetes mellitus, heart failure, previous acute myocardial infarction, atrial fibrillation, previous transient ischemic attack (TIA)/stroke, and neoplasia.

The patient charts were subsequently analyzed during the data extraction phase to obtain necessary information for the study.

Those aged 18 years or above, were provided with the level III PSG service by the Department of Otorhinolaryngology of Garcia de Orta Hospital, and provided a signed informed consent form were included as study participants.

The patients were exclusively referred for level III PSG by an otorhinolaryngologist when they experienced one or more of the following along with snoring: witnessed OSA, excessive daytime sleepiness (Epworth scale ≥ 11), fragmented or non-restorative sleep, difficulty in controlling HBP (using three different drug classes), or had median body mass index (BMI) equal to or greater than 25 kg/m2.

Those with incomplete PSG study (loss of signal in one of the channels), or who lasted less than six hours and provided incorrectly or incompletely filled in questionnaires were excluded.

Questionnaire variables were analyzed as well as the presence or absence of OSA according to the apnea-hypopnea index (AHI), classified according to the guidelines of the American Academy of Sleep Medicine, which defines OSA as AHI ≥ 5 events/hour was considered. 4 OSA severity was also determined as "mild" for patients with AHI between 5-¬14.9 events/hour, "moderate" for patients with AHI between 15¬-29.9 events/hour, and "severe" for patients with AHI ≥ 30 events/hour.

The Stata software version 26 was used for statistical analysis. Categorical variables were analyzed using the Chi-square and Fisher

tests and reported in terms of frequency and percentage (%). Normally-distributed continuous variables were reported as mean and standard deviation (SD), and p-values were calculated using the independent T-test. Continuous variables not following a normal distribution curve were reported as falling under the median and interquartile range (Q1/Q3), and the p-value was determined based on the Mann-Whitney test. Receiver Operating Characteristic (ROC) curves were used to compare the predictive power of the different questionnaires used. P-values < 0.05 were considered to suggest statistically significant differences.

Results

A total of 193 patients were included in the study, with a mean age of 56 (± 14) years, of which 111 (57.5%) were men and 82 (42.5%) were women. The BMI of the sample was 29.4 (26.7¬-33.0) kg/m2, being 30.2 (27.1¬3-3.3) and 27.8 (23.5¬-30.2) kg/m2 in patients with and without OSA, respectively. The prevalence of OSA in this study was 77% (n = 150), with 42% (64 patients) indicating mild OSA, 29% (44 patients) indicating moderate OSA, and 29% (43 patients) indicating severe OSA (Graph 1).

The most frequent comorbidities were HBP (48%), diabetes mellitus (18.6%), and arrhythmia (13.4%). There was a significant association between OSA and the two most frequent comorbidities, i.e.,HBP (p = 0.006) and diabetes mellitus (p = 0.003).

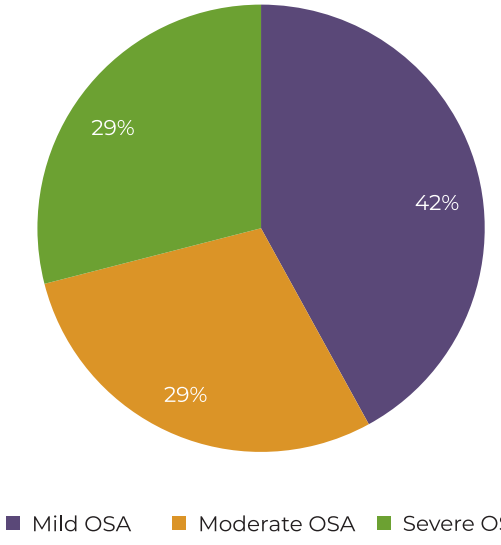
Of the three questionnaires, the only one that showed a significant correlation with the presence of OSA was the STOP-Bang (p = 0.001), indicating an 11.4 times higher risk of OSA in patients with a high-risk score (3 or more positive responses).

In this sample, 88% (169) patients had a high-risk score on the STOP-Bang, compared with 77% (148 patients) on the Berlin questionnaire, and 35% (66 patients) on the Epworth Sleepiness Scale.

