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Original Research

A Comparative Study Of Stop Bang Questionnaire With Oxygen Desaturation Index In Screening Of Obstructive Sleep Apnea In Central Karnataka

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ABSTRACT

Background: Obstructive sleep apnea syndrome (OSAS) is frequent partial (hypopnea) or complete (apnea)upper airway collapse during sleep leads to oxygen desaturation, increased respiratory effort, arousal and sleep fragmentation. OSAS is considered independent risk factor for hypertension and has association with heart failure, arrhythmias , coronary disease , metabolic syndrome and type 2 diabetes. Although due increasing prevalence of OSAS, overnight technician attended polysomnography performed in sleep laboratory remains gold standard fordiagnosis, its high cost , long waiting list and limited accessibility have made it impractical in OSA screening. This study evaluated the value of Stop BANG Questionnaire (SBQ) to screen for OSA and compared it with the oxygen desaturation index (ODI) and their combination.

Objectives:

1. Evaluating the effectiveness of diagnostic value of individual and the combined SBQ and ODI with AHI in diagnosing OSA.
2. Assessing the individual and combined validity of the ODI and SBQ alongside the AHI in diagnosing OSA.

Methodology: One year cross sectional study conducted among 80 patients who are clinically risk for OSA based on screening SBQ in comparison to the objective assessment who underwent standard overnight attended polysomnography (PSG level -1. PHILIPS RESPIRONICS SLEEPWARE G3) in Central Karnataka.

Results: Of 80 screened patients 53 % had OSA. All the patients reported at least one suspected OSA Symptom, the most common were snoring (72%) and tiredness (57%).SBQ showed increased sensitivity than specificity to screen OSA.As severity of OSA increased , the sensitivity increased and specificity decreased for both measurements. ODI achieved an increased specificity and could correctly diagnose OSA which was better than SBQ. For all severities of OSA, ODI alone displayed a larger AUC than SBQ and similar AUC to their combination.

Conclusion: This study focused on improving the diagnostic capability of the SBQ for screening and Assessing the severity of OSA by combining it with ODI. The results showed that ODI alone had superior sensitivity and specificity compared to SBQ, and the addition of SBQ did not enhance the diagnostic value. Consequently, a simple and affordable portable pulse oximeter for overnight monitoring may be a preferable initial screening tool for OSA, offering a more Cost-effective alternative to the more expensive PSG.

Keywords: Obstructive sleep apnea (OSA), Stop bang questionnaire (SBQ), Oxygen Desaturation index (ODI), Polysomnography (PSG)

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INTRODUCTION

Obstructive sleep apnea (OSA) is a sleep-related breathing disorder (SBD) characterized by intermittent obstruction and cessation of airflow in the upper airway (apnea).It can be characterized by the narrowing of the airway which results in the reduction of airflow (hypopnea).The syndrome is associated with impaired quality of life , cognitive functioning and work performance and with increased risk of road traffic accidents[1].OSAS is considered an independent risk factor for hypertension and has associations with coronary disease ,stroke, heart failure , arrhythmias , metabolic syndromes and type 2 diabetes.

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Despite of substantial burden of this disease, it is under-recognised. According to the Wisconsin cohort study [2], approximately 75% of people with SBD remain undiagnosed which suggests that OSA -being one of the main types of SBD - is currently highly undiagnosed in the general population. Although due increasing prevalence of OSAS, overnight technician attended polysomnography performed in sleep laboratory remains gold standard for diagnosis its high cost , long waiting list and limited accessibility have made it impractical in OSA screening.

Several questionnaires have been designed to screen for sleep disordered breathing (SDB) in different populations such as Berlin questionnaire, STOP BANG (snoring , tiredness, observed apnea, blood pressure, body mass index, age, neck circumference , gender) SBQ questionnaires, NoSAS (neck , obesity , snoring, age ,sex).A systematic review by Abrishami et al. [3]showed that the SBQ was one of the best predictors of moderate to severe OSA by displaying the highest sensitivity and methodological validity compared to other questionnaires[3].The SBQ is a concise evaluation tool that enables healthcare professionals to determine the severity of OSA.SBQ has high sensitivity but primary drawback is its low specificity , particularly for detecting mild OSA.

