DOI: 10.7860/JCDR/2022/55873.16996

Original Article

Internal Medicine Section

Predictability of STOP-Bang Questionnaire and Epworth Sleepiness Scale in Identifying Obstructive Sleep Apnoea against Polysomnography: A Cross-sectional Study

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ABSTRACT

Introduction: Rising morbidty resulting from Obstructive Sleep Apnoea (OSA) is an emerging public health concern. The estimated prevalence of OSA in India has been investigated. STOP-Bang and Epworth Sleepiness Scale (ESS) have proven beneficial in identifying sleep breathing disorder. Validity of these questionnaire has been verified against polysomnography in many studies.

Aim: To assess the predictive ability of STOP-Bang questionnaire and ESS in identifying OSA and comparing their efficacy with polysomnography.

Materials and Methods: The cross-sectional study was conducted in the Department of Respiratory Medicine, Government Medical College, Kota, Rajasthan, India, from January 2020 to June 2021, among 100 patients with symptoms of OSA. The STOP-Bang questionnaires were administered to the patients, and scoring was done, followed by overnight attended polysomnography. The normality of data was tested by Shapiro Wilk's test. The values obtained were statistically analysed and to compare the parameters between groups and with in groups for normal data parametric test One-way Analysis of Variance (ANOVA) followed by Tukey's HSD test, for intragroup Paired t-test.

Results: Mean age of the study population was 49.46±6.523 years, 79 were males and 21 females. Total, 79% of the subjects were males, and 21% of the study subjects were females. Among the 100, 65% had OSA as per polysomnography. STOP-Bang questionnaire had a higher sensitivity as compared to ESS in predicting OSA (75.38% for STOP-Bang and 72.31% for ESS). Conversely, the specificity of ESS (82.8%) was found to be greater than STOP-Bang (45.71%). Similar results were obtained for positive predictive value, in which ESS scored 88.6% while STOP-Bang scored 50%. For negative predictive values, ESS again scored higher (65%) than STOP-Bang (61.7%). Similarly, the Likelihood Ratio for a positive result (LR^+) of ESS was greater than STOP-Bang (4.2 and 1.3 respectively). The STOP-Bang questionnaire, however, had higher Likelihood Ratio for a negative test (LR-) as compared to ESS (0.5 and 0.3 respectively).

Conclusion: Polysomnography is the gold standard to diagnose OSA. For screening OSA, patients with symptoms of sleep disordered breathing, this study found that STOP-Bang questionnaire is better in identifying OSA as compared to ESS.

Keywords: Predictive ability, Screening, Sleep breathing disorder, Sleep study, Snoring, Sleep apnoea, Questionnaire

INTRODUCTON

Obstructive Sleep Apnoea (OSA) is a major public health problem. In India, the prevalence of Obstructive Sleep Apnoea Syndrome (OSAS) in men is estimated between 2.4% to 4.96% and in women, 1% to 2%. Globally, the prevalence of OSAS is reported to be 4% to 14% in male and 2% to 5% in female [1-9]. Undiagnosed and untreated OSA results in several health and economical consequences. Excessive daytime sleepiness indirectly impairs individual's social, work and driving capabilities [10]. Ischaemic heart diseases, cardiovascular and cerebrovascular disorders have been found to be associated with OSA. The correlation of OSAS with metabolic syndromes and neuropsychological manifestations has also been elucidated [11].

Polysomnography (PSG) is the gold standard test for diagnosing OSA [12]. This is a non invasive investigation which includes overnight observation of numerous variables like eye movements, respiratory effort, electroencephalography, muscle tone, thoracic and abdominal movements, electrocardiography, airflow and oxygen saturation.

The most popular questionnaires for screening OSA are STOP-Bang {Snoring, Tiredness, Observed apnea, high blood Pressure (STOP)-Body mass index (BMI), Age, Neck circumference, and Gender (BANG)} Epworth Sleepiness Scale (ESS). These questionnaires had wide range of sensitivity and specificity in different races [13-16]. The STOP-Bang Questionnaires (SBQ), is a self-reported, eight question survey instrument based on a limited set of known risk factors for OSA. STOP and SBQ were used in some studies as a screening tool to preoperatively screen and stratify patients having undiagnosed OSA [17]. The ESS is a subjective questionnaire which estimates excessive daytime sleepiness using eight questions relating to daily activities [18].

