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Original Research Article

Obstructive Sleep Apnoea: Comparison of Screening Questionnaires with Polysomnography

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Abstract:

Background: Obstructive Sleep Apnea (OSA) is a prevalent disorder associated with significant chronic conditions such as hypertension and cardiovascular disease. While laboratory polysomnography (PSG) is the gold standard for diagnosis, the high prevalence of OSA often overwhelms available sleep laboratory resources, creating a need for effective screening tools. This study aimed to compare the predictive accuracy of four standard screening questionnaires and a sleepiness scale against PSG to identify OSA and its severity.

Methods: This observational study was conducted at the Government Medical College, Srinagar, involving 453 patients clinically suspected of having OSA. The study population had a mean age of 49 years and was predominantly female (64.6%) and obese (70.8%). Participants were evaluated using the STOP-BANG, P-SAP, DES-OSA, and Berlin questionnaires, alongside the Epworth Sleepiness Scale (ESS). These results were compared against overnight Level-1 PSG data to determine sensitivity, specificity, and Area Under the Curve (AUC).

Results: The study found a high prevalence of OSA (96.2%) within the referred cohort, with 44.3% diagnosed with severe OSA. The STOP-BANG questionnaire exhibited the highest sensitivity at 93.8% (95% CI: 90.9–96.1), followed by P-SAP (81.2%) and DES-OSA (79.1%). In contrast, the ESS demonstrated the highest specificity at 76.5% and the highest overall diagnostic accuracy with an AUC of 0.90. Statistically significant predictors for OSA included increased age, high Body Mass Index (BMI), hypertension, increased waist circumference, and a high Mallampati score.

Conclusion: The STOP-BANG questionnaire is the most sensitive instrument for screening, making it highly effective for identifying high-risk patients. However, the ESS offers superior specificity. The authors conclude that while these questionnaires effectively categorize high-risk patients, their increased sensitivity comes at the expense of specificity, meaning they cannot accurately exclude low-risk patients without PSG confirmation.

Introduction

Obstructive sleep apnea (OSA) is a common disorder characterized by snoring, daytime sleepiness, fatigue, apnea and hypoxemia. OSA is defined by an AHI of at least 5 events/hour. Obesity hypoventilation syndrome (OHS), or the Pickwickian syndrome, is defined by obesity (BMI ≥30 kg/m2) and hypoventilation with daytime hypercapnia in the absence of other causes for hypoventilation [1-4]. OSA and associated sleep disturbance appear to be associated with many chronic conditions such as obesity, type 2 diabetes mellitus, hypertension, stroke, heart failure, atrial

fibrillation, and coronary artery disease. Studies suggest that comorbid OSA increases morbidity and mortality in these conditions [5-10]. Although the gold standard for diagnosis of obstructive sleep apnea is laboratory polysomnography (PSG); however, the occurrence of OSA is far more prevalent than can be handled by the available sleep laboratories. Therefore, a screening tool is necessary to stratify patients based on their clinical symptoms, physical examinations, and risk factors, in order to ascertain patients at high risk and in urgent need of PSG and/or further treatment. A number of screening questionnaires and clinical screening models have been developed to help identify patients with OSA [11-12]. In this study various standard questionnaires were utilized to predict the like hood of obstructive sleep apnea and compared against overnight polysomnography.

The STOP questionnaire was developed in 2008 in an attempt to establish an easy-to-use questionnaire for OSA screening in surgical patients. The SQ includes four subjective (STOP: Snoring, Tiredness, Observed apnea, and high Blood Pressure). An alternative scoring model incorporates four demographics items (BANG: BMI, Age, Neck circumference, Gender). Total score of 3 or more indicates high risk for OSA [13-14]. The Berlin questionnaire was developed in 1996 at the Conference on Sleep in Primary Care in Berlin-Germany. The first section is about snoring, the second section is about daytime fatigue and sleepiness, and the last section is about medical history and anthropometric measures such as hypertension and BMI. Total score of 2 or more in each of 3 categories indicates a positive category and 2 or more positive categories indicates high risk for OSA [15-16]. The P-SAP score validates 6 of the 8 elements of the STOP-BANG model, PSAP score > 4 indicates high risk for OSA. The DES-OSA score was derived exclusively on the morphologic characteristics, DES being the acronym for 2 of the participating investigators (ED and SD) and OSA for obstructive sleep apnea. DES-OSA score > 7 indicates high risk for OSA. The Epworth Sleepiness Scale (ESS), created by Murray Johns in 1990, is a validated self-administrated 8-item questionnaire that measures subjective daytime sleepiness; it uses a four-point Likert response format (0–3), and the score ranges from 0 to 24. An ESS score ≥ 11 indicates excessive daytime sleepiness and high risk for OSA [17-25].