PSG measures the frequency of apnea and hypopneas over the whole night to yield the apnea– hypopnea index (AHI) and oxygen desaturation index (ODI). The AHI measures the occurrence of apneas and hypopneas due to airflow obstruction. ODI defined as the average number of desaturation episodes per hour of recording, with oxygen desaturation defined as a decrease in blood oxygen saturation (SPO2) by more than 3 % below baseline. When breathing is obstructed during sleep , blood oxygen levels drop. Therefore, it can identify apnea and hypopneas well [4].

OBJECTIVES:

1.Evaluating the effectiveness of diagnostic value of individual and the combined SBQ and ODI with AHI in diagnosing OSA.

2.Assessing the individual and combined validity of the ODI and SBQ alongside the AHI in diagnosing OSA.

METHODOLOGY:

Patient with clinical suspicion of OSA were enrolled for the study following an informed consent. Its is a hospital based cross sectional study aimed at predicting high risk of OSA based on STOP BANG screening questionnaires in comparison to the objective assessment using standard overnight attended polysomnography (PSG) in Institution in Central Karnataka.

The sample size estimated based on prevalence of OSA among Indians considering 13.7% with allowable error 10% minimum sample needed to conduct this study is 46 cases. 80 patients were selected.

INCLUSION CRITERIA:

• Patient age > 18 years or older.
• Patients who completed STOP BANG screening questionnaires.
• Patients with symptoms of snoring, overweight, obese, excessive daytime sleepiness, insomnia, breathing difficulty during sleep, other sleep disturbances.
• Patients who undergoing Polysomnography (PSG).

EXCLUSION CRITERIA:

• Cases who do not give consent for study.
• Patients is age group < 18 years.
• Critically ill and ICU admitted patients.

Detailed data collection Methodology

Subject's sociodemographic details and history of patients recorded.General physical examination like Anthropometric measurements like Weight, height and BMI (weight in kg, height in cm, BMI in kg/m2),Neck circumference (in cms)measured using standard instruments.Screening questionnaires like STOP- BANG assess high risk (score >3) and low risk (score < 3) for OSA.Polysomnography (PSG level-1, PHILIPS RESPIRONICS SLEEPWARE G3) study will be conducted over night, the following parameters were monitored – frontal, central and occipital EEG, electrooculogram (EOG), submentalis EMG, nasal and oral airflow, anterior tibialis EMG, body position and ECG.

Additionally, thoracic, and abdominal movements were recorded by inductance plethysmography, oxygen saturation (SPO2 is monitored using pulse oximetry) and severity will be graded based on Apnoea-hypopnea index [AHI]< 5), mild OSA (15> AHI≥ 5), moderate OSA (30> AHI≥ 15), and severe OSA (AHI≥ 30). ODI with ≥5 high risk and less than 5 low risk.

Statistical analysis

The data collected was entered into an excel sheet and was analysed using SPSS version 25.0. Categorical variables were expressed as frequencies(percentages) and quantitative variables as mean±SD. Spearman's correlation coefficient was calculated to assess the strength of relationship between AHI with SBQ, ODI and their combination and also between different levels of AHI severity with SBQ, ODI and their combination. Positive predictive value (PPV), and negative predictive value(NPV) were calculated to validate sensitivity and specificity of the cut-off values SBQ≥3, ODI≥5 and their combination. Logistic regression was applied to test the model which combines ODI with SBQ. This was done to check if the combination increases the sensitivity and specificity of each measure. ROC curves wereplotted to assess the diagnostic value of ODI alone, SBQ

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alone, the combination of two for different severities of AHI. The AUC ranged from 0.5 to 1 and was confirmed with Youden statistics.

RESULTS :

PATIENT CHARACTERISTICS:

The sample consisted of 80 patients who visited the outpatient department with symptoms of OSA. The dimorphic and mean SBQ responses from patient shown in Table1.The mean age group 51.31 +/- 9.46, with 70% male and female 30%.All patients reported at least one suspected OSA symptom, the most common symptoms were snoring (67.5%), tiredness (53.75%) and hypertension(50%) with BMI >35kg/m2 – 37.5%. From this sample size 91.2% were diagnosed with OSA, with mean AHI of 25.58±14 events/h and an ODI of 36.94±22.41.

