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Predictive Ability of STOPBANG Scale and Epworth Sleepiness Scale in Identifying Obstructive Sleep Apnoea

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Abstract: *The increased prevalence of obstructive sleep apnea (OSA) mandates the presence of simple but accurate tools to identify patients with this disorder for early detection and prevention of various serious consequences. This study aimed at comparing two sleep questionnaires as regards their predictive probabilities for OSA. Two sleep questionnaires (Epworth Sleepiness Scale [ESS] and STOP-Bang) were administered to the patients and scoring of the results of the questionnaires was done. Overnight attended polysomnography (PSG) was done for all patients and was considered the gold standard for the diagnosis of OSA. The sensitivity, specificity, positive and negative predictive values of the two questionnaires was calculated. Of 35 screened patients; 30(85%) had OSA. The STOP-Bang questionnaire had the highest sensitivity to predict OSA (96.66%) whereas ESS had a sensitivity of 73.33%. Specificity of STOP-BANG and ESS were 40% and 60% respectively. Positive predictive value of STOP-BANG and ESS questionnaires were 90.62% and 91.66% respectively. Negative predictive value of STOP-BANG and ESS were 66.66% and 27.27% respectively. The likelihood ratio for a positive result (LR+) of STOP-BANG and ESS were 1.61 and 1.83. The likelihood ratio for a negative test (LR-) of STOP-BANG and ESS were 0.08 and 0.44 respectively. We found no gender predilection in the prediction of OSA by STOP-BANG and ESS questionnaires.*
Conclusion: STOP-BANG is a better predictor of OSA than ESS questionnaire.
Keywords: *OSA, STOPBANG, ESS Questionnaires*

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I. Introduction

Obstructive sleep apnoea syndrome (OSAS) is common with prevalence of approximately 4% in middle-aged men and 2% in middle aged women.[1] Frequent partial (hypopnoea) or complete (apnoea) upper airway collapse during sleep leads to oxygen desaturation, increased respiratory effort, arousal and sleep fragmentation. Patients typically present with witnessed apnoeas, loud snoring and excessive daytime somnolence. The syndrome is associated with impaired quality of life, cognitive functioning and work performance and with increased risk of road traffic accidents[6] OSAS is considered an independent risk factor for hypertension and has associations with coronary disease, stroke, heart failure, arrhythmias, metabolic syndrome and type 2 diabetes.

Despite the substantial burden of this disease, it is under-recognized. One study estimated that 93% of women and 82% of men with moderate-to-severe OSAS were not clinically diagnosed[2] Sleep studies are required for OSAS diagnosis but are expensive and not widely available. Predictors of sleep disordered breathing (SDB) are required to allow recognition of OSAS and prioritization of investigations.

Several questionnaires have been designed to screen for SDB in different populations. The Berlin Questionnaire was first validated in primary care against portable unattended sleep studies and a 'high risk' score predicted a respiratory disturbance index >5 with sensitivity 0.86, specificity 0.77, positive predictive value (PPV) 0.89 and likelihood ratio 3.79.[3] The STOP and STOP-BANG Questionnaires were originally validated in surgical patients using in-hospital attended polysomnography.[4] For prediction of apnoea hypopnoea index (AHI) greater than 5, 15 and 30, sensitivities for the STOP and STOP-BANG Questionnaires were 65.6%, 74.3% and 79.5%, and 83.9%, 92.9% and 100%, respectively.

The Epworth Sleepiness Scale (ESS) was developed by Dr. Johns in 1990. By identifying persons with excessive daytime sleepiness, which may result from sleep disruptions, it may assist in identification of persons at high risk for OSA. The ESS is a tool used to assess the likelihood of falling asleep in different situations The scale depends on accurate patient recall and addresses sleep propensity or daytime sleepiness.

The Berlin and STOP Questionnaires have been compared in a cohort of surgical patients and the STOP and STOP-BANG Questionnaires have been compared in a large study involving several distinct cardiovascular and respiratory disease cohorts. No study has, however, compared these screening tools in a sleep service-referred population. Finally, because of rising obesity rates, there is the potential for increasing recognition of SDB in primary care, and in the face of this evolution in sleep clinic practice, it is therefore necessary to update and re-evaluate established assessment tools.