As sedentary life style is prevailing along with obesity, there is potential for increasing recognition of sleep disordered breathing at primary level. The lack of awareness among both subjects and doctors, lack of standard questionnaire renders the diagnosis of OSA is bit quandary. So finally, PSG is needed for both diagnosis and titration, however the facility of PSG and sleep laboratory is limited, even in urban area. Vulli V et al., analysed patients for OSA, found that SBQ has higher sensitivity than ESS [19]. Some studies in past have given conflicting evidence for same. A study from western India analysed patients and found ESS have higher sensitivity and negative predictive value than SBQ in detecting OSA [20]. So it is necessary to re-assess the established assessment tool for screening.

Therefore, this study was conducted to assess the predictive ability of STOP-Bang questionnaire and ESS of study population in identifying OSA and comparing their efficacy with PSG.

MATERIALS AND METHODS

The cross-sectional study was conducted in the Department of Respiratory Medicine, Government Medical College, Kota, Rajasthan, India, from January 2020 to June 2021. The Institutional Ethical Committee approved the study (vide letter number-F.3Acad/Ethical Clearance/2020/07, dated-19.06.2020). The sample size was taken as 100. Data was obtained from patients with symptoms of sleep breathing disorder, who visited the Department of Respiratory Medicine for seeking medical advice for complaints snoring, excessive daytime sleepiness.

Inclusion criteria: All patients visiting Outpatient Department with symptoms of OSA, with age >18 years, and who have given consent to participate were included in the study.

Exclusion criteria: Patients who could not undertake PSG or give proper response to SBQ and ESS either due to physical or mental inabilities were excluded from the study.

Study Procedure

Following informed consent, a detailed history of patients was taken which included sleep history, anthropometric data, socio-demographic, family, personal and past history. Both questionnaires (SBQ and ESS) were completed in consecutive order, on the same day when consent was provided. Type 2 polysomnography was done for all the patients. Following this, the final score of Apnoea-Hypopnoea Index (AHI) was documented [12]. The machine used for polysomnography (Embletta MPR and the software is Resmed version 3.4) is a Level I device with seven channels including Electroencephalography (EEG), Electrooculogram (EOG), chin Electromyography (EMG), Electrocardiography (ECG), oximetry, airflow and respiratory effort channels leads were used. AHI ≥5 was taken for diagnosing OSA [12,13], and cut-off values for SBQ and ESS were 3 and 11, respectively [19].

STATISTICAL ANALYSIS

The data was entered into Microsoft Excel XP software program. Statistical analysis was done using Statistical Package for the Social Sciences (SPSS, Inc, Chicago IL, USA) version 16.0. The descriptive statistics like mean, median, SD, and frequency distribution of data was calculated. The normality of data was tested by Shapiro-Wilk's test. The values obtained were statistically analysed and to compare the parameters between groups and with in groups for normal data parametric test One way Analysis of Variance (ANOVA) Analysis of Variance (ANOVA) followed by Tukey's HSD test, for intragroup Paired t-test. The association between qualitative variable was tested by Pearson's Chi-square test, and the correlation between quantitative variable Karl-Pearson's correlation coefficient was calculated. The level of significance and confidence interval was 5% and 95%, respectively (p-value <0.05).

RESULTS

Among the 100 patients, 79 were males and 21 females. The mean age of the study population was 49.46 years (range 37-78 years). Mean value neck circumference among study population was 37.95±3.53 cm [Table/Fig-1]. Maximum neck circumference value among study subjects was 46 cm. History of smoking was present in 59 % of the study population, 34% of study population were known diabetic and 26% of the study population were known hypertensive. About 13 subjects were having history of obstructive airway disease. Snoring was the most common symptom among study subjects (67%). Excessive day time sleepiness and cough was present in 39% of the subjects. The mean SpO_2 value among study subjects was 91.248. Majority of the subjects had mean SpO_2 above 90%. Lowest value of mean SpO_2 among study subjects was 66%.

Sixty five patients had AHI score more than 5 and hence were diagnosed as OSA -30 subjects had severe OSA, moderate OSA was diagnosed in 27 subjects, and 8 had mild OSA [Table/Fig-2].

Variables		Results
Gender	Male	79
	Female	21
Mean age (years)		49.46±6.52
Mean neck circumference (cm)		37.95±3.53
Mean SpO_2 values (%)		91.24±6.12
Mean value of average desaturation (%)		5.93±4.06
Co-morbidity	Smoking (%)	59
	Diabetes (%)	34
	Hypertension (%)	26
	Obstructive airways disease (%)	13
Symptoms	Snoring (%)	67
	Excessive daytime sleepiness (%)	39
	Cough	39

[Table/Fig-1]: Characteristics of study population.