Aim and Objectives: Our study aimed at comparing the various sleep questionnaires with polysomnography in predicting obstructive sleep apnea and its severity and to identify factors predicting OSA.

Materials and Methods

This observational study was conducted in the Post-Graduate Department of Respiratory Medicine, Government Medical College, Srinagar, after obtaining ethical clearance from Institutional Ethics Committee. Patients of age equal or more than 18 years, who were referred from outpatient department of our hospital or associated hospitals for polysomnography, based on clinical suspicion of obstructive sleep apnea syndrome were included in the study. Those patients who were already on treatment for obstructive sleep apnea, those with any active psychiatric disorder, and those having exacerbation of respiratory disease or acute myocardial infarction within last 4 weeks were excluded.

Methodology: Patients included in the study were subjected to detailed history and thorough clinical examination. The clinical evaluation included demographics, symptoms of snoring, witnessed apnea, and excessive daytime sleepiness. Patient's vital parameters and anthropometric measurements including body mass index (BMI), waist circumference, neck circumference (measured at the level of the cricothyroid membrane), thyromental distance and mallampati score were also measured and recorded. Patient parameters which were analysed for correlation with OSA included: age, gender, anthropometric measurements including BMI, neck circumference, waist circumference, thyromental distance and mallampati score.

Polysomnography: The diagnostic level-1 PSG was performed overnight using computerized polysomnographic system; ALICE 6 LDx base station (Philips healthcare) with LDxN headbox with total 68 channels. It included the monitoring of electroencephalogram (EEG), submental and anterior tibial electromyogram (EMG), oxygen saturation, electrocardiogram (ECG), inductance plethysmography of chest wall and abdomen, nasal pressure sensor, and oronasal thermister. The polysomnographic recording was scored manually by the sleep specialist who was blinded to the results of the questionnaires and other clinical information concerning the patients. The sleep stage scoring and event scoring was done in accordance with the American Academy of Sleep Medicine (AASM) Manual-3 for the Scoring of Sleep and Associated Events. Total obstructive Apnea/hypopnea index (AHI) was calculated as the number of obstructive apneas and hypopneas per hour of total sleep time (TST). The threshold for diagnosis of OSA was set at an AHI 5 and the severity of OSA is arbitrarily defined by cut-off levels of AHI; 5-<15 episodes per hour of TST for mild, 15– <30 episodes per hour of TST for moderate, and 30 or >30 episodes per hour of TST for severe OSA. [26]

Statistical Analysis: Data was entered in a Microsoft Excel spreadsheet. Continuous variables were summarized as mean and standard deviation. Chi square test was used to analyse the relationship between two categorical variables. Sensitivity, specificity, Positive predictive value, Negative predictive value was calculated and compared. Two-sided p-values were reported and $p<0.05$ was considered statistically significant. Analysis was done using Stata version 18. Confidence intervals at the 95% level were calculated for sensitivity, specificity, and area under the ROC curve.

Results

Demographic and anthropometric parameters: Total 500 patients were included in our study. Among them 453 had acceptable sleep study data and were thus included for final analysis of this study. The mean age of study population was 49 years (±11.2), with a range of 16-80 years. Majority of the patients were females 64.6% (n=293) while males constituted 35.3% of patients(n=160). The mean weight and height of patients was 80.9kgs (±12.5) and 157cms (±9.2) with a range from 35-105kgs and 124-180cms respectively. Mean BMI was 32.6 kg/m2 (±5) with a range from 14.5- 49.3kg/m2. Mean waist circumference (inches), neck circumference (cm) and thyromental distance (cm) was 39.9(± 3.6), 38.2 (±2.8), and 6.1 (±1) respectively. Mean mallampati score (MPS) was 3.1 (±1) with the most observed score of 3, found in 53.5% patients (n=244). Majority of the patients were obese comprising of 70.8 % (n=321), 22% (n=100) patients were overweight, while 6.4% (n=29) patients had a normal BMI. Hypertension was the most prevalent comorbidity comprising of 50.9% (n=231) patients, followed by hypothyroidism (19.8%, n=90).

