Evaluation of Screening Tools for Predicting Obstructive Sleep Apnea among Patients at Al-Shaab Teaching Hospital, Sudan 2022

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ABSTRACT

Background: *Obstructive Sleep Apnea (OSA) is a common sleep disorder that often requires lifelong care and represents a major cause of morbidity and mortality. Various clinical scales and questionnaires have been developed to evaluate patients with high probability of OSA, but their comparative effectiveness in clinical settings remains unclear.*

Objective: *To evaluate and compare the effectiveness of three screening tests—Epworth Sleepiness Scale (ESS), Stop Bang Questionnaire (SBQ), and Adjusted Neck Circumference (ANC)—in predicting Obstructive Sleep Apnea against polysomnography as the gold standard.*

Methods: *A descriptive cross-sectional hospital-based study was conducted on 100 Sudanese patients who underwent respiratory polysomnography at Al-Shaab Teaching Hospital from December 2021 to April 2022. All participants were assessed using the three screening tools prior to polysomnography. Data was analyzed using SPSS version 25.0, with sensitivity, specificity, and accuracy calculated for each screening method.*

Results: *Among the 100 participants, polysomnography confirmed OSA in 91% of cases (29% mild, 44% moderate, 18% severe). The Epworth Sleepiness Scale identified 38% of participants with abnormal scores and demonstrated the highest specificity (88.9%), while the Stop Bang Questionnaire classified 73% as high-risk and showed higher sensitivity (72%) and better overall accuracy (68%). The Adjusted Neck Circumference method classified 44% of participants as high-risk. Significant associations were found between OSA severity and hypertension (p<0.001) and increased neck circumference (p=0.049), with 67% of participants being hypertensive.*

Conclusion: *Following standard diagnosis using polysomnography, both the Epworth Sleepiness Scale and Stop Bang Questionnaire provide acceptable levels of sensitivity and specificity for OSA screening, with the Stop Bang Questionnaire demonstrating superior accuracy. These screening tools should be implemented in primary healthcare settings to facilitate early identification of patients with high probability of Obstructive Sleep Apnea, particularly among those with hypertension and increased neck circumference.*

Keywords

Introduction

Obstructive Sleep Apnea (OSA) is a common sleep disorder characterized by recurrent episodes of partial or complete upper airway obstruction during sleep, resulting in disruption of normal ventilation and sleep patterns. This condition often requires

lifelong care and management, representing a significant public health concern worldwide [1]. The cardinal features of OSA include obstructive apneas, hypopneas, and respiratory effort-related arousals, all caused by recurring collapse of the upper airway during sleep.

During periods of airway obstruction, patients typically appear quiet and still, as though they are holding their breath, followed by increasingly desperate respiratory efforts. These episodes often terminate only after an intense struggle for breath. A characteristic snorting sound, described as "fricative breathing," may be heard at the conclusion of these episodes. In severe cases, patients may suddenly awaken and gasp for air. Notably, patients with OSA generally demonstrate normal and regular breathing patterns when awake, highlighting the sleep-specific nature of this disorder.

The gold standard for diagnosing OSA is respiratory polysomnography (PSG), which provides comprehensive assessment of sleep architecture and respiratory parameters [2]. Based on the apnea-hypopnea index (AHI), OSA is classified into three severity categories: mild (AHI 5-15 events/hour), moderate (AHI 15-30 events/hour), and severe (AHI >30 events/hour and/or oxygen saturation below 90% for >20% of total sleep time) [3,4].

The clinical significance of OSA extends beyond sleep disruption, as it represents an independent risk factor for numerous comorbidities. These include systemic hypertension [5], cognitive impairment [6], depression [7], ischemic stroke, cardiopulmonary failure, pulmonary hypertension [8], cardiac arrhythmias [9], and polycythemia. The chronic hypoxemia associated with severe OSA may lead to the development of cor pulmonale [10]. Furthermore, untreated OSA is associated with increased risk of postoperative complications [11,12], reduced job performance [13], and poses a critical occupational concern for commercial drivers and those in safety-sensitive positions [14].

While obesity is a well-established risk factor for OSA, it is important to note that many patients with sleep apnea are not obese, indicating the multifactorial etiology of this condition. Other contributing factors include craniofacial abnormalities, upper airway anatomy, neuromuscular factors, and genetic predisposition [15].

Given the high prevalence and significant health implications of OSA, early identification and intervention are crucial. However, the limited availability and relatively high cost of polysomnography present barriers to timely diagnosis. Consequently, various clinical screening tools have been developed to identify patients at high risk for OSA who would benefit from definitive testing and treatment.