This study aimed at comparing two established sleep questionnaires - ESS and STOP-BANG questionnaires regarding their predictive abilities for identifying OSA.

II. Objectives

1. To assess the predictive ability of STOP-BANG and EPWORTH SLEEPINESS SCALE (ESS) in identifying obstructive sleep apnoea (OSA) and comparing their efficacy with polysomnography.
2. Also, to assess the significance of various patient characteristics, symptoms and individual components of STOP-BANG in identifying OSA.

III. Materials And Methods

Patients with clinical suspicion of OSA were enrolled for the study following an informed consent. They were subjected to ESS and STOP-BANG questionnaires. All patients were subjected to polysomnography.
Study design -- it is a hospital based observational study aimed at predicting high risk of OSA based on two screening questionnaires (ESS and STOP-BANG) in comparison to the objective assessment using standard overnight attended polysomnography (PSG) on all the recruited patients.
The study was conducted at GHCCD (government hospital for chest and communicable diseases), Visakhapatnam on 35 patients who are suspected to have OSA.
Inclusion criteria:
-- Snoring, overweight, obese, excessive daytime sleepiness, insomnia, breathing difficulties during sleep, other sleep disturbances
Exclusion criteria:
-- Pregnant women, paediatric people (age < 14), end stage organ failure patients
The following data were recorded in all patients:
• Clinical history and demographic data
• Blood pressure (recorded after at least 5 minutes of rest in both arms sitting/supine position)
• Weight, height and BMI (weight in kg, height in cm, BMI in kg/m2)
• Neck circumference (in inches)
• Waist circumference (measured in a horizontal plane midway between the inferior margin of the ribs and superior border of the iliac crest)
• All patients were screened using ESS and STOP-BANG questionnaires (appendix 1 and 2).
• Subjects underwent an overnight polysomnography (PSG) with seven channels including electro encephalogram (EEG), electro oculogram (EOG), chin electromyogram (EMG), ECG, nasal airflow measurement, respiratory effort measured by thoraco-abdominal belts, and pulse oximetry, at the sleep laboratory, Government Hospital for Chest and Communicable Diseases, Andhra Medical College. PSG recordings were manually scored according to standard criteria.[5]
The **Apnea-Hypopnea Index (AHI)** refers to the average number of apneas and hypopneas per hour of sleep. The term **Respiratory Disturbance Index (RDI)** refers to the average number of apneas, hypopneas, and respiratory effort-related arousals (RERAs) per hour of sleep.

The severity of sleep apnea is graded according to AHI. Less than 5 AHI is normal. AHI of 5 to 14.9, 15 to 29.9 and >30 were classified as mild, moderate and severe OSA.

Data analysis:

The quantitative variables were summarized in terms of descriptive statistics such as minimum, maximum, and mean ± standard deviation (SD). The categorical variables were analysed by chi-square test, fisher's exact t test whichever is appropriate. The continuous variables were analysed by area under receiver operator characteristics curve (AU ROC). Each questionnaire was compared on the following parameters: sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), the likelihood ratio for a positive result (LR+), and the likelihood ratio for a negative test result (LR-). An area under the curve (AUC) >0.7 was considered clinically significant. A p value <0.05 was considered statistically significant.

IV. Results

Of 35 patients included in the study, 28 (80%) were males and 7 (20%) were females. The mean age of the study population was 53.82 years (range 42-69 years). Most common symptom in the study population was snoring (74.28%) followed by excessive daytime sleepiness (45.71%), non-refreshing sleep (31.42%), witnessed apneas (28.57%) and gasping or choking sensation during sleep (14.28%). Polysomnography is done in all the study population to find OSA. Out of 35 patients, 30 had OSA whereas in remaining 5 patients OSA was not detected. The prevalence of OSA in the present study was 85.71%. All the symptoms of OSA were more common in patients with OSA when compared with patients without OSA. History of snoring or excessive daytime sleepiness was not present in all cases with OSA. Except for snoring, no other symptom was found to be statistically significant in this study (table 4).