	STOP-Bang score		ESS score		AHI
Category	≥3 (Intermediate & high-risk)	<3 (Low risk)	≥11 (High-risk)	<11 (Low risk)	
	n (%)	n (%)	n (%)	n (%)	n (%)
OSA	49	16	51	14	65
Non-OSA	19	16	6	29	35
	68	32	57	43	100
Total	100		100		

[Table/Fig-2]: STOP-Bang score, ESS score and AHI distribution among study population.
n(%): Number of subjects in percentage; AHI: Apnoea-hypopnea index; ESS: Epworth sleepiness scale

Analysing ESS scores: Overall, 57 subjects scored ≥11 on ESS scale, out of which 51 subjects had OSA. Out of 43 subjects who had ESS score <11, 14 actually had OSA [Table/Fig-2]. The sensitivity of ESS score in identifying OSA was 72.31%, while specificity was 82.86%. The PPV of ESS was 88.68% and NPV was 61.7% in predicting OSA [Table/Fig-3].

Questionnaire	Sensitivity	Specificity	PPV	NPV	LR^+	LR^-
STOP-Bang	75.38	45.71	50	65	1.39	0.54
ESS	72.31	82.86	88.68	61.70	4.22	0.33

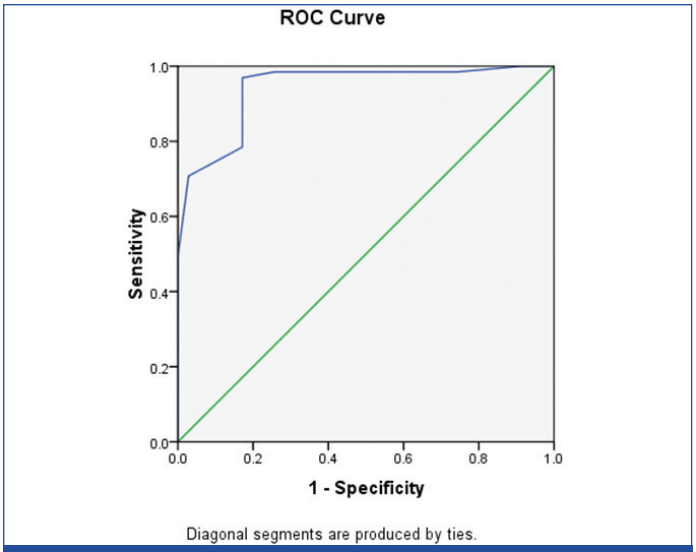
[Table/Fig-3]: STOP-Bang and ESS in identifying OSA (AHI ≥5) in study population.
ESS: Epworth sleepiness scale; OSA: Obstructive sleep apnoea; AHI: Apnoea-hypopnea index; PPV: Positive predictive value; NPV: Negative predictive value; (LR+): Likelihood ratio for a positive; LR: Likelihood ratio for a negative test

Analysing STOP-Bang scores: On STOP-Bang scale, 68 subjects scored ≥3, out of which 49 had OSA. Similarly, out of 32 subjects who scored <3 on STOP-Bang scale, 16 had OSA [Table/Fig-2]. Thus the sensitivity of STOP-Bang score on predicting OSA was 75.38%, while specificity is 45.71%. The PPV of the STOP-Bang score was 50% and NPV was 65 % [Table/Fig-3].

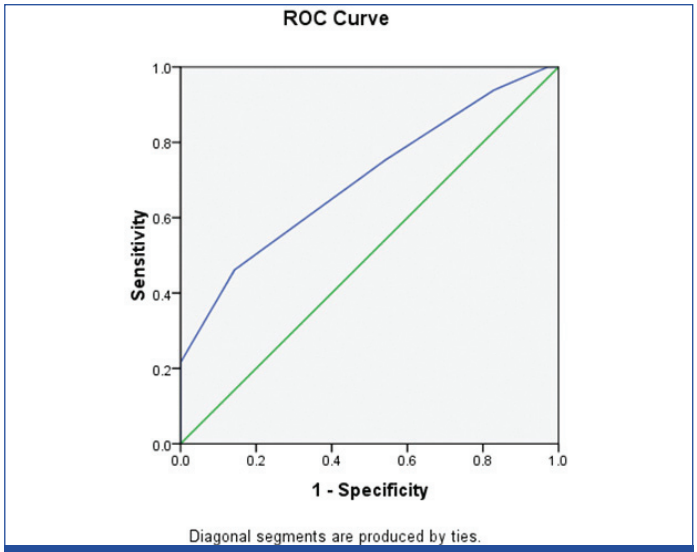
The Receiver Operator Characteristic (ROC) curve, plotted based on the distribution of STOP-Bang score and ESS score versus diagnosis of OSA based on AHI value, showed a positive correlation between STOP-Bang versus OSA (AUC=0.700) and ESS versus OSA (AUC = 0.942) [Table/Fig-4,5].