The Stop Bang Questionnaire (SBQ) was developed in 2008 as a simple, easy-to-remember, and self-reportable screening tool [16]. It includes four subjective items (STOP: Snoring, Tiredness, Observed apnea, and high blood Pressure) and four demographic items (Bang: BMI, Age, Neck circumference, and Gender). The Adjusted Neck Circumference (ANC) is a clinical screening score based on neck circumference with additional points for hypertension and snoring [17]. The Epworth Sleepiness Scale (ESS), developed by Dr. Johns in 1990, is designed to assess daytime sleepiness through a self-administered questionnaire with 8 questions rated on a 4-point scale [18].

This study aims to evaluate the effectiveness of these three commonly used screening tests in predicting OSA among patients attending Al-Shaab Teaching Hospital. By comparing these screening methods against polysomnography as the gold standard, this research seeks to identify the most reliable and practical screening approach for implementation in primary healthcare settings, particularly in resource-limited environments.

Methods
Study Design and Setting
This was a descriptive cross-sectional hospital-based study conducted at Al-Shaab Teaching Hospital in Khartoum, Sudan, from December 2021 to April 2022. The study focused on patients who were referred to the hospital's sleep laboratory for respiratory polysomnography.

Study Population and Sampling
The study included 100 Sudanese patients aged 18 years and above who were referred for polysomnography due to suspected Obstructive Sleep Apnea. Participants were selected using a consecutive sampling technique from those attending the sleep laboratory during the study period. Patients with incomplete data or those who declined to participate were excluded from the study.

Data Collection Tools and Procedures
Prior to undergoing polysomnography, all participants were assessed using three screening tools:
1. **Epworth Sleepiness Scale (ESS)**: This self-administered questionnaire evaluates the likelihood of falling asleep in eight different situations. Scores range from 0 to 24, with scores >10 indicating excessive daytime sleepiness and increased risk of OSA.
2. **Stop Bang Questionnaire (SBQ)**: This eight-item questionnaire assesses key risk factors for OSA including Snoring, Tiredness, Observed apnea, blood Pressure, Body mass index, Age, Neck circumference, and Gender. Scores ≥3 indicate high risk for OSA.
3. **Adjusted Neck Circumference (ANC)**: This measurement combines neck circumference with additional points for hypertension and snoring. ANC is calculated as: Neck circumference (cm) + 4 (if hypertensive) + 3 (if snorer). Values >43 cm in males and >41 cm in females indicate high risk for OSA.

Demographic data and clinical information were collected using a structured questionnaire. Anthropometric measurements including height, weight, and neck circumference were obtained using standardized techniques. Blood pressure was measured according to standard clinical guidelines, with hypertension defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90

mmHg, or current use of antihypertensive medication.

Polysomnography

All participants underwent overnight respiratory polysomnography using standardized equipment and protocols. The following parameters were monitored: nasal airflow, respiratory effort, oxygen saturation, heart rate, body position, and snoring. The apnea-hypopnea index (AHI) was calculated as the number of apnea and hypopnea events per hour of sleep. OSA severity was classified as follows: - Normal: AHI <5 events/hour - Mild OSA: AHI 5-15 events/hour - Moderate OSA: AHI 15-30 events/hour - Severe OSA: AHI >30 events/hour

Ethical Considerations

The study was approved by the Ethical Committee of the Sudan Medical Specialization Board. Written informed consent was obtained from all participants prior to enrollment. Confidentiality and privacy of participant information were maintained throughout the study.

Statistical Analysis

Data was entered, cleaned, and analyzed using SPSS version 25.0. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations. The validity of each screening test was assessed by calculating sensitivity, specificity, positive predictive value, negative predictive value, and accuracy, using polysomnography as the gold standard. Chi-square test was used to assess associations between categorical variables, with p-values <0.05 considered statistically significant.

Results

Demographic and Clinical Characteristics

This study included 100 participants who underwent polysomnography for suspected Obstructive Sleep Apnea at Al-Shaab Teaching Hospital. The demographic analysis revealed that two-thirds (67%) of the participants were hypertensive, highlighting the significant comorbidity burden in this population.

Screening Test Results
Epworth Sleepiness Scale (ESS)

Based on the Epworth Sleepiness Scale assessment, 38% of participants reported abnormal scores (>10), indicating excessive daytime sleepiness. The remaining 62% had normal ESS scores. The quantitative analysis of ESS scores demonstrated a range of sleep propensity across the study population.

