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ORIGINAL ARTICLE

Predictive Abilities of Epworth Sleepiness Scale and Stop Bang in Identifying Patients at High Risk of Obstructive Sleep Apnea

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ABSTRACT

Background: The aim of the study is to evaluate the diagnostic precision of utilizing both Stop-bang and Epworth sleepiness scale in predicting obstructive sleep apnea (OSA) for individuals with clinical suspicion, while considering polysomnography as the reference standard.

Methods and Material: A cross-sectional (validation) study was conducted between 4th September 2017 and 3rd January 2018 at the Department of Pulmonology, Military Hospital Rawalpindi. A total of two hundred and eight (n=208) clinically suspected cases of OSA between age 40-60 years irrespective of gender were enrolled in the study. ESS and stop-Bang score was measured in all patients compared with apnea-hypopnea index (AHI). Diagnostic accuracy of combined ESS/Stop-Bang was calculated.

Results: The findings of our research indicate that the utilization of combined ESS/Stop Bang (with a cut off point of ESS>3/STOP BANG >10) yielded a sensitivity, specificity, positive predictive value, negative predictive value and accuracy of 73.7%, 66.7%, 79.7%, 58.8% and 71.2% respectively.

Conclusion: ESS/Stop-Bang when combined allow diagnosis of OSA with reasonable accuracy. The outcomes of our investigation revealed that the accuracy, sensitivity, specificity, NPV and PPV were 71.2%, 73.7%, 66.7%, 58.8% and 79.7% correspondingly.

Keywords: Epworth sleepiness score, Obstructive sleep apnea, Stop-Bang

INTRODUCTION

Obstructive sleep apnea (OSA) affects as many as 2-26% of people throughout the world.[1] In this condition, the upper airways repeatedly collapse during sleep, leading to frequent awakenings. Patients suffering from OSA may not show any symptoms or could experience issues like snoring, gasping, choking, waking up in the middle of the night or feeling excessively sleepy during the day. There is a connection between OSA and other health conditions such as refractory hypertension, diabetes mellitus, cardiovascular ailments, nocturnal arrhythmias, pulmonary hypertension and depression.. By screening individuals early for OSA, one can reduce their risk of associated diseases and death.[2-6] While an overnight polysomnography is considered the most reliable method of diagnosing OSA, it requires a specialized sleep laboratory, proficient personnel, and financial resources which may not be easily accessible in our healthcare system. Furthermore, the sensitivity and specificity rates of polysomnography stand at 80% and 97%, respectively.[7]

At our setup we use class-three sleep study. Due to high prevalence of OSA, the load of patients outnumber the available sleep labs resources in many countries. For this reason, several screening tools have been developed, including clinical assessment questionnaires, to identify patients who may be at high risk. The ESS, Berlin questionnaire, and STOP-bang questionnaire are tools that are commonly utilized. Epworth sleepiness scale (attached as annex 2) is a useful screening stool to identify the patients at risk of obstructive sleep apnea. ESS is likely to miss a number of cases as it does not cater for tiredness which is essential while assessing patients of OSA.[8] The STOP-Bang questionnaire is distinguished from other assessments by its incorporation of a comprehensive range of indicators that encompass snoring, exhaustion, evident breathing difficulties, blood pressure readings, body mass index calculations, age, neck circumference measurements and gender.[9] In this study we determined whether using a combining Stop bang and ESS questionnaires in clinically suspected cases of OSA will lead to higher sensitivity and specificity than using ESS or Stop Bang isolation and whether these clinical tools (ESS and STOP-bang) can be used as a surrogate to polysomnography.

Testing the diagnostic reliability of Stop -bang combined with Epworth sleepiness scale for predicting OSA in clinically suspected cases with polysomnography as a gold standard

MATERIAL AND METHODS:

A cross-sectional (validation) study was conducted between 4th September 2017 and 3rd January 2018 at the Department of Pulmonology Military Hospital Rawalpindi. Sample size was calculated using sensitivity & specificity sample size calculator taking

Confidence level:	95%
Prevalence of OSA:	26%1
Sensitivity of the test	94.7%3
Specificity of the test:	10.7%3
Absolute Precision required:	5%

The sample size calculated comes out to be n=208

A non-probability convenience sampling technique was utilized to recruit participants in the study.