Patients were categorized as 'HIGH OR LOW RISK' using various standard sleep questionnaires. As per STOP-BANG, P-SAP, DES-OSA, and Berlin questionnaires, 8.6% (39/453), 20.5% (93/453), 21.8% (99/453), and 23.6% (107/453) patients were classified as low risk for OSA, while 91.3% (414/453), 79.5% (360/453), 78.2% (354/453), and 76.4% (346/453) patients were classified as high risk, respectively.

Using the Epworth Sleepiness Scale, 23.8% (108/453) patients were categorized as low risk and 76.2% (345/453) as high risk for excessive daytime sleepiness.

Table 1: Distribution of Patients as per AHI

	Number	Percentage
No OSA	17	3.75
Mild OSA	95	20.97
Moderate OSA	140	30.91
Severe OSA	201	44.37
Total	**453**	**100.00**

(No OSA means AHI <5, Mild OSA means AHI 5-<15, Moderate OSA means AHI 15-<30 and Severe OSA means AHI >30)

Table 1 shows the distribution of patients as per AHI. Mean AHI was 31.6 (±21.8) ranging from 1 to 113. Using an AHI cut-off point of 5 events/hour, 3.7% (n=17) were found to have 'NO OSA' (AHI< 5) and 96.2%(n=436)) had OSA (AHI>5), among them 20.9% (n=95) patients had mild OSA (AHI 5-14), 30.9%(n=140) patients had moderate OSA (AHI15-29) and44.3%(n=201) patients had severe OSA(AHI> 30).

Table 2: Comparison of Screening Questionnaires Results (High/Low Risk) with Final OSA Diagnosis

Questionnaire	Risk Category	OSA (n, %)	No OSA (n, %)	Total
STOP BANG	High Risk	409 (98.8%)	5 (1.2%)	414
	Low Risk	27 (69%)	12 (31%)	39
PSAP	High Risk	354 (98.3%)	6 (1.7%)	360
	Low Risk	82 (88%)	11 (12%)	93
DES-OSA	High Risk	345 (97.4%)	9 (2.6%)	354
	Low Risk	91 (91.9%)	8 (8.1%)	88
Berlin Questionnaire	High Risk	339 (98%)	7 (2%)	346
	Low Risk	97 (90.6%)	10 (9.4%)	107
Epworth Sleepiness Scale	High Risk	341 (98.9%)	4 (1.1%)	345
	Low Risk	95 (88%)	13 (12%)	108
Questionnaire	**Risk Category**	**OSA (n, %)**	**No OSA (n, %)**	**Total**

STOP-BANG demonstrated the highest sensitivity 93.8% (95% CI: 90.9–96.1), followed by P-SAP 81.2% (95% CI: 76.9–85.0), DES-OSA 79.1% (95% CI: 74.6–83.1), Epworth Sleepiness Scale 78.2% (95% CI: 73.6–82.4), and Berlin questionnaire 77.8% (95% CI: 73.1–82.0).

The Epworth Sleepiness Scale showed the highest specificity 76.5% (95% CI: 65.5–85.3), followed by STOP-BANG 70.6% (95% CI: 58.6–80.7), P-SAP 64.7% (95% CI: 52.4–75.5), Berlin 58.8% (95% CI: 46.6–70.1), and DES-OSA 47.1% (95% CI: 35.0–59.5).