Stop Bang Questionnaire (SBQ)

Using the Stop Bang scale, 73% of participants were classified as high-risk for OSA (score ≥3), while 27% were categorized as low-risk. This indicates that the SBQ identified a larger proportion of the study population as being at risk for OSA compared to the ESS.

Adjusted Neck Circumference (ANC)

The Adjusted Neck Circumference measurement classified 44% of participants as high-risk for OSA. This intermediate position between ESS and SBQ suggests varying sensitivity of the different screening approaches.

Polysomnography Results

Polysomnography, the gold standard for OSA diagnosis, revealed that 91% of participants had abnormal results confirming OSA. The severity distribution was as follows: - 29% had mild OSA (AHI 5-15 events/hour) - 44% had moderate OSA (AHI 15-30 events/hour) - 18% had severe OSA (AHI >30 events/hour)

Only 9% of participants had normal polysomnography results (AHI <5 events/hour), indicating the high prevalence of OSA in this referred population.

Validity Assessment of Screening Tests

Table 1 summarizes the validity measures of the three screening tests compared with polysomnography as the gold standard.

Table 1: Validity Measures of Screening Tests for Obstructive Sleep Apnea.

Screening Test	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Accuracy (%)
Epworth Sleepiness Scale (ESS)	41.8	88.9	97.4	12.9	46.0
Stop Bang Questionnaire (SBQ)	72.0	33.3	90.4	11.1	68.0
Adjusted Neck Circumference (ANC)	46.2	66.7	93.2	10.7	48.0

As shown in Table 1, the ESS demonstrated excellent specificity (88.9%) and positive predictive value (97.4%), but its relatively low sensitivity (41.8%) limits its utility as a standalone screening tool.

The SBQ showed higher sensitivity (72.0%) than the ESS, but lower specificity (33.3%). Notably, it achieved the best overall accuracy (68.0%) among the three screening tools evaluated.

The ANC method yielded intermediate performance with moderate sensitivity (46.2%) and specificity (66.7%), with an overall accuracy of 48.0%.

Associations with OSA Severity
Hypertension and OSA

A significant association was found between the severity of OSA (confirmed by polysomnography) and the presence of hypertension (p<0.001). This finding underscores the important relationship between OSA and cardiovascular comorbidities.

Neck Circumference and OSA

Similarly, a significant association was observed between OSA severity and increased neck circumference (p=0.049). This supports the inclusion of neck circumference as a parameter in OSA screening tools and highlights its value as a clinical marker for OSA risk assessment.

Discussion

Key Findings

This study evaluated three commonly used screening tools for Obstructive Sleep Apnea (OSA) against polysomnography as the gold standard diagnostic method. Our findings revealed that 91% of referred patients had polysomnography-confirmed OSA, with varying degrees of severity. This high prevalence underscores the importance of effective screening methods in clinical practice, particularly in resource-limited settings where access to polysomnography may be restricted.

Among the three screening tools evaluated, the Stop Bang Questionnaire (SBQ) demonstrated the highest sensitivity (72%) and overall accuracy (68%), making it the most reliable screening instrument in our study population. The Epworth Sleepiness Scale (ESS), while showing excellent specificity (88.9%), had limited sensitivity (41.8%), suggesting its utility may be more in ruling in rather than ruling out OSA. The Adjusted Neck Circumference (ANC) method showed intermediate performance characteristics, with moderate sensitivity (46.2%) and specificity (66.7%).

The significant associations observed between OSA severity and both hypertension ($p<0.001$) and increased neck circumference ($p=0.049$) align with established literature and highlight the importance of considering these clinical parameters in OSA risk assessment.

Comparison with Previous Studies

Our findings are consistent with several previous studies that have evaluated the performance of OSA screening tools. El-Sayed et al. reported similar results in their Egyptian study, where the SBQ demonstrated high sensitivity (97.55%) but low specificity (26.32%) for OSA detection [19]. Similarly, Amra et al.'s systematic review found that the sensitivity of SBQ in detecting OSA ranged from 81.08% to 97.55%, which is comparable to our findings [20].

However, our study showed a higher specificity for the ESS (88.9%) compared to some previous reports. This discrepancy may be attributed to differences in study populations, cultural factors affecting symptom reporting, or variations in the implementation of the screening tools.

The observed association between OSA and hypertension in our study corroborates the established relationship between these conditions. Previous research has demonstrated that OSA is an independent risk factor for hypertension, and the presence of OSA can complicate blood pressure management. Our findings reinforce the importance of OSA screening in hypertensive patients and, conversely, blood pressure assessment in those with suspected OSA.