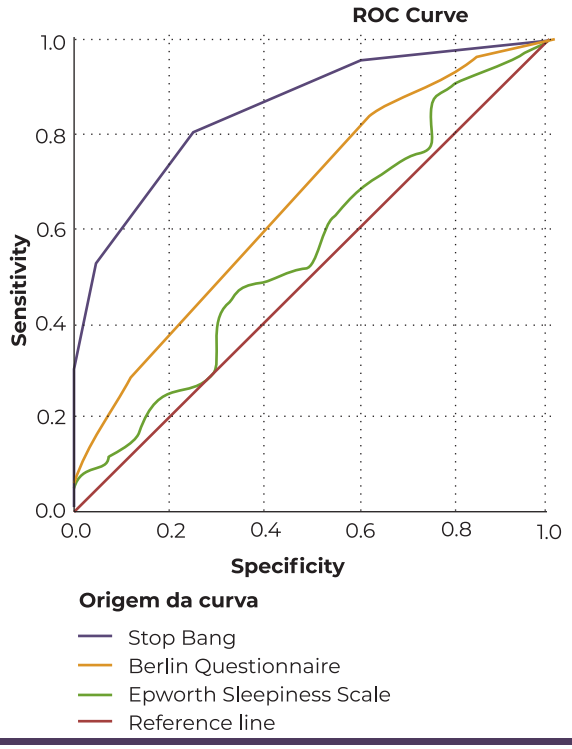
ROC curve analysis showed that the STOP-Bang questionnaire had the best discriminative capacity to detect the presence of OSA (0.853, p = 0.001), followed by the Berlin questionnaire (0.659, p = 0.002) and the Epworth Sleepiness scale (0.559, p = 0.257) (Graph 2).

The analysis of each of the questionnaires by OSA severity showed that the Epworth Sleepiness Scale has better discrimination

Graph 1
Sample distribution by OSA severity

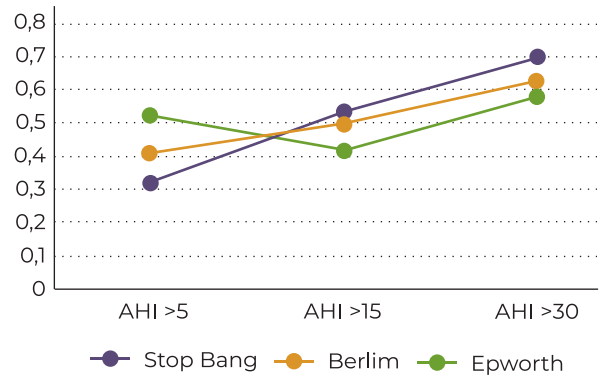


Graph 2
ROC curve for OSA prediction with the STOP-Bang questionnaire, Epworth Sleepiness Scale, and Berlin questionnaire



power (0.52) for mild OSA, while the STOP-Bang questionnaire obtained a better correlation in cases of moderate and severe OSA (0.52 and 0.69, respectively) (Graph 3).
Thus, the STOP-Bang questionnaire has the best sensitivity for detecting OSA (95%), although it has a specificity of 39%. Its percentage of false positives is 54% compared to the false positives of Berlin questionnaire's 68% and Epworth Sleepiness Scale's 30%. Its percentage of false negatives is 5% compared to the false negatives of Berlin questionnaire's 21% and Epworth Sleepiness Scale's 64%. Overall, the STOP-Bang questionnaire showed the highest accuracy for OSA identification (83%) (Table 2).

Graph 3
Area under the curve (AUC) of the three questionnaires by AHI



Discussion

Over the last few decades, OSA emerged as one of the most prevalent chronic diseases worldwide; it is a systemic disease associated with important comorbidities, such as HBP, acute myocardial infarction, TIA/stroke, and diabetes mellitus, among others.[8]
In our study, a significant association was demonstrated with HBP (p = 0.006) and diabetes mellitus (p = 0.006), supporting the scientific evidence that OSA is a predisposing factor for these comorbidities.[9,10]

Table 1
Summarizes the sample characteristics

	Without OSA (n = 43)	With OSA (n = 150)	Odds ratio (CI)	p-value
Age (years)	50.07	57.55		0.002
Men n (%)	19 (54)	92 (61)	0.54 (0.27-1.10)	0.085
BMI (kg/m2)	27.8	30.2		0.001
Smoker n (%)	9 (22)	32 (21)	0,90 (0.39-2.09)	0.800
Sleep medication n (%)	11 (27)	36 (24)	0,84 (0.38-1.85)	0.664
Wakes up to go to the toilet n (%)	33 (81)	126 (84)	1,21 (0.44-3.26)	0.712
Insomnia after waking up at night (%)	20 (49)	73 (49)	1,01 (0.51-2.01)	0.981
Working in shifts n (%)	4 (10)	17 (11)	1,18 (0.37-3.71)	1.000
Morning headache n (%)	17 (42)	63 (42)	1,05 (0.52-2.11)	0.899
Professional driver/Operates machines n (%)	7 (17)	36 (24)	1,53 (0.62-3.75)	0.352
HBP n (%)	12 (29)	80 (53)	2,76 (1.31-5.82)	0.006
TIA/stroke n (%)	0	10 (7)	0,77 (0.72-0.84)	0.123
Acute myocardial infarction n (%)	0	7 (5)	0,78 (0.72-0.84)	0.349
Heart failure n (%)	0	9 (6)	0,78 (0.72-0.84)	0.209
Arrhythmia n (%)	5 (12)	10 (13)	1,04 (0.37-2.99)	0.936
Diabetes mellitus n (%)	1 (2)	34 (23)	11.7 (1.55-88.45)	0.003
Neoplasia n (%)	2 (5)	11 (7)	1.54 (0.33-7.26)	0.738