Majority of patients with OSA belonged to BMI of 35.0 to 39.9 kg/m2. The mean BMI of the patients in the study population was 34.52 ± 3.05 Kg/m2 (range 29 - 39). There was an increase in incidence of OSA with increase in BMI. All the patients except for 3 individuals who had moderate to severe obesity had OSA.

The mean neck circumference was 40.47 ± 1.32 cm (range 38 - 42.30). 12 patients (34.28%) had NC<40cm, of which 8 had OSA and 4 had no OSA. 23 patients (65.71%) had NC>40cm, of which 22 had OSA. 19 out of 28 males had NC>40cm, of which all 19 had OSA. Similarly 4 out of 7 females had NC>40cm, of which 3 had OSA.

Among 35 individuals, 19 were hypertensive and 16 were normotensive. Among hypertensive's, 16 were males, 3 were females and all 19 members had OSA. Among 16 individuals who had no hypertension, 12 were males and 4 were females among which 10 males and 3 females had OSA.

All patients included in the study were subjected to both STOPBANG and ESS questionnaires before subjecting them to overnight polysomnography. Of 35 patients included in the study, 30 were diagnosed to have OSA while 5 individuals had NO OSA. Among 30 individuals with OSA, 24 were males and 6 were females. Patients with OSA are categorized into mild, moderate and severe OSA basing on the AHI. Accordingly, 2 patients have mild OSA (both are males), 15 patients have moderate OSA (12 males, 3 females) and 13 have severe OSA (10 males and 3 females).

Analyzing STOP-BANG scores:

Of 35, 4 patients had low risk for OSA (of which all are males), 16 patients had intermediate risk (12 males and 4 females) and 12 patients had high risk for having OSA (12 males and 3 females). Among individual components of STOP-BANG, snoring, neck circumference and hypertension are found to be statistically significant in identifying OSA (table 1).

Table 1: STOP BANG components among study group

Components	TOTAL	OSA	NO OSA	P VALUE
S	26 (21 , 5)	25 (20 , 5)	1 (1 , 0)	0.010
T	17 (12 , 5)	14 (10 , 4)	3 (2 , 1)	0.658
O	10 (7 , 3)	10 (7 , 3)	0	0.291
P	19 (16 , 3)	19 (16 , 3)	0	0.013
B	21 (15 , 6)	20 (15 , 5)	1 (0 , 1)	0.133
A	24 (20 , 4)	21 (17 , 4)	3 (3 , 0)	0.6399
N	23 (19 , 4)	22 (19 , 3)	1 (0 , 1)	0.0375
G	35 (28 , 7)	30 (24 , 6)	5 (4 , 1)	1.000

With in parenthesis: red=male, green=females

A score of ≥3 is taken as cut-off for analyzing the efficacy of STOP-BANG scale in identifying OSA.
Accordingly, 31 patients had a score of ≥3, of which 29 had OSA and among 4 patients who had a score of <3, 1 had OSA (table 2).
After analyzing the data, sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) were 96.66%, 40%, 90.62%, 66.66%, 1.61 and 0.08 respectively.

Table 2: validity of STOP-BANG scale

STOP-BANG score	OSA	NO OSA	Total
>3	29 (23, 6)	2 (1 , 1)	31
<3	1 (1 , 0)	3 (3 , 0)	4
Total	30	5	35

With in parenthesis: red=male, blue=female

Analyzing ESS scores:

Of 35 patients in the study, 24 patients had ESS score >11, of which 4 have mild risk, 9 have moderate risk and 11 have high risk of having OSA. And 11 patients had ESS score <11 i.e., categorized as no risk of having OSA according to ESS (table 3).

Among 4 patients with mild risk, 2 were confirmed to have moderate OSA while other 2 had no OSA. Among 9 patients with moderate risk, 1 had mild OSA, 6 patients have moderate OSA and 2 patients have severe OSA. Among 11 patients with high risk, 3 have moderate OSA and 8 have severe OSA. Among 11 patients classified as no risk, 1 had mild OSA, 4 have moderate OSA, 3 have severe OSA and 3 have no OSA.