The eligibility requirements for this investigation are delineated as follows: prospective subjects must be individuals with clinical indications of obstructive sleep apnea (OSA) who fall within the age range of 40 to 60 years and may belong to any gender. On the other hand, the exclusion criteria include individuals who have already been diagnosed with OSA, those who have hypothyroidism or severe cardiac failure, and individuals with developmental delays, dementia, or cerebrovascular accidents (CVA). The study aims to investigate the prevalence of OSA among individuals who are suspected to have this condition but have not yet been diagnosed. The study's objective is to manage potential variables associated with age by constraining the age bracket to individuals aged between 40-60 years. Additionally, excluding individuals with certain medical conditions or impairments aims to ensure that the results are more generalizable to the wider population.

Upon receiving authorization from the Hospital's Ethical Review Committee, all patients who displayed clinical suspicion and presented at the Pulmonology Department in Military Hospital Rawalpindi were selected as cases for this study, given that they met the aforementioned criteria and expressed a willingness to participate.They were interviewed by the primary investigator at

sleep clinic to fill the ESS and Stop-bang questionnaires. Subsequently, those who fulfill criteria offered to have sleep studies as inpatient. Sleep study was carried out by using a portable sleep device. Those having AHI of > 5/hour were labeled as suffering from OSA.

After inputting the gathered information into SPSS 17, a series of analyses were conducted. When dealing with qualitative variables like gender, the frequency and percentages of each variable were calculated. On the other hand, quantitative variables such as age, BMI, Epworth sleepiness scale (ESS), and Stop-bang underwent analysis to determine their mean and standard deviation. To further understand the data set's accuracy, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated by utilizing a 2X2 table. Additionally, the ROC curve and likelihood ratio were determined to better evaluate the model's performance. Effect modifiers such as age, gender, BMI and hypertension were controlled by stratification with post-stratification diagnostic accuracy being measured for improved accuracy assessment.

2 × 2 Table

Stop Bang/ESS	Polysomnography	
AHI > 5	AHI ≤ 5	
>3/>10	True Positive	False Positive
≤3/≤10	False Negative	True Negative

1. Sensitivity = x 100
2. Specificity = x 100
3. Positive Predictive Value = x 100
4. Negative Predictive Value = x 100
5. Accuracy = x 100
6. LR+ = Sensitivity
   (1-specificity)

RESULTS

Table 1: Sociodeographic and clinical characteristics among study population

Age groups	N (%)
40-50 years	107 (51.4%)
51-60 years	101 (48.6%)
Gender	
Male	150 (72.1%)
Female	58 (27.9%)
Hypertension	
Present	146 (70.2%)
Absent	62 (29.8%)
BMI	
<30kg/m2	43 (20.7%)
>30kg/m2	165 (79.3%)

The results of the study indicate that the analyzed group has an elevated mean body mass index (BMI) of 35.6 kg/m2, signifying obesity. The average Epworth Sleepiness Scale (ESS) score is 12.6, while the mean score on the STOP-BANG questionnaire is 5.6. Our research revealed that when utilizing ESS/STOP-BANG in combination (with a cut-off point of ESS>3/STOP BANG >10), there was a sensitivity, specificity, positive predictive value, negative predictive value and accuracy of 73.7%, 66.7%, 79.7%, 58.8% and 71.2% respectively. Results are shown in table 2.