Table 2
Comparison of questionnaire performance for OSA detection

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	% False positives	% False negatives	Accuracy (%)
STOP-Bang	95	39	85	67	54%	5%	83
Berlim	79	32	81	29	68%	21%	69
Epworth	36	70	81	23	30%	64%	43

PPV = positive predictive value; NPV = negative predictive value

According to relevant studies, the prevalence of OSA is rapidly increasing, which may be due to the combined effect of several factors like obesity, an aging population, and the increasing accessibility to PSG.[2,10,11] The present study also showed that BMI had a statistically significant correlation with OSA (p = 0.001) and so did the cervical circumference (p = 0.001), which is an indirect measure of obesity.

Age was also a relevant factor for the presence of OSA, with the mean age in the group with OSA being 57 years and 50 years in the group without OSA (p = 0.002), corroborating the study by Rede Médicos-Sentinela, in Portugal, and the study by Caselhos S. et al.[9,12]

Due to long waiting lists in most respiratory sleep pathology hospitals and clinics, screening tools should be used to prioritize patients for an OSA diagnostic test, in this case, level III PSG, based on the probability of obtaining a positive result.[13]

The ideal screening tool should have high sensitivity and specificity, but this is rare. The sensitivity and specificity of a screening model are inversely correlated, and high sensitivity is often achieved at the expense of lower specificity. For diseases like OSA, the screening test should have high sensitivity rather than high specificity to ensure that individuals with OSA do not go undiagnosed.[10]

Of the three tools evaluated in this study, the only one that showed a significant correlation with OSA was the STOP-Bang (p = 0.001) questionnaire. Patients at high risk according to this questionnaire had 11.4 times more chances of having OSA than patients at low risk. When the analysis was detailed according to ROC curves, the STOP-Bang questionnaire presented the best discriminative capacity to detect the presence of OSA (0.853, p = 0.001), followed by the Berlin questionnaire (0.659, p = 0.002) and the Epworth Sleepiness Scale (0.559, p = 0.257), corroborating the study by Amra B. *et al*., which reported an area under the curve (AUC) of 0.89, 0.76, and 0.69, respectively, for the STOP-Bang questionnaire, Berlin questionnaire, and Epworth Sleepiness Scale.[14] The study by Zhang Z. *et al*. detailed an analysis based on OSA severity and also showed a phenomenon similar to that observed in the present study, i.e., the fact that the STOP-Bang questionnaire presented better prediction values for moderate and severe OSA; however, this was not true for mild OSA, which may lead to the conclusion that the greater the severity of OSA, the more reliable the questionnaire.10

Sensitivity and specificity analysis showed that the STOP-Bang questionnaire (95%) had the highest sensitivity but low specificity (39%), emphasizing that this same relationship was found in other studies, with STOP-Bang specificity ranging between 8.5-¬48%.[7,10,11,15]

Despite a high number of false positives (54%), the STOP-Bang showed a very low number of false negatives (5%), which, as previously detailed, is quite relevant in a screening model for this type of pathology, with high accuracy (83%). This makes it very credible as an outpatient screening tool due to the low risk of not being able to diagnose someone with OSA.

Conclusion

The STOP-Bang questionnaire demonstrated a significant correlation with OSA, making it a useful outpatient tool for selecting and

referring patients for level III PSG. It also would yield interesting results with regard to populations at risk that are not included in this questionnaire, such as patients with diabetes mellitus.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

Funding Sources

This work did not receive any contribution, funding or scholarship.

Availability of scientific data

There are no datasets available, publicly related to this work.

Bibliographic references

1.Balachandran JS, Patel SR. In the clinic. Obstructive sleep apnea. Ann Intern Med. 2014 Nov 4;161(9):ITC1-15; quiz ITC16. doi: 10.7326/0003-4819-161-9-201411040-01005.