DISCUSSION

The present study was directed towards finding the predictive ability of questionnaires, i.e. SBQ and ESS for OSA. These questionnaires were tested on the subject population and the scores were evaluated against the PSG based AHI. It was conducted in a population, who came to visit the OPD, with symptoms of sleep disordered breathing. The mean age of study population was 49.46±6.52 years. The prevalence of OSA was 65%. Subjects were evaluated against two questionnaire followed by PSG-75.38 % had intermediate and high-risk for OSA according to SBQ (score



[Table/Fig-4]: ROC curves of ESS vs OSA (AUC=0.942).



[Table/Fig-5]: ROC curves of STOP-Bang vs OSA (AUC= 0.700).

Authors of study	STOP-Bang score						ESS score					
	Sn	Sp	PPV	NPV	LR^+	LR^-	Sn	Sp	PPV	NPV	LR^+	LR^-
Present study	**75.38**	**45.71**	**50**	**65**	**1.39**	**0.54**	**72.31**	**82.86**	**88.68**	**61.70**	**4.22**	**0.33**
Vulli V et al., [19]	96.66	40	90.62	66.66	1.61	0.08	73.33	60	91.66	27.27	1.83	0.49
Amra B et al., [22]	81.46	82.35	99	16.47	4.50	0.23	59	76.47	98.26	7.64	2.45	0.53
Prasad et al [23]	89	43.5	84.9	52.6	1.6	0.3	55.5	67.4	85.9	29.8	1.7	0.7
Pataka et al., [24]	96.2	14	83.3	45	1.2	0.3	50	67	86.6	24	1.5	0.7
El-syed IH et al., [25]	97.55	26.32	93.43	50	1.32	0.09	72.55	75	96.73	21.13	2.9	0.37

[Table/Fig-6]: Comparing STOP-Bang and ESS in identifying OSA (AHI ≥5) among different studies.
ESS: Epworth sleepiness scale; OSA: Obstructive sleep apnoea; AHI: Apnoea-hypopnea index; Sn: Sensitivity; Sp: Specificity; PPV: Positive predictive value; NPV:Negative predictive value, LR+: Likelihood ratio for a positive; LR: Likelihood ratio for a negative test

≥3), while 72.31% had high-risk for sleepiness according to ESS (score ≥11).

ESS questionnaire is a tool employed as a measure of severity of excessive daytime sleepiness. Besides OSA, many other sleep disorders can lead to hypersomnia. So, ESS questionnaire just play small role theoretically in screening patients at high-risk OSA and cannot be used as a tool to screen the high-risk patients [21]. Most of the studies have reported SBQ to be more sensitive while ESS as more specific. PPV of both ESS and SBQ are comparable while NPV of SBQ is more than ESS. Current study reveals comparable sensitivity of both ESS and SBQ, with specificity of ESS being higher (82.86%) as compared to SBQ (45.71%). In contrast to previous published literature, the PPV of ESS is strikingly higher (88.68%) as compared to SBQ. The NPV is again comparable [Table/Fig-6] [19,22-25].

SBQ is a comprehensive screening tool, includes question based on the symptoms, co-morbidities and physical parameters of OSA. The advantage is that patients can finish it in minutes and options are just 'yes' and 'no'. Questionnaires were acceptable to the patients. SBQ has questions that are easy to recall for the patients, and easy to calculate by the accessor. Such questionnaire-based approaches are more practical and affordable due to paucity of sleep laboratory and cost of investigation is higher.

Limitation(s)

The study population that visited the OPD, with symptoms of sleep breathing disorder were analysed, which would influence the accuracy of the questionnaire. A selection bias cannot be ruled out as all these patients presented to tertiary care centre, and were bound to be symptomatic and most of them had severe OSA. So, the result cannot be generalised.

CONCLUSION(S)

For screening OSA, patients with symptoms of sleep disordered breathing, can be subjected to appropriate questionnaire-based approach is more practical. These questionnaires cannot replace polysomnography, but it may be used in controlled setting to prioritize patients for subsequent PSG diagnosing OSA and help in early management. This study, conducted in sleep labouratory, found the STOP-Bang questionnaire to be better in identifying OSA, as compared to ESS.

Acknowledgement

The authors acknowledge the help of Medicine Ward Nursing Staff for their cooperation in the study.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Mar 03, 2022
- Manual Googling: Jun 09, 2022
- iThenticate Software: Jun 11, 2022 (18%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Feb 24, 2022**
Date of Peer Review: **Mar 23, 2022**
Date of Acceptance: **Jun 13, 2022**
Date of Publishing: **Oct 01, 2022**