After analyzing the data, sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) of ESS in identifying OSA were 73.33%, 60%, 91.66%, 27.27%, 1.83 and 0.44 respectively.

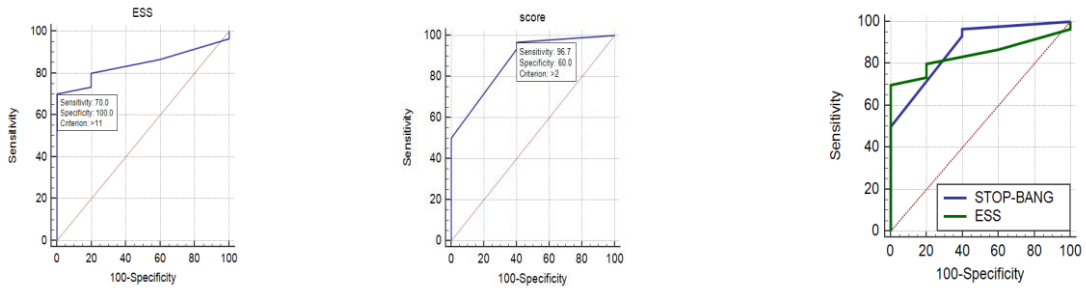
Table 3: validity of ESS scale

ESS score	OSA	NO OSA	Total
> **11**	22 (18 , 3)	2 (2 , 0)	24
< **11**	8 (6 , 3)	3 (2 , 1)	11
Total	30	5	35

With in parenthesis: red=male, blue=females

From these results it is clearly evident that STOP-BANG has more sensitivity than ESS while, the specificity is more for ESS.

ROC curves shows that the ability of STOP-BANG in identifying OSA is statistically significant and that of ESS in identifying OSA is also statistically significant. Comparing ROC curves of STOP-BANG and ESS in identifying OSA shows that the difference between the two scales in identifying OSA is not statistically significant. But, predictive ability of STOP-BANG in terms of sensitivity and NPV is more in comparison to ESS



(i) (ii) (iii)

Figure 1: ROC curves of (i) ESS Vs OSA, (ii) STOPBANG Vs OSA, (iii) ESS Vs STOPBANG

Table 4: comparison of patient characteristics, symptoms, anthropometry, questionnaires in different groups of OSA and their significance in identifying OSA

	All (30)	Mild OSA (2)	Moderate OSA (15)	Severe OSA (13)	P value
Age (yrs) (mean)	54.2	55.55	53.26	55.07	0.4272
Gender (M/F)	24/6	2/0	12/3	10/3	1.000
BMI (mean)	34.42	30.5	33.76	35.77	0.0472
NC (mean)	40.64	39.35	40.74	40.73	0.0027
AHI (mean)	31.03	9.5	23.26	43.30	0.0001
ESS					0.0001
ESS <11 (%)	26.67	50	26.67	23.07	
ESS >11 (%)	73.33	50	73.33	76.92	
ESS (mean)	14.7	12	13.26	16.76	
STOP-BANG					0.0001
Snoring (%)	83.33	0	86.67	92.30	0.0104
Tiredness (%)	46.67	50	33.33	61.53	0.658
Observed apneas (%)	33.33	0	13.33	61.53	0.291
Hypertension (%)	63.33	100	46.67	76.92	0.013
BMI ≥ 35 (%)	66.67	0	53.33	92.30	0.133
Age ≥ 50 (%)	66.67	50	66.67	76.92	0.6399
NC ≥ 40 (%)	70.00	50	73.33	69.23	0.0375
STOP-BANG score (mean)	5.1	3	4.53	6.07	