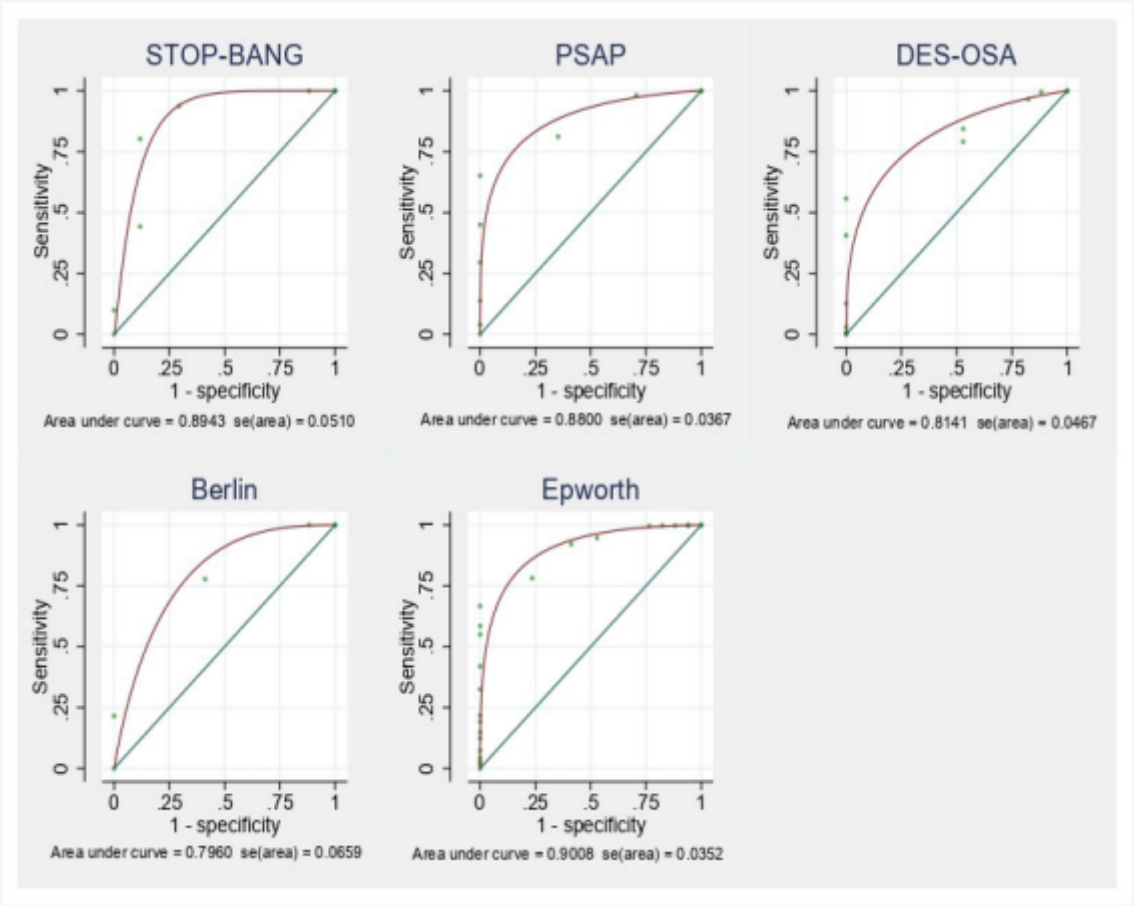

Figure 1:

Figure 1 compares the ROC curve of STOP BANG, PSAP, DES-OSA, BERLIN and ESS questionnaire for identifying OSA. Receiver operating characteristic curve analysis demonstrated that the Epworth Sleepiness Scale had the highest diagnostic accuracy with an AUC of 0.90 (95% CI: 0.86–0.94), followed by STOP-BANG 0.89 (95% CI: 0.85–0.93), P-SAP 0.88 (95% CI: 0.84–0.92), DES-OSA 0.81 (95% CI: 0.76–0.86), and Berlin questionnaire 0.79 (95% CI: 0.74–0.84).

Table 3: Correlation of Various Parameters with OSA and its Severity

Parameter	No OSA	Mild OSA	Moderate OSA	Severe OSA	p-value
Age (mean)	39.9 (±12.2)	48.9 (±12.1)	48.2 (±10.5)	50.5 (±10.8)	0.0015
BMI (mean)	21.3 (±2.9)	28.6 (±3.7)	31.5 (±3.1)	36.2 (±3.3)	0.000
Hypertension	2 (0.87%)	4 (17%)	85 (36.8%)	103 (44.5%)	0.000
Snoring	7 (1.6%)	86 (19.8%)	140 (32.2%)	201 (46.3%)	0.000
Waist circumference (mean)	32.4 (±1.8)	38.1 (±3)	39.9 (±2.7)	41.3 (±3.3)	0.004
Thyromental distance (mean)	7.3 (±0.78)	6.7 (±0.733)	6.3 (±0.94)	5.6 (±1.0)	0.000
Mallampati score (mean)	2 (±0.5)	2.8 (±0.66)	3.1 (±0.65)	3.3 (0.59)	0.001

Table 3 shows various parameters which were found to have significant corelation in predicting OSA and its severity.