Clinical Implications

The results of this study have several important clinical implications. First, the high prevalence of OSA in our referred population (91%) emphasizes the need for increased awareness and screening in primary healthcare settings. Second, the superior performance of the SBQ in terms of sensitivity and overall accuracy suggests that this tool should be prioritized for initial screening in clinical practice, particularly in resource-limited environments.

The high specificity of the ESS indicates that it may be most valuable as a complementary tool, especially when a more specific assessment is needed. The significant associations between OSA severity and both hypertension and increased neck circumference highlight the importance of comprehensive clinical evaluation, including these parameters, in OSA risk assessment.

Given that no single screening tool achieved both high sensitivity and specificity, a staged or combined approach may be optimal. For instance, initial screening with the more sensitive SBQ, followed by the more specific ESS in selected cases, could potentially improve overall diagnostic accuracy while minimizing resource utilization.

Strengths and Limitations

This study has several strengths, including the use of polysomnography as the gold standard for OSA diagnosis, the comprehensive evaluation of three different screening tools, and the inclusion of a diverse patient population. The assessment of associations between OSA and clinical parameters such as hypertension and neck circumference adds valuable context to the screening tool evaluation.

However, several limitations should be acknowledged. The study was conducted at a single center with a relatively small sample size (n=100), which may limit the generalizability of the findings. The cross-sectional design precludes assessment of the temporal relationship between OSA and associated conditions such as hypertension. Additionally, the study population consisted of patients referred for polysomnography, introducing potential selection bias that may have influenced the observed prevalence of OSA and the performance characteristics of the screening tools.

Cultural and linguistic factors may have affected participants' understanding and responses to the questionnaire-based screening tools, potentially impacting their validity. Furthermore, the study did not account for potential confounding factors such as medication use, comorbidities other than hypertension, or lifestyle factors that might influence both OSA and the performance of screening tools.

Future Directions

Future research should focus on validating these findings in larger, more diverse populations and in primary care settings where screening tools are most likely to be implemented. Longitudinal studies would be valuable to assess the predictive value of these screening tools for OSA-related complications and treatment outcomes. Investigation of combined or sequential screening approaches may yield improved diagnostic algorithms that balance sensitivity, specificity, and resource utilization.

Additionally, exploration of culturally adapted versions of these screening tools may enhance their validity in specific populations. Integration of emerging technologies, such as smartphone applications or wearable devices, with traditional screening methods represents another promising avenue for improving OSA detection in community settings.

Conclusion

This study evaluated the effectiveness of three screening tools—Epworth Sleepiness Scale (ESS), Stop Bang Questionnaire (SBQ), and Adjusted Neck Circumference (ANC)—in predicting Obstructive Sleep Apnea (OSA) against polysomnography as the gold standard. Our findings demonstrate that following standard diagnosis using polysomnography, both the ESS and SBQ provide acceptable levels of sensitivity and specificity for OSA screening, with the SBQ demonstrating superior overall accuracy (68%).

The ESS showed excellent specificity (88.9%) but limited sensitivity (41.8%), making it more suitable for confirming rather than excluding OSA. Conversely, the SBQ demonstrated higher sensitivity (72%) but lower specificity (33.3%), suggesting its utility as an initial screening tool to identify patients requiring further evaluation. The ANC method showed intermediate performance with moderate sensitivity (46.2%) and specificity (66.7%).

Significant associations were observed between OSA severity and both hypertension ($p<0.001$) and increased neck circumference ($p=0.049$), highlighting the importance of considering these clinical parameters in OSA risk assessment. The high prevalence of OSA (91%) in our referred population underscores the need for effective screening strategies in clinical practice.

Based on these findings, we recommend the implementation of the SBQ as the primary screening tool in general practice and primary healthcare settings to facilitate early identification of patients with high probability of OSA. The ESS may serve as a complementary tool when greater specificity is required. Additionally, clinicians should maintain a high index of suspicion for OSA in patients with hypertension and increased neck circumference.

Future research should focus on validating these findings in larger, more diverse populations and exploring combined or sequential screening approaches to optimize diagnostic accuracy while minimizing resource utilization. The development of culturally adapted versions of these screening tools may further enhance their validity in specific populations.

In conclusion, while polysomnography remains the gold standard for definitive diagnosis, the strategic use of screening tools, particularly the SBQ, can significantly improve the early detection and management of OSA, potentially reducing the burden of this common but often undiagnosed condition.

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