TABLE 1: **Demographic data and STOP-Bang questionnaire characteristics**

Variable	N
Age	51.31±9.46*
● 21-30	1(1.25)
● 31-40	11(13.75)
● 41-50	22(27.5)
● 51-60	33(41.25)
● 61-70	13(16.52)
Sex	
● Male	56(70)
● Female	24(30)
AHI, event/h	25.58±14.1*
ODI/h	36.94±22.41*
STOP Bang questionnaire	
S-Snoring	54(67.5)
T-Tiredness	43(53.75)
O-Observed apnea	36(45)
P-Hypertension	40(50)
B-BMI ≥35 kg/m^2	30(37.5)
A-Age ≥ 50 years	46(57.5)
N-Neck circumference ≥ 40cm	29(36.25)
G-Gender- Male	56(70)
Total STOP BANG score	4.18±0.78*

Correlation analysis between ODI, SBQ and AHI

A significant positive correlations exists between the AHI, ODI and SBQ in patients with OSA. The ODI highly correlated with the AHI ($p< 0.05$ and $r = 0.994$) while SBQ ($p< 0.05$ and $r = -0.766$) showed no significant correlation with AHI. The analysis found that AHI had significant positive correlation with the ODI for moderate and severe OSA patients when compared with SBQ had no significant correlation.

TABLE. 2: Correlations between oxygen desaturation index and STOPBANG questionnaire for apnea–hypopnea index ≥ 5, ≥ 15, or ≥ 30

Groups	Values	SBQ	AHI
AHI≥5	AHI	0.178	
	ODI	0.391**	0.247
AHI≥15	AHI	-0.001	
	ODI	0.424**	0.447**
AHI≥30	AHI	0.037	
	ODI	0.472**	0.775

**p<0.01-highly statistically significant

EVALUATING THE VALUES OF SBQ≥3, ODI≥5 AND THEIR COMBINATIONS

The diagnostic accuracy of ODI ≥5 , SBQ≥ 3 , their combinations , and a logistic regression model presented in Table3. Overall ,SBQ ≥ 3precisely screened 91.2% of OSA patients [AHI ≥ 5/h].The sensitivity of SBQ increased as severity of OSA increased [mild- 97.3%, moderate -98.3%, severe =100%] and also NPV increased [60%,80%,100%]. But in contrast, specificity of SBQ decreased as theseverity of OSA increased [mild -50%, moderate-18.2%, severe -9.6%]and similarly , the PPV decreased [96%,76%,37.3%]. This indicates SBQ may be susceptible to accepting false positives as the severity of AHI increases.

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The accuracy of ODI was 100% for increasing severity of OSA , but the specificity of the ODI is 0% and the NPV is not applicable meaning the proportion of individuals with negative test result who are truly disease free cannot be calculated. The PPV decreased with the severity of the disease [mild-92.5%, moderate-72.5% , severe- 35%].

The combination of SBQ with ODI and a logistic regression model [SBQ +ODI] showed similar specificity in all severity levels of OSA as SBQ[mild-50%, moderate -18.2% , severe- 9.6%] and there was decrease in PPV as severity of OSA increased [mild-96%, moderate-76% , severe- 37.3%], but however the values remained higher than ODI alone.

The consequences of this combination showed that sensitivity was slightly lower when ODI and SBQ measures were evaluated separately.

Table 3: Diagnostic accuracy of SBQ ≥ 3 and ODI ≥ 5, the combination, and a logistic regression model to detect OSA

	Sensitivity	Specificity	PPV	NPV
AHI/REI≥5/h				
● SBQ≥3	97.3%	50%	96%	60%
● ODI≥5	100%	0%	92.5%	NA
● Combination of SBQ≥3 with ODI≥5	97.3%	50%	96%	60%
● Logistic regression model(SBQ+ODI)	96%	60%	97.3%	50%
AHI/REI≥15/h				
● SBQ≥3	98.3%	18.2%	76%	80%
● ODI≥5	100%	0%	72.5%	NA
● Combination of SBQ≥3 with ODI≥5	98.3%	18.2%	76%	80%
● Logistic regression model(SBQ+ODI)	76%	80%	98.28%	18.18%
AHI/REI≥30/h				
● SBQ≥3	100%	9.6%	37.3%	100%
● ODI≥5	100%	0%	35%	NA
● Combination of SBQ≥3 with ODI≥5	100%	9.6%	37.3%	100%
● Logistic regression model(SBQ+ODI)	100%	9.6%	37.3%	100%

The ROC of the SBQ≥ 3 AND ODI ≥ 5

The AHI cut- off either 5, 15 or 30 , the average AUC for ODI 0.928,0.5,0.548 and for the combination of SBQ and ODI 0.736, 0.582,0.548. According to the z-test , all of which were significantly larger ($p<0.05$)than SBQ ≥ 3(0.677,0.582,0.548). However ,when the SBQ was combined with ODI , it did not significantly contribute to the value of ODI.Overall , ODI≥5 had higher sensitivity , specificity and a larger AUC than SBQ ≥ 3 for screening all OSA. Furthermore, ODI showed higher sensitivity , specificity .