V. Discussion

This study aimed at comparing two established sleep questionnaires regarding their predictive probabilities for OSA. The questionnaires tested in this study were the STOP-Bang and ESS. These questionnaires were tested among the same population and the scores were evaluated against the PSG-based AHI serving as the ‘‘gold standard’’ diagnosis for OSA. The cut-offs of the questionnaires used in this study were those previously described. The STOP-Bang questionnaire was originally validated to screen for OSA in the surgical population. The STOP and STOP-Bang questionnaires were previously evaluated in some studies as preoperative screening instruments mostly among the surgical population in an attempt to stratify patients for unrecognized OSA to prevent any possible OSA-related intra or post operative complications.[6,7] Recently, two studies were concerned with the validation of the STOP-Bang questionnaire in patients referred to the sleep clinic.[8,9] The present study highlights the evaluation of STOP-BANG questionnaire among the non-surgical population. ESS measures self rated average sleep propensity (chance of dozing) over eight common situations that almost everyone encounters. The propensity to fall asleep is rated as 0, 1, 2, or 3 where 0 corresponds to never and 3 to a high chance of dozing. The maximum score is 24 and normal is assumed to be 10 or less. ESS scores of 16 or greater are associated with severe sleepiness. The ESS correlates roughly with the severity of OSA (apnea-hypopnea index [AHI])[10,11] and improves (lower score) after continuous positive airway pressure (CPAP) treatment.[12] A large study by Gottlieb and coworkers[11] found a modest correlation between the ESS and OSA severity in a large population-based study of 1824 subjects.

ESS

Of 35 patients in the study, 24 patients had ESS score > 11, of which 4 have mild risk, 9 have moderate risk and 11 have high risk of having OSA. While, 11 patients had ESS score < 11 i.e., categorized as no risk of having OSA according to ESS. In this study, the mean ESS score among study group was 13.88 and among OSA group was 14.7.

The sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) of ESS in identifying any OSA (AHI ≥ 5) were 73.33%, 60%, 91.66%, 27.27%, 1.83 and 0.44 respectively.

The sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) of ESS in identifying moderate-severe OSA (AHI ≥ 15) were 75.04, 57.14, 87.5, 36.36, 1.75, 0.44 respectively.

The sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) of ESS in identifying severe OSA (AHI ≥ 30) were 76.92, 36.36, 41.67, 72.73, 1.21, 0.63 respectively.

This shows that ESS questionnaire has high specificity in identifying any OSA (AHI ≥ 5) but with low sensitivity.

STOP-BANG questionnaire:

In the present study, of 35 individuals, 31 had a score of ≥3, of which 28 had OSA and among 4 patients who had a score of <3, 1 had OSA. The mean score among study group was 4.74 and among OSA group was 5.01. The individual components like snoring, hypertension, BMI and neck circumference are found to be statistically significant in identifying OSA ($p<0.05$) in this study. The total STOP-BANG score was also found to be statistically significant in identifying OSA ($p=0.0001$) in this study.

Accordingly the sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) were 96.66%, 40%, 90.62%, 66.66%, 1.61 and 0.08 respectively in identifying OSA (AHI ≥ 5). Similarly, the sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) for identifying moderate-severe OSA (AHI ≥ 15) were 100%, 57%, 90.32, 100, 2.33 and 0 respectively. And for identifying severe OSA (AHI ≥ 30), the sensitivity, specificity, positive predictive value, negative predictive value, LR(+) and LR(-) were 100%, 18.18%, 41.93, 100, 1.22 and 0 respectively (table 5).

This shows that STOP-BANG questionnaire has high sensitivity and low specificity in identifying OSA (AHI ≥ 5) and still more sensitive in identifying severe OSA (AHI ≥ 30) but specificity is lost.

Table 5: Performance of STOP-BANG and ESS in identifying OSA and severity of OSA

	Sensitivity	Specificity	PPV	NPV	LR+	LR-
In identifying any OSA (AHI ≥ 5)						
STOP-BANG	96.66	40	90.62	66.66	1.61	0.08
ESS SCORE	73.33	60	91.66	27.27	1.83	0.49
In identifying moderate-severe OSA (AHI ≥ 15)						
STOP-BANG	100	57	90.32	100	2.33	0
ESS SCORE	45.04	57.14	87.5	36.36	1.75	0.44
In identifying severe OSA (AHI ≥ 30)						
STOP-BANG	100	18.18	41.93	100	1.22	0
ESS SCORE	76.92	36.36	41.67	72.73	1.21	0.63