Table 2: Cross-tabulation of results

Combined Ess/Stop Bang	AHI		
	>5	≤5	Total
Ess>3/Stop Bang >10	98 (True Positives)	25 (False Positives)	123
Ess≤3/Stop Bang≤10	35 (False Negatives)	50 (True Negatives)	85
Total	133	75	208

None of the following variables were found to be significant predictors of AHI: age, weight, BMI scale, neck circumference, smoker, ESS, and STOPBANG. On the other hand, gender, hypertension, and the combined STOPBANG/ESS score emerged as significant predictors. Males and individuals without hypertension had a greater likelihood of experiencing sleep apnea. Conversely, a higher combined STOPBANG/ESS score was associated with reduced odds of sleep apnea. (Table 3).

Table 3: Regression of AHI with respect to stratified variables

Variables	Odds Ratio	95% CI [Upper, Lower]	p-value
(Constant)	0	[0.431, 1.972]	0.002
Age Groups	0.089	[-0.034, 0.206]	0.161
Gender	-0.255	[-0.455, -0.092]	0.003
Weight	-0.049	[-0.008, 0.005]	0.672
BMI	0.102	[-0.011, 0.026]	0.428
BMI Scale	0.1	[-0.072, 0.308]	0.221
Neck Circumference	-0.014	[-0.015, 0.012]	0.842
Hypertension	-0.139	[-0.28, -0.012]	0.033
Smoker	-0.057	[-0.204, 0.094]	0.466
ESS	-0.039	[-0.245, 0.167]	0.71
STOPBANG	0.096	[-0.065, 0.385]	0.162
Combined STOPBANG/ESS	-0.347	[-0.548, -0.131]	0.002

Furthermore, age, weight, BMI scale, neck circumference, hypertension, and smoker were not significant predictors of the combined STOPBANG/ESS score. Gender, ESS, STOPBANG, and AHI were significant predictors, with females and those with higher ESS and STOPBANG scores having higher odds of having sleep apnea, while a higher AHI score was associated with lower odds of having sleep apnea (Table 4).

Table 4: Regression of Combined STOPBANG/ESS with respect to stratified variables

Variables	Odds Ratio	95% CI [Upper, Lower]	p-value
(Constant)	0	[-0.392, 0.646]	0.629
Age Groups	0.039	[-0.04, 0.118]	0.336
Gender	0.089	[-0.024, 0.219]	0.114
Weight	0.104	[-0.001, 0.007]	0.163
BMI	-0.126	[-0.022, 0.003]	0.126
BMI Scale	-0.032	[-0.164, 0.087]	0.548
Neck Circumference	0.013	[-0.008, 0.01]	0.781
Hypertension	0.065	[-0.019, 0.159]	0.121
Smoker	-0.041	[-0.139, 0.057]	0.413
ESS	0.692	[0.624, 0.806]	0
STOPBANG	0.14	[0.094, 0.384]	0.001
AHI	-0.143	[-0.237, -0.057]	0.002

DISCUSSION

Sleep apnea, if not diagnosed and treated, can lead to serious health problems. Polysomnography is considered the most effective method of diagnosing obstructive sleep apnea. However, it may not be accessible to everyone because of its high cost. OSA questionnaires are frequently used as an alternative diagnostic tool but their precision has produced mixed results. Researchers believe that differences in study designs including population type, questionnaire design and validity play a key role in this variability. To address this issue, healthcare professionals have recommended using STOP and STOP-Bang questionnaires for screening purposes specifically among surgical patients. Stop-Bang and ESS are superior in terms of methodology quality and ease of use.[10] The primary aim of this investigation was to further evaluate the accuracy and reliability of these two tools for diagnosing sleep apnea. This study will help medical practitioners gain more confidence in the effectiveness of these questionnaires so that they can provide better care for their patients suffering from obstructive sleep apnea. The research conducted involved recruiting a total of 208 individuals aged between 40 and 60 years, regardless of their gender. All participants were suspected to be affected by Obstructive Sleep Apnea (OSA) based on clinical examination. In order to determine the severity of the condition, the researchers used two methodologies: apnea-hypopnea index (AHI), which measures how many times a person stops breathing