THE OPTIMAL CUT OFF OF THE SBQ AND ODI

The optimal cut off score for SBQ was 3.5 for all the severities of OSA and for ODI optimal cut off 13, 18,28 indicating maximal AUC of 0.928, 0.5 and 0.5 for mild, moderate and severe respectively. Both individual ODI and combination of ODI with SBQ analyses showed statistically significant diagnostic values for OSA across all severity levels. For identification of mild OSA , SBQ AUC = 0.677 [0.152-0.504], ODI AUC= 0.928 [0.001- 0.866] and both combined AUC = 0.736 [0.055-0.477] with a Youden index of 0.381,0.787 and 0.487 respectively. For identification of moderate OSA , SBQ AUC = 0.582 [0.433-0.731], ODI AUC= 0.5 [0.357-0.643] and both combined AUC = 0.582 [0.433-0.731] with a Youden index of 0.403,0.768 and 0.749 respectively. For identification of severe OSA , SBQ AUC = 0.548 [0.419-0.677], ODI AUC= 0.5 [0.367-0.633] and both combined AUC = 0.548[0.419-0.677] with a Youden index of 0.381,0.913 and 0.929.ODI at optimal cut off value could display an almost perfect diagnostic ability for all severities of OSA.

Table 4: ROC analyses of oxygen desaturation index and STOP BANG questionnaire for AHI ≥5, ≥15, ≥30

AHI	Variable	AUC	SE	95% CI		Cut-off	Sensitivity	Specificity	Youden index
				Low area	Upper area				
≥5	SBQ	0.677	0.088	0.152	0.504	3.5	0.548	0.833	0.381
	ODI	0.928	0.031	0.001	0.866	13.3	0.865	0.922	0.787
	SBQ with ODI	0.736	0.132	0.055	0.477	0.716	0.612	0.875	0.487
≥15	SBQ	0.582	0.076	0.433	0.731	3.5	0.623	0.780	0.403
	ODI	0.5	0.073	0.357	0.643	18.25	0.916	0.852	0.768

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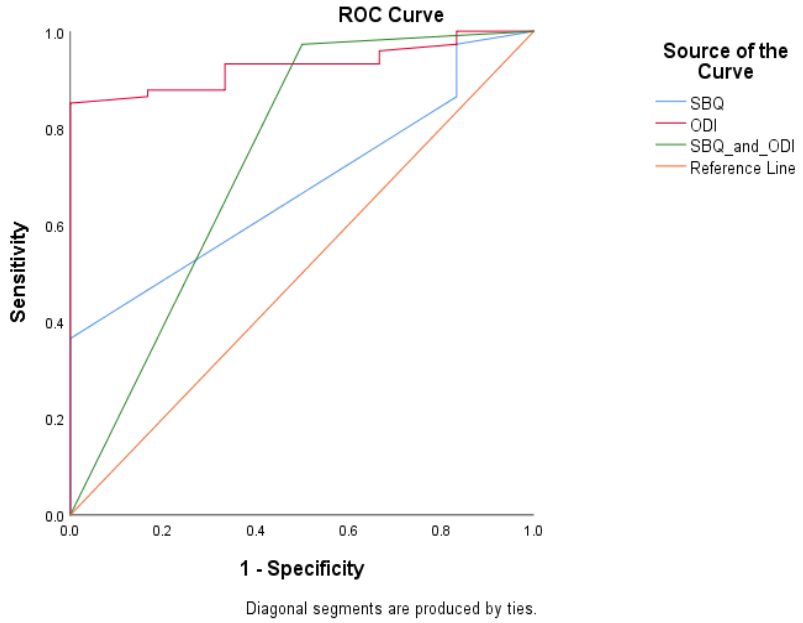
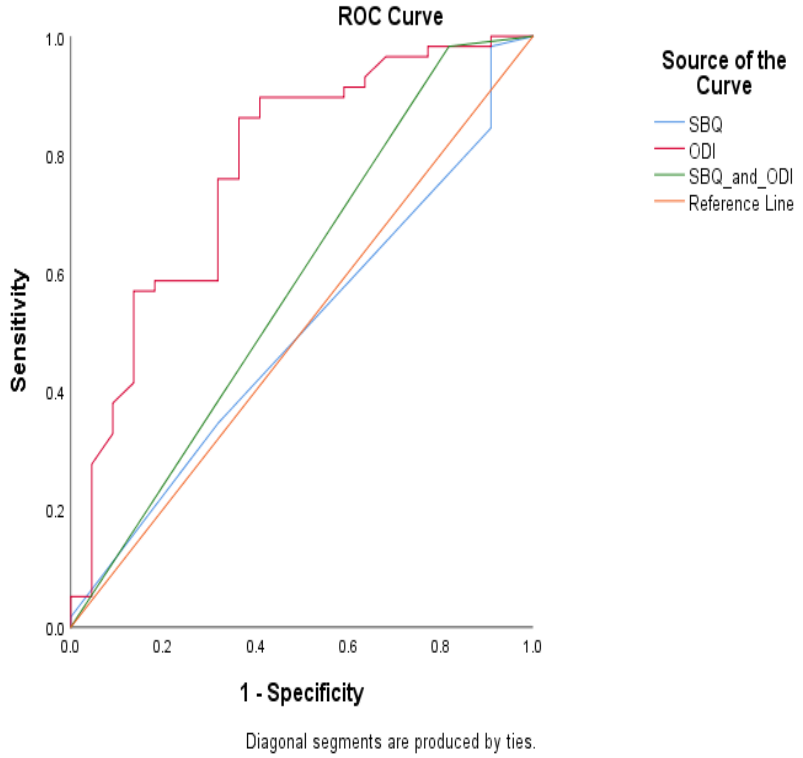
	SBQ with ODI	0.582	0.076	0.433	0.731	0.24	0.983	0.766	0.749
≥30	SBQ ODI SBQ with ODI	0.548 0.5 0.548	0.066 0.068 0.066	0.419 0.367 0.419	0.677 0.633 0.677	3.5 28.5 0.09	0.713 1.00 1.00	0.668 0.913 0.929	0.381 0.913 0.929