2.Senaratna CV, Perret JL, Lodge CJ, Lowe AJ, Campbell BE, Matheson MC. et al. Prevalence of obstructive sleep apnea in the general population: A systematic review. Sleep Med Rev. 2017 Aug;34:70-81. doi: 10.1016/j.smrv.2016.07.002.

3.Senaratna CV, Perret JL, Matheson MC, Lodge CJ, Lowe AJ, Cassim R. et al. Validity of the Berlin questionnaire in detecting obstructive sleep apnea: A systematic review and meta-analysis. Sleep Med Rev. 2017 Dec;36:116-124. doi: 10.1016/j.smrv.2017.04.001.

4.Kapur VK, Auckley DH, Chowdhuri S, Kuhlmann DC, Mehra R, Ramar K. et al. Clinical practice Gguideline for diagnostic testing for adult obstructive sleep apnea: an American Academy of Sleep Medicine Clinical Practice Guideline. J Clin Sleep Med. 2017 Mar 15;13(3):479-504. doi: 10.5664/jcsm.6506.

5.Gottlieb DJ, Punjabi NM. Diagnosis and management of obstructive sleep apnea: a review. JAMA. 2020 Apr 14;323(14):1389-1400. doi: 10.1001/jama.2020.3514.

6.Jonas DE, Amick HR, Feltner C, Weber RP, Arvanitis M, Stine A. et al. Screening for obstructive sleep apnea in adults: evidence report and systematic review for the US Preventive Services Task Force. JAMA. 2017 Jan 24;317(4):415-433. doi: 10.1001/jama.2016.19635.

7.Chiu HY, Chen PY, Chuang LP, Chen NH, Tu YK, Hsieh YJ. et al. Diagnostic accuracy of the Berlin questionnaire, STOP-BANG, STOP, and Epworth sleepiness scale in detecting obstructive sleep apnea: A bivariate meta-analysis. Sleep Med Rev. 2017 Dec;36:57-70. doi: 10.1016/j.smrv.2016.10.004.

8.Lim DC, Pack AI. Obstructive sleep apnea: update and future. Annu Rev Med. 2017 Jan 14;68:99-112. doi: 10.1146/annurev-med-042915-102623.

9.Rodrigues AP, Pinto P, Nunes B, Bárbara C. Síndrome de apneia obstrutiva do sono: epidemiologia, diagnóstico e tratamento. Um estudo da Rede Médicos-Sentinela. [Internet] Lisboa: Direção Geral da Saúde; 2014. Available from:http://hdl.handle.net/10400.18/2686

10.Zheng Z, Sun X, Chen R, Lei W, Peng M, Li X. et al. Comparison of six assessment tools to screen for obstructive sleep apnea in patients with hypertension. Clin Cardiol. 2021 Nov;44(11):1526-1534. doi: 10.1002/clc.23714.

11.Prasad KT, Sehgal IS, Agarwal R, Nath Aggarwal A, Behera D, Dhooria S. Assessing the likelihood of obstructive sleep apnea: a comparison of nine screening questionnaires. Sleep Breath. 2017 Dec;21(4):909-917. doi: 10.1007/s11325-017-1495-4.

12.Caselhos S, Teles RV, Matos C, Fernandes F. Síndrome de apneia obstrutiva do sono: nove anos de experiência. Revista Portuguesa Otorrinolaringologia e Cirurgia de Cabeça e Pescoço. 2011;49(2):85-90. doi: https://doi.org/10.34631/sporl.162.

13.Vaz AP, Drummond M, Mota PC, Severo M, Almeida J, Winck JC. Tradução do Questionário de Berlim para língua Portuguesa e sua aplicação na identificação da SAOS numa consulta de patologia respiratória do sono. Rev Port Pneumol. 2011 Mar-Apr;17(2):59-65. doi:10.1016/S0873-2159(11)70015-0

14.Amra B, Javani M, Soltaninejad F, Penzel T, Fietze I, Schoebel C. et al. Comparison of Berlin Questionnaire, STOP-Bang, and Epworth Sleepiness Scale for diagnosing obstructive sleep apnea in persian patients. Int J Prev Med. 2018 Mar 9;9:28. doi: 10.4103/ijpvm.IJPVM_131_17.

15.Herschmann S, Berger M, Haba-Rubio J, Heinzer R. Comparison of NoSAS score with Berlin and STOP-BANG scores for sleep apnea detection in a clinical sample. Sleep Med. 2021 Mar;79:113-116. doi: 10.1016/j.sleep.2021.01.004.