or has shallow breaths during sleep, and Epworth Sleepiness Scale (ESS) & Stop-Bang score, which help gauge daytime sleepiness and risk factors such as body mass index (BMI), gender, age etc. The study examined the correlation between AHI readings and ESS/Stop-Bang measurements in all participants. The results revealed that combining ESS/Stop Bang with a threshold cutoff value set at ESS>3/STOP BANG >10 displayed high diagnostic accuracy with regards to identifying OSA in individuals. The method exhibited sensitivity levels of 73.7%, specificity rates of 66.7%, positive predictive values of 79.7%, negative predictive values of 58.8% and an overall accuracy rate of 71.2%. This implies that this combined approach can be helpful for medical professionals in diagnosing sleep apnea more effectively than using just one metric alone.

Our research findings are consistent with existing literature on the topic. Luo J, et al[11] performed a study to assess the efficacy of utilizing the STOP-Bang questionnaire (SBQ) for detecting OSAHS in sleep-disordered breathing clinics. This evaluation entailed comparing the SBQ against other assessment tools including the Epworth Sleepiness Scale (ESS), Berlin questionnaire, and STOP questionnaire. In this study, the researchers included 212 patients and asked them to complete various questionnaires before undergoing overnight polysomnography (PSG). The SBQ, ESS, Berlin questionnaire, and STOP questionnaire were used as screening tools for Obstructive Sleep Apnea Hypopnea Syndrome (OSAHS), with PSG as a reference standard. Results indicated that there was no significant difference between using an ESS score of ≥11 versus other questionnaires in detecting moderate to severe OSAHS. However, the SBQ was found to be more effective than the Berlin questionnaire or STOP questionnaire in screening for OSAHS and assessing its severity. The study found that an SBQ score of ≥3 had high sensitivities when compared with AHI gold standards of ≥5/h, ≥15/h, and ≥30/h respectively. Specificities for these same measurements were low at only 50%, 28.6%, and 17.9%. Additionally, based on SBQ results participants were divided into two risk groups - high-risk group and low-risk group - which differed significantly in various factors such as gender distribution,BMI,and neck circumference. In conclusion,the findings of this research show that the SBQ is a more effective screening tool compared to other questionnaires like ESS,Berlin questionnaire,and STOP questionnaire for detecting OSAHS in the general population. This suggests that further use should be made of this particular tool in future screenings for this condition among the populace at large. However, they did not estimate the combined accuracy of ESS and SBQ.[11]

Chiu HY, et al[12] investigated and compared the summary sensitivity, specificity, and diagnostic odds ratio (DOR) of various screening tools such as BQ, SBQ, STOP and ESS in detecting different levels of OSA severity. The studies included in this analysis examined the sensitivity and specificity of these tools against AHI or RDI. The research encompassed a total of 108 studies with 47,989 participants. Based on the results, pooled estimates were calculated for detecting mild (AHI/RDI ≥ 5 events/h), moderate (AHI/RDI ≥ 15 events/h), and severe OSA (AHI/RDI ≥ 30 events/h). The performance levels of BQ, SBQ, STOP and ESS were evaluated accordingly. For instance, for mild OSA detection, pooled sensitivity levels were found to be 76%, 88%, 87% and 54%, respectively while the pooled specificity levels were observed to be at 59%, 42%, 42% and 65%. Similarly for moderate OSA detection pooled sensitivities ranged between;77%-90% whereas specificities varied from;36%-621%. Lastly, regarding severe OSA detection, the range of sensitivities was around;84%-93% whereas specificities varying within range;28%-60%. Accordingly it was discovered that in cases where mild to severe categories are concerned, SBQ had significantly higher sensitivity rates than other screening methods($P < .05$); however its associated specificity rate was comparatively lower than that obtained by using ESS($P < .05$).