Discussion

This study aimed to compare the four established sleep questionnaires in predicting OSA and their correlation with the gold standard

polysomnography. The questionnaires tested in this study were the STOP BANG, PSAP, DES-OSA and Berlin questionnaires, as well as the Epworth sleepiness scale (ESS) used for predicting sleepiness was tested. In our study we observed that the prevalence of mild OSA was 20.9%, moderate OSA was 30.9% and severe OSA was 44.3%. Abhishek Goyal et al. BLESS STUDY (2023) [27] found that OSA was highly prevalent in Indian population with mild OSA (AHI >=5) and moderate-severe OSA (AHI≥15) reported in 75% and 30.6% individuals respectively. Global studies have also confirmed high prevalence of OSA worldwide. A Swiss study Hypnolaus (2015) [28] and German study SHIP Trend (2018) [29] found 75% and 46% prevalence of OSA in their population's respectively. We observed that among all the screening questionnaires, STOP BANG had the highest sensitivity of 93.8 %, followed by PSAP with 81.2%, DES-OSA with 79.1%, Epworth sleepiness scale with 78.2% and Berlin with 77.8% sensitivity. When comparing the STOP BANG with other 4 questionnaires in terms of sensitivity we found statistically significant difference (p-value <0.05). Epworth sleepiness scale had the highest specificity of 76.5 %, followed by STOP BANG with 70.6%, PSAP with 64.7%, Berlin with 58.8% and DES-OSA with 47.1% specificity. This difference was not statistically significant (p-value >0.05). While comparing the receiver operating characteristic curves (ROC) for all 5 screening questionnaires, we found that area under the curve (AUC) (95% CI) was highest for ESS (0.9), followed by STOP BANG (0.89), PSAP (0.88), DES OSA (O.81) and BERLIN (0.79). El Syed et al. (2012) [30] compared four sleep questionnaires (Berlin, Epworth Sleepiness Scale [ESS], STOP, and STOP-Bang) with level 1 polysomnography in a cross-sectional study including 234 patients. The STOP-Bang, Berlin and STOP questionnaires had the highest sensitivity to predict OSA (97.55%, 95.07% and 91.67%, respectively), but with a very low specificity for OSA patients (26.32%, 25% and 25%, respectively), while the ESS had the highest specificity (75%) to predict OSA, but with the lowest sensitivity (72.55%, 75.71% and 79.73%, respectively). SK Shrestha et al. (2021) [31] compared level 1 polysomnography with individual scores from Epworth Sleepiness Score, STOP BANG score, Pittsburg Sleep Quality Index and Functional Outcome of Sleep Quality-10 and the composite sleep score derived from all the four in 120 patients with clinical suspicion of OSA. They concluded that STOP BANG score and AHI showed good correlation. STOP BANG score had the highest sensitivity for all levels of AHI. ESS showed good PPV and NPV to predict OSA [31]. Solecka S et al.(2022) [32] compared the reliability of five sleep questionnaires, the Epworth Sleepiness Scale (ESS), the STOP-Bang questionnaire, the STOP questionnaire, the Berlin questionnaire (BQ) and the Pittsburgh Sleep Quality Index (PSQI) in detecting the occurrence of obstructive sleep apnea (OSA) in a group of 201 patients, STOP-Bang, Berlin and STOP questionnaires had the highest sensitivity for OSA detection (81.6%, 78.7%, and 74.2%, respectively), The ESS, STOP-Bang, STOP and Berlin questionnaires had the highest specificity (82.6%, 75%, 61.9%, and 61.9%). They found STOP-Bang and Berlin questionnaires to be the most suitable for OSA screening with the highest sensitivities (81.6%, 78.7%) and satisfactory specificities (75%, 61.9%).

Summary and Conclusion

Our study showed a prevalence of 20.9% for mild OSA, 30.9% for moderate OSA and 44.3% for severe OSA. Our study showed good correlation between STOP BANG score and AHI. STOP BANG score when compared to rest of the questionnaires had the highest sensitivity, PPV and NPV, while ESS had the highest specificity to predict OSA. We conclude that STOP-Bang questionnaire could be regarded as the most accurate questionnaires for OSA screening, although the increased sensitivity of questionnaires in this study was at the expense of the specificity of these questionnaires. Thus, these questionnaires were able to identify high-risk patients for OSA but without accurately excluding those at low risk. Finally, the various parameters which we observed to have statistically significant correlation in predicting OSA and its severity include: Increased age, High BMI, Presence of hypertension, Increased waist circumference, Low thyromental distance and High mallampati score. All these factors have been shown to have significant correlation in predicting OSA in many previous studies too and thus we advocate their use as part of OSA screening in suspected patients.

Study Limitations: The increased sensitivity of various sleep questionnaires, observed in our study could be related to the fact that our study patients included only those who had a high clinical suspicion of OSA and were either referred to us from various departments of GMC and its associated hospitals or patients were found to have high risk of OSA during routine visits to our OPD.

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