AHI ≥5 – FIG 1



AHI ≥15 – FIG 2

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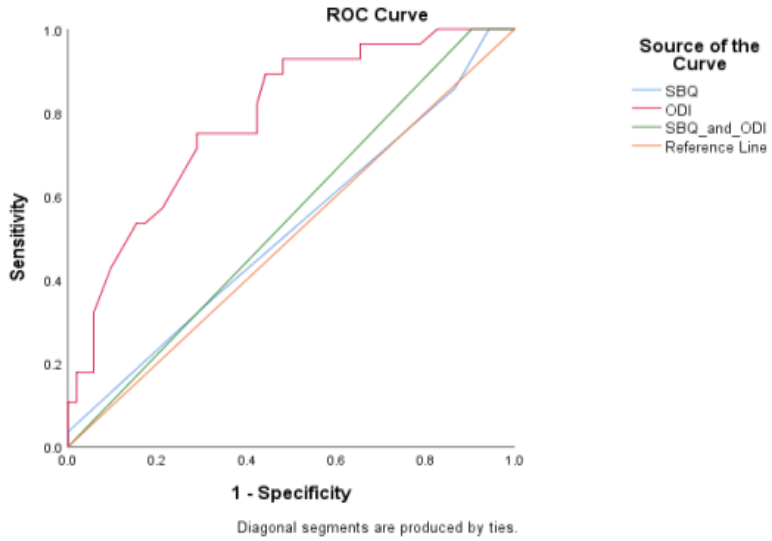

AHI ≥30 – FIG 3

DISCUSSION

This study showed that ROC curves offer amore comprehensive and visual representation of a diagnostic test's accuracy, providing a more detailed understanding of its performance than manual calculations of sensitivity and specificity. The study found that ODI can serve as a reliable initial assessment for OSA, bridging the gap until a definitive diagnosis is made through PSG. However combining SBQ with ODI did not enhance the diagnostic accuracy of OSA and slightly increased the rate of accepting false negatives.

Correlation analysis showed that as AHI severity increases , both ODI and SBQ scores decreases , indicating a positive relationship between AHI and these diagnostic measures.

The analysis relieved a strong positive correlation between ODI scores and severity of OSA ,particularly in cases of moderate to severe OSA , whereas SBQ did not demonstrate a significant relationship. In addition of SBQ to ODI failed to improve diagnostic performance and had no significant relationships. However ODI alone was excellent diagnostic tool for diagnosing moderate to severe OSA than SBQ and combination of SBQ and ODI.