A systematic review was conducted by Nagappa M, et al[13] to analyze the effectiveness of using STOP-Bang for screening OSA-suspected patients and evaluating its ability to measure OSA severity in different populations. The review consisted of 17 studies with a total of 9,206 patients who met the specified criteria. The sensitivity rates were determined for sleep clinic and surgical populations to identify any OSA (AHI≥5), moderate-to-severe OSA (AHI≥15), and severe OSA (AHI≥30). According to the study's findings, detection rates for any OSA, moderate-to-severe OSA, and severe OSA were noted at 90%, 94%, and 96%, respectively. Negative predictive values ranged from low to high depending on the severity level being screened for- at 46%, it was lower while at 75% & 90% it rose higher. The probability rate of having severe OSA in sleep clinic populations when presented with a STOP-Bang score of three was found to be approximately25%. However an increase in score from three towards four,five,six or seven/eight led to a proportional rise in corresponding likelihood up until around an estimated figure of about 75%. When surgical populations presented with a STOP-Bang score of three, their risk assessment outcome suggested that their likelihood for having severe OSA was around 15%. Here too as the score increased stepwise upwards towards four,five,six or seven/eight ,the estimated figures rose proportionally up until almost an approximate rate of 65%. Overall, these results show that STOP-Bang is highly effective in diagnosing different levels of sleep apnea across various patient groups. Healthcare practitioners can use this scoring tool as part of routine screenings to aid in the diagnosis and treatment plan development process. They concluded that higher the STOP-Bang score, the greater is the probability of moderate-to-severe OSA.[13]

Vulli et al.[14] conducted a study on dental patients in India, the effectiveness of two screening tools in identifying OSA was investigated. The researchers discovered that compared to the Epworth Sleepiness Scale (ESS), the STOP-Bang questionnaire exhibited higher sensitivity and specificity in identifying OSA. Therefore, it is implied that the STOP-Bang questionnaire may be a superior tool for screening purposes. Similarly, RAnjAn et al.[15] RAnjAn et al.15 conducted a study with the objective of evaluating the reliability of the STOP-Bang questionnaire and ESS in identifying OSA in patients who visited a sleep clinic in India. The results were consistent with those of Vulli et al.[14], as the STOP-Bang questionnaire was found to be more efficient than ESS in screening for OSA, demonstrating greater sensitivity and specificity.

Researchers have conducted studies to determine the effectiveness of the STOP-Bang questionnaire in detecting obstructive sleep apnea (OSA). Miskedaki et al.[15] conducted a study on a population of patients in Greece and found that the questionnaire was an effective method for detecting OSA. In fact, their findings were consistent with previous research that showed the STOP-Bang questionnaire had superior sensitivity and specificity compared to other tests such as ESS for OSA detection. Moreover, Orbea et al. evaluated how midlife women relied on the STOP-Bang questionnaire as a screening tool for identifying OSA. The researchers discovered that this screening tool was quite effective, displaying good predictive ability and high reliability ratings for use in clinical practice. These findings provide further evidence of the usefulness of using the STOP-Bang questionnaire to detect this common sleep disorder among different populations, which could lead to early diagnosis and appropriate treatment planning.[17]

Research has shown that the STOP-Bang survey could be more effective than the ESS in identifying obstructive sleep apnea (OSA) in people with varying characteristics[18]. However, it is important to note that these studies were conducted on specific groups and demographics, and thus cannot be generalized for the wider population. Further investigation is required to ascertain whether these research findings can be extended to other populations as well. Moreover, polysomnography serves as the benchmark for OSA diagnosis, and conducting further

investigations to compare the prognostic efficiency of alternative diagnostic tools with polysomnography would be advantageous.

CONCLUSION

In summary, SBQ was found to be a better diagnostic tool when compared with other tools like Berlin score and ESS. Present study results demonstrated that by combining SBQ and ESS the overall specificity and negative predictive value increases. The inconsistency in reported validity results are largely due to use of different cut off values for screening tests and AHI as well. ROI analysis revealed that higher the cut off values better is the specificity of ESS and SBQ. We recommend further studies using different cut off values.

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