This study have shown that prevalence of OSA in the study group was 85.71% , considering the patients at risk using the two questionnaires; 96.66% were classified as being at high risk of OSA by the STOP-BANG questionnaires (score≥3) while 73.33% were classified as being at high risk for sleepiness by the ESS (score≥11). It is worth mentioning that the risk increases with the increase in the severity of OSA. In terms of sensitivity, the STOP-BANG questionnaire identified more subjects at cut-offs of AHI ≥ 5 (96.66%), AHI ≥ 15 (100%), and AHI ≥ 30 (100%). Unfortunately, the specificity of this questionnaire was very low at the same cut-offs for OSA.

Based upon the results in this study, the ESS had the lowest sensitivity to predict OSA, moderate-to-severe OSA, and severe OSA in comparison to the STOP-BANG questionnaire. This is not surprising because the ESS is a standard questionnaire to measure subjective excessive daytime sleepiness which is a diagnostic criterion for OSA but can occur secondary to multiple causes other than OSA. Moreover, it was previously shown that this questionnaire is of no value in distinguishing between simple snorers and patients with OSA.[13]

Findings in this study showed that there was an increase in the predictive parameters (namely sensitivity, and NPV) of the ESS and STOP-Bang questionnaires with the increase in the severity of OSA while the PPV decreased with the increase in severity for both the questionnaires.

Pataka et al., Iman Hasan et al., Vana KD et al.,[14,15] conducted similar studies to validate these questionnaires for identifying OSA. The results obtained in these studies were compared to that of the present study and it was found to be similar (table 6).

Table 6: Comparison of performance of STOP-BANG and ESS in identifying any OSA (AHI ≥ 5) among various studies.

Study	STOP-BANG						ESS					
	Se	Sp	PPV	NPV	LR(+)	LR(-)	Se	Sp	PPV	NPV	LR(+)	LR(-)
Present	96.66	40	90.62	66.66	1.61	0.08	73.33	60	91.66	27.27	1.83	0.49
Pataka et al	96.2	14	83.3	45	1.2	0.3	50	67	86.6	24	1.5	0.7
Iman Hassan EI syed et al	97.55	26.32	93.43	50	1.32	0.09	72.55	75	96.73	21.13	2.9	0.37
Vana KD etal	93.8	33.3	75	71.4	0.63	0.49	31.3	53.3	58.8	26.7	0.42	0

VI. Conclusion

In conclusion, among screening questionnaires included in the study, STOP-BANG was a better predictor than ESS questionnaire in identifying any OSA and with increase in the score there was an increased risk of having severe OSA.

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APPENDIX 1:

EPWORTH SLEEPINESS SCALE:

0 - would never doze
1 - slight chance of dozing
2 - moderate chance of dozing
3 – high chance of dozing

SITUATION

1) Sitting quietly after a lunch without alcohol
2) Sitting and talking to someone
3) Sitting and reading
4) Watching TV
5) Sitting inactive in a public place (e.g. a theatre or a meeting)
6) As a passenger in a car for an hour without a break
7) In a car, while stopped for a few minutes in the traffic
8) Lying down to rest in the afternoon when circumstances permit

TOTAL SCORE =

APPENDIX 2:

STOP-BANG SCALE:

1. **S**noring Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?	Yes/No
2. **T**ired Do you often feel tired, fatigued, or sleepy during daytime?	Yes/No
3. **O**bserved apnea Has anyone observed you stop breathing during your sleep?	Yes/No
4. Blood **p**ressure Do you have or are you treated for high blood pressure?	Yes/No
5. **B**MI more than 35 kg/m^2?	Yes/No
6. **A**ge Age over 50 yr old?	Yes/No
7. **N**eck circumference Neck circumference greater than 40 cm?	Yes/No
8. **G**ender Gender male?	Yes/No
High risk of OSA: answering yes to three or more items **Low risk of OSA:** answering yes to fewer than three items	

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