Our findings revealed that both the SBQ and ODI, when used individually, demonstrated high sensitivity in identifying the different severities of OSA according to the AHI. However, the SBQ showed consistently low specificity at each severity level. Regarding PPV and NPV, there is a greater tendency to accept false positives over false negatives. This implies that relying solely on the SBQ alongside the AHI could result in a higher chance of misclassifying the severity of OSA, especially in moderate and severe cases, due to the SBQ's lower specificity.Nagappa et al. [5],conducted a meta analysis to measure the validity of the SBQ as a screening tool for severe OSA and found high validity. They also reported that when the severity of AHI increased, the sensitivity of the SBQ increased whilst the specificity decreased, which is in line with the results shown in this current study.

Compared with previous studies Wang Y et al[6]-study attempted to improve the diagnostic ability of the SBQ in screening and predicting the degree of OSA by combining it with ODI.

According to the findings, ODI alone had a higher sensitivity and specificity than SBQ, andthe combination with SBQ failed to provide additional diagnostic value. Alternatively,our study showed using the ODI alone or in conjunction with both diagnostic tools, compared to the AHI, resulted in higher specificity across all severity levels, though it led to a slight reduction in sensitivity for each severity. This suggests that the ODI, either on its own or combined with other methods, could be valuable for improving the accuracy of OSA

diagnosis by boosting specificity. Dette et al. [7]combined SBQ scores with Mallampati scores,

which failed to improve the specificity in predicting SBD.Senaratna et al. [8] found that when combining the SBQ with the Epworth Sleepiness Scale ≥ 8,the specificity was high (94–96%) and the sensitivity was low (36–51%). In 2012, Chung et al.[9] demonstratedthat the serum HCO3-levels only increased the specificity of the SBQ in predicting moderate/severe OSA.

This study shows a strong correlation between ODI and AHI to screen all severities of OSA, therefore, overnight oximetry appears to be a cost-effective, easily accessible, and simple method for screening OSA. Mashaqi et al. [10] found that the use of nocturnal oximetry Measures (ODIPOx) improved the accuracy of SBQ insevere OSA in both inpatient and Outpatient settings. Previous studies have also emphasized the accuracy of ODI as a tool to detect SBD and suggested it should be an essential assessment criterion for diagnosis[4,11,12].Chung et al. [13] found that ODI from a high-resolution nocturnal

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oximeter was a sensitive and specific tool to detect undiagnosed SBD in surgical patients. Another study examined the predictive ability of OSA screening questionnaires versus oximetry for CPAP therapy initiation and identified that oximetry performed better than questionnaires (Berlin questionnaire, Epworth Sleepiness Scale, and SBQ) in predictive ability. However, their combination did not improve their predictive value 14.The main issue with the SBQ is that it lacks high specificity, especially for mild OSA [15].The current study showed that ODI optimal cut off 13, 18,28 indicating maximal AUC of 0.928, 0.5 and 0.5 for mild, moderate and severe respectively. The SBQ cut-off points were also modified to enhance the diagnostic accuracy of all evaluations.When both the ODI alone and the ODI-SBQ combination were optimized, they both showed exceptional capacity to differentiate between mild, moderate, and severe OSA in all patients.The combination of ODI and SBQ demonstrated the highest AUC and Youden index in patients with severe OSA. This indicates that, with optimized ODI cut-off scores, it can accurately assess OSA across all severity levels. Therefore, to maximize ODI's diagnostic performance in OSA, these optimized cut-off scores should be taken into consideration.

LIMITATIONS

1.A limitation of the study is small sample size.
2.The method was screening OSA was limited to SBQ and did not consider other screening tools.
3.The response to questionnaire was subjective to patient could lead to skew the accuracy and comparability of value.
4.The correlation and ROC analyses in this study showed inconsistent findings concerning the relationship between the AHI and the combined use of ODI and SBQ.

CONCULSION

This study focused on improving the diagnostic capability of the SBQ for screening and assessing the severity of OSA by combining it with ODI. The results showed that ODI alone had superior sensitivity and specificity compared to SBQ, and the addition of SBQ did not enhance the diagnostic value. Consequently, a simple and affordable portable pulse oximeter for overnight monitoring may be a preferable initial screening tool for OSA, offering a more cost-effective alternative to the more expensive